Co-evolution of innovative business models and sustainability transitions: The case of the Energy Service Company (ESCo) model and the UK energy system

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Submitted in accordance with the requirements for the degree of:

Doctor of Philosophy

October 2012

The University of Leeds

Sustainability Research Institute, School of Earth and Environment

Energy Research Institute, School of Process, Environmental and Materials Engineering

The candidate confirms that the work submitted is his own, except where work which has formed part of jointly-authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given within the thesis where reference has been made to the work of others.

> Hannon, M. J., Foxon, T. J., Gale, W. F. The co-evolutionary relationship between Energy Service Companies and the UK energy system: implications for a low-carbon transition (under review)

This paper essentially constitutes a concise version of my thesis. The chapters where there is greatest overlap between the paper and the thesis are Chapter 3: *Analytical Framework*; Chapter 6: *Sector Level and Case Study Analysis of ESCos in the UK*; Chapter 7: *Coevolution of the ESCo model and the UK energy system* and Chapter 8: *Future evolution of the ESCo model in relation to a low-carbon transition of the UK energy system*. I am lead author on the paper as it represents a publication that has been generated from my PhD studies. Consequently, in the paper I draw on my own analytical framework, empirical results and analysis. The paper was written in conjunction with my supervisors, who were mainly responsible for helping to refine the structure and content of the paper. At the time of submission, the paper is under review.

> Bale, C.S.E., Foxon, T.J., Hannon, M.J., Gale, W.F., (2012) Strategic energy planning within local authorities in the UK: A study of the city of Leeds. *Energy Policy* (48) 242 - 251

This paper contains a brief section I personally wrote on the different ESCo business models Local Authorities might adopt to meet their political objectives. Consequently, the contents of this section are echoed in Chapter 6: Sector Level and Case Study Analysis of ESCos in the UK where reference is made to the different form of ESCo variants, in particular the Local Authority 'Arm's Length' ESCo variant. The paper is referenced accordingly.

Acknowledgements

This thesis could not have been written without the support of a number of people.

I would like to thank both Timothy Foxon and William Gale for always being available to share their wisdom, expertise and moral support. Whenever I required their advice they were always there to help. Furthermore, if it were not for them, I would not have had this opportunity to undertake this PhD. I owe a huge debt of gratitude to them for going above and beyond the role of supervisors. I would also like to thanks both Lucie Middlemiss and Andy Gouldson for their insightful input into the development of my thesis at critical times. Importantly, I would like to thank Andy and the *Centre for Climate Change, Economics and Policy* (CCCEP) for funding my final year, which ultimately enabled me to complete my thesis.

Beyond my research committee, I would also like to thank Ronan Bolton for his unwavering support over the last 3 years. He has played a crucial role as a sounding board throughout this research and his constructive feedback has been extremely valuable.

I would also like to thank all of the interviewees who made this research possible. Their cooperation was invaluable and I hope the insights provided by this thesis will prove both interesting and useful to them.

I am also hugely appreciative of both Edward Slaney's and David Varney's help and support during my studies and particularly the work opportunities they provided me with which enabled me to fund my studies.

Turning to my family and friends, I would like extend special thanks to Jane for first cultivating my interest in academic research and opening my mind to the possibility of undertaking a PhD. During this research she has continued to both support and challenge me, something I will always be grateful for.

I also would like to thank my parents who have supported me in every possible way, both prior to and during the writing of this thesis. Quite simply, without their help, I would not have been able to undertake this degree.

Finally, I would like to thank my dearest Katherine for constantly reminding me there is light at the end of the tunnel and for providing me with an escape when I needed one.

Abstract

There is a growing consensus that the current energy system we rely on is fundamentally unsustainable and that it will have to be transformed if we are to continue to satisfy our energy needs in the future. At present we have a poor understanding of the role that the development and implementation of innovative business models, designed to satisfy our energy needs in a sustainable manner, could play in facilitating a transition to a sustainable energy system. To improve this understanding, this thesis develops an analytical framework that integrates co-evolutionary and business model theories, and applies this framework to analyse the case of the Energy Service Company (ESCo) business model and the wider UK energy system.

The thesis begins by presenting the core characteristics of the ESCo business model and its key variants; its strengths and weaknesses; and the factors that have constrained and enabled the uptake of this sustainable business model. It then examines the coevolutionary relationship the ESCo model shares with the UK energy system to explain not only why the model has struggled to gain traction, compared to the incumbent Energy Utility company (EUCo) model, but also the role the ESCo model could play in a transition to a sustainable UK energy system.

In light of the empirical investigation, the research finds that the development and adoption of the ESCo business model could play a valuable role in facilitating transitions to sustainable energy systems. However, it is likely to struggle to gain traction due to ESCos' poor fitness with the prevailing selection environment, which can in part be attributed to the causal influence of the unsustainable, incumbent EUCo model. Conversely, worsening ecosystem crises, the introduction of supportive regulation and positive feedbacks associated with the adoption of this model by new and incumbent system actors could help the ESCo model to proliferate and thus, have an important influence on the transition to a sustainable energy system.

Table of Contents

1 FRAMING THE ENERGY CHALLENGE: THE PRESSING NEED FOR A TRANSITION TO A SUSTAINABLE ENERGY SYSTEM 1

1.1 INTRODUCTION 1
1.2 THE GLOBAL ENERGY DILEMMA 2
1.2.1 Climate Change 2
1.2.2 Energy Insecurity 3
1.2.3 Affordability of Energy Services 4
1.3 THE UK'S ENERGY DILEMMA 5
1.3.1 Carbon Intensity of Energy System 6
1.3.2 Energy Insecurity 10
1.3.3 Affordability of Energy 13
1.4 ACCELERATING THE TRANSITION TO A SUSTAINABLE UK ENERGY SYSTEM VIA THE IMPLEMENTATION OF SUSTAINABLE ENERGY BUSINESS MODELS 16
1.4.1 Business Models for Sustainable Development 17
1.4.2 Sustainable Energy Business Models 18
1.4.3 Sustainable Energy Business Models in the UK 19
1.4.4 The Need for Further Research 20
1.5 RESEARCH QUESTIONS 24
1.6 THESIS STRUCTURE 25

2 LITERATURE REVIEW: PERSPECTIVES ON SOCIO-TECHNICAL SYSTEM CHANGE AND THE IMPORTANCE OF BUSINESS MODEL INNOVATION 29

2.1 CHAPTER INTRODUCTION 29
2.1.1 Structure of Literature Review 29
2.2 SOCIO-TECHNICAL APPROACHES TO SYSTEM CHANGE 30
2.2.1 Social Shaping of Technology 31
2.2.2 Multi-Level Perspective on Socio-Technical Transitions 34
2.3 EVOLUTIONARY APPROACHES TO TECHNOLOGICAL, INDUSTRIAL AND ECONOMIC CHANGE 44
2.3.1 Variation, Selection & Retention of Non-biological Populations 44
2.3.2 Evolutionary Approaches to Non-Biological System Change 47
2.3.3 Co-evolution of Socio-Technical Dimensions 49
2.4 BUSINESS MODELS, BUSINESS MODEL INNOVATION AND SYSTEM CHANGE 57
2.4.1 The Business Model Concept 57
2.4.2 Business Model Innovation 61
2.4.3 Factors That Shape Business Models 65
2.4.4 How Business Models Shape their Environment 68
2.4.5 Business Model Positive Feedbacks 72

2.5 Sustainable Business Models 75

2.5.1 Product-Service Systems 75

2.5.2 The Impetus to Align Economic and Environmental Objectives 77

2.5.3 Barriers to Sustainable Business Models 79

2.5.4 Scope for Additional Research 80

2.6 Energy Service Contracting 81

2.6.1 Energy Supply Contracting 81

2.6.2 Energy Performance Contracting 82

2.6.3 Allocation of Risk and Revenue 84

2.6.4 Weaknesses of Energy Service Contracting 85

2.7 Chapter Summary 88

3 ANALYTICAL FRAMEWORK 89

3.1 A Framework for Business Model Characterisation 90

3.1.1 Potential Challenges of Adopting Business Model Framework 92

3.2 A Framework for Analysing Business Model and Socio-Technical System Coevolution 93

3.2.1 Potential Challenges of Adopting the Co-evolutionary Framework 96

3.3 Summary of Integrated Analytical Framework 98

4 METHODOLOGY 101

4.1 Research Strategy 101

4.1.1 Straussian Grounded Theory Approach 102

4.1.2 Qualitative Research Strategy 105

4.1.3 Summary of Research Strategy 106

4.2 Research Scope 108

4.3 Phased Empirical Investigation 109

4.3.1 Phase 1 – Sector Level Study of ESCo Market 110

4.3.2 Phase 2 – ESCo Case Studies 112

4.4 Data Collection 116

4.4.1 Phase 1 Data Collection 116

4.4.2 Phase 2 Data Collection 121

4.5 Data Analysis 123

4.5.1 Coding 123

4.5.2 Document Analysis 125

4.5.3 Case Study Analysis 126

4.6 Chapter Summary 127

5 EMPIRICAL CONTEXT: HISTORICAL DEVELOPMENT OF ESCOS IN THE UK ENERGY SYSTEM 129

5.1 1940s – 1980s: State Owned 130

5.2 1980 – 1990s: Privatisation 132

5.3 1990 - 2000S: LIBERALISATION 133

5.4 2000S – 2010S: SECURITY, AFFORDABILITY AND SUSTAINABILITY OF ENERGY SUPPLY 138

5.5 INTERNATIONAL COMPARISON OF UK ENERGY SERVICES MARKET 140

5.5.1 United States 140

5.5.2 Germany 141

5.5.3 France 141

5.6 CHAPTER SUMMARY 142

6 SECTOR LEVEL AND CASE STUDY ANALYSIS OF ESCOS IN THE UK 143

6.1 PHASE 1: SECTOR LEVEL 144

6.1.1 Core Characteristics of the ESCo Business Model 144

6.1.2 Comparison of ESCo and EUCo Models 158

6.1.3 Strengths and Weaknesses of the ESCo model 162

6.1.4 Key Drivers and Barriers to ESCo Model Adoption and Operation in the UK 164

6.1.5 Key ESCo Variants Operating in the UK 176

6.2 PHASE 2: 4 ARCHETYPAL ESCO CASE STUDIES 184

6.2.1 Thameswey Energy Ltd 186

6.2.2 MOZES 198

6.2.3 Honeywell 209

6.2.4 Energy Utility X 220

6.2.5 Cross-Case Analysis 230

6.3 CHAPTER SUMMARY 232

7 CO-EVOLUTION OF THE ESCO MODEL WITH THE UK ENERGY SYSTEM 235

7.1 EVOLUTION OF THE ESCO POPULATION 236

7.2 COEVOLUTIONARY INTERACTIONS 240

7.2.1 ESCos and Ecosystems 240

7.2.2 ESCos and Institutions 241

7.2.3 ESCos and Technology 244

7.2.4 ESCos and User Practices 246

7.2.5 Competition between ESCos and Energy Utilities 248

7.3 CHAPTER SUMMARY 255

8 FUTURE EVOLUTION OF THE ESCO MODEL IN RELATION TO A LOW-CARBON TRANSITION OF THE UK ENERGY SYSTEM 257

8.1 EXPECTED CHANGES TO THE ESCO POPULATION 257

8.2 FUTURE COEVOLUTIONARY INTERACTIONS 259

8.2.1 ESCos and Ecosystems 260

8.2.2 ESCos and Institutions 261

8.2.3 ESCos and Technology 263

8.2.4 ESCos and User Practices 265

8.2.5 Competition between ESCos and Energy Utilities 266

8.2.6 Summary ESCo Model's Role in a Low-carbon UK Energy System Transition 268

8.3 COMPARISON OF RESULTS WITH THE TRANSITION PATHWAYS NARRATIVES 270

8.4 POLICY RECOMMENDATIONS 273

8.4.1 Standardized Energy Service Contract Templates 273

8.4.2 City-level GHG emissions Targets 274

8.4.3 Better Accommodate Decentralised Generation in BETTA 274

8.4.4 Green Deal Recommendations 275

8.4.5 Alter Energy Company Obligations 276

8.4.6 Adjust OJEU Procurement Process 276

8.4.7 Landlord & Tenant Act 276

8.4.8 Low Carbon Skills Training Schemes 277

8.4.9 General Policy Recommendations 277

8.5 CHAPTER SUMMARY 278

9 DISCUSSION: CONTRIBUTION OF THE RESEARCH TO THE WIDER LITERATURE 279

9.1 CONTRIBUTION OF RESEARCH TO WIDER LITERATURE 279

9.1.1 Socio-Technical System Change Literature 279

9.1.2 Sustainable Business Model Literature 284

9.1.3 ESCo Literature 287

9.2 CHAPTER SUMMARY 289

10 CONCLUSION 291

10.1 ADDRESSING THE RESEARCH QUESTIONS 291

10.2 STRENGTHS AND LIMITATIONS OF ANALYTICAL FRAMEWORK AND RESEARCH STRATEGY 299

10.2.1 Analytical Framework 299

10.2.2 Research Strategy 302

10.3 POTENTIAL AVENUES FOR FUTURE RESEARCH 303

11 BIBLIOGRAPHY 305

12 APPENDICES 329

12.1 APPENDIX A: A SECTION OF OSTERWALDER & PIGNEUR'S BUSINESS MODEL CANVAS 329

12.2 APPENDIX B: AN EXTRACT FROM A CODED INTERVIEW 330

12.3 APPENDIX C: HISTORICAL STRUCTURE OF THE UK ELECTRICITY SECTOR 331

12.4 APPENDIX E: PHASE 1 – SECTOR-LEVEL INTERVIEWEES 332

12.5 APPENDIX F: PHASE 2 - CASE STUDY INTERVIEWEES 333

12.6 APPENDIX G – A LIST OF ESCOS OPERATING IN THE UK 334

List of Tables

Table 2.1 Exchange of Personnel as a Causal Mechanism of Evolutionary Change and Its Effect on the Evolution of Industries and Academic Disciplines (Murmann, 2012 p.17) 53

Table 2.2 The 9 Building Blocks of a Business Model (adapted from Osterwalder & Pigneur 2010) 59

Table 2.3 Comparing energy supply and energy performance contracting (adapted from Helle, 1997, Sorrell, 2007, Sorrell, 2005) 84

Table 4.1 Summary of Research Phases 109

Table 4.2 Case studies of ESCo variants conducted for Phase 2 115

Table 6.1 – Phase 1, sector-level investigation of UK ESCo activity 144

Table 6.2 Typical key ESCo partners 153

Table 6.3 Detailed account and comparison of EUCo & ESCo business models 161

Table 6.4 Key drivers to ESCo adoption and operation in the UK 167

Table 6.5 Legend for ESCo Drivers Table 167

Table 6.6 Key barriers to ESCo adoption and operation in the UK 170

Table 6.7 Legend for ESCo Barriers Table 170

Table 6.8 Overview of interviews conducted for the 4 ESCo case studies 184

Table 6.9 Key Facts and Figures for Thameswey Energy 186

Table 6.10 Key Facts and Figures for MOZES 198

Table 6.11 Key Facts and Figures for Honeywell UK 209

Table 6.12 Key Facts and Figures for Energy Utility X 220

Table 10.1 The core characteristics of the ESCo business model according to Osterwalder & Pigneur's (2010) 9 business model building blocks framework 292

Table 12.1 Market structure of the UK electricity sector during periods of nationalisation, privatisation and liberalisation (adapted from Pond, 2006) 331

List of Figures

Figure 1.1 Global anthropogenic GHG emissions in 2004 (IPCC, 2007b) 3
Figure 1.2 Global GHG emissions by sector in 2004 (IPCC, 2007b) 3
Figure 1.3 Total energy real end-use price index for industry and households (IEA, 2012b) 5
Figure 1.4 Triumvirate of UK energy dilemmas and policy solutions (DECC, 2012e) 6
Figure 1.5 Carbon dioxide emissions by source, 1990-2011 (DECC, 2012b) 7
Figure 1.6 Electricity Generation Mix for 2011 (DECC, 2012i) 7
Figure 1.7 Indicative annual percentage emissions reductions required to meet the legislated carbon budgets (CCC, 2012a) 8
Figure 1.8 Homes in Great Britain with cavity wall insulation and loft insulation: April 2007 to April 2012 (Thousands) (DECC, 2012v) 9
Figure 1.9 CO_2 emissions under pre-recession trend versus required reductions (1990 – 2050) (CCC, 2011) 10
Figure 1.10 UK Energy Import Dependency 1970 to 2011 (DECC, 2012v) 11
Figure 1.11 Fuel price indices for the domestic sector in the UK: 1980 – 2011 (DECC, 2012v) 14
Figure 1.12 Baseline projections of the number of households in fuel poverty under the Lower Income High Cost (LIHC) and fuel poverty indicators 1996 to 2016 (millions) (Hills, 2012a) 15
Figure 2.1 A map of key contributions and core research strands in the field of sustainability transition studies (Markard et al., 2012) 31
Figure 2.2 The basic elements and resources of socio-technical systems (Geels, 2004) 35
Figure 2.3 Multi-level perspective on transitions (Geels and Schot, 2007) 36
Figure 2.4 Three typical positive feedbacks in socio-technical systems (Hekkert et al., 2007) 51
Figure 2.5 Exchange of Personnel as a Causal Mechanism of Evolutionary Change and Its Effect on the Evolution of Industries and Academic Disciplines (Murmann, 2012) 53
Figure 2.6 An illustration of the techno-institutional complex that fosters lock-in in electric power networks 54
Figure 2.7 Foxon's (2011) coevolutionary framework 55
Figure 2.8 Southwest Airlines' activity system (Porter, 1996) 59
Figure 2.9 Apple's Business Model (Osterwalder and Pigneur, 2010) 60
Figure 2.10 Environmental factors that determine business model characteristics (Osterwalder, 2004) .67
Figure 2.11 Three examples of positive feedbacks in relation to Ryanair's business model (Casadesus-Masanell and Ricart, 2010) 74
Figure 2.12 Mobility product service systems (Kley et al., 2011 adapted from Tukker 2004) 77
Figure 2.13 Differentiation between forms of Energy Utility and Energy Service contracting (adapted from Sorrell, 2007) 83
Figure 2.14 Illustration of rebound effect for consumers 87

Figure 3.1 An integrated analytical framework illustrating the coevolutionary relationship between novel and incumbent business models and the various dimensions of the wider socio-technical system (adapted from Foxon, 2011, Norgaard, 1994) ... 98
Figure 4.1 The Straussian Grounded Theory Approach (Ezzy, 2002) ... 103
Figure 4.3 Visual representation of key stages of research strategy ... 106
Figure 4.4 NVivo screenshot of ESCo case study coding structure ... 125
Figure 5.1 Overview of BETTA market structure (National Grid, 2006) ... 135
Figure 6.1 Integral and Peripheral ESCo Partnerships ... 154
Figure 6.2 An ESCo's revenue and cost model for a basic Energy Performance Contract (adapted from Sorrell, 2005) ... 156
Figure 6.3 Energy efficiency of CHP compared to conventional sources of heat and power generation (shown in units of power) (Carbon Trust, 2010) ... 157
Figure 6.4 An ESCo's revenue and cost model for a basic Energy Supply Contract ... 158
Figure 6.5 An illustration of the Green Deal process (BRE, 2012) ... 172
Figure 6.6 Illustration of how carbon price floor is likely to work under the EMR (in real 2009 prices and calendar years) (DECC, 2012e) ... 175
Figure 6.7 Local Authority 'Arms' Length' ESCo ... 177
Figure 6.8 Energy Services Provider ESCo ... 179
Figure 6.9 Community Owned and Run ESCo ... 182
Figure 6.10 Organizational structure of Woking Borough Council's Thameswey Group (Thameswey, 2012b) ... 187
Figure 6.11 Woking town centre CHP plant (WBC, 2007c) ... 190
Figure 6.12 Albion Square PV canopy, next to Woking railway station (Smith, 2007b) ... 190
Figure 6.13 A map of the Greater Meadows area. The yellow denotes MOZES's catchment area and the red the wider Meadows area (MOZES, 2012g) ... 198
Figure 6.14 Meadows housing after PV installation (MOZES, 2012e) ... 201
Figure 6.15 Examples of the energy efficiency lighting and boilers installed at Gwent Healthcare NHS Trust (Brind, 2008) ... 210
Figure 6.16 The 4 stage process of Honeywell's EPC (Petersen, 2009) ... 212
Figure 7.1 The coevolutionary relationship between the ESCo & EUCo business models and the wider UK energy system ... 240
Figure 7.2 Positive feedback loop involving customer awareness and understanding of the ESCo model ... 247
Figure 7.3 Positive feedback loop between Energy Utility population and UK regulatory framework ... 250
Figure 7.4 Co-evolution of ESCo and Energy Utility populations, focusing on financial institutional arrangements ... 252
Figure 7.5 Co-evolution of ESCo and Energy Utility populations, focusing on electricity market institutional arrangements ... 254
Figure 8.1 Government energy R&D expenditures 1990 to 2010 (IEA, 2012a) ... 263

Figure 8.2 An emerging positive feedback loop between ESCo population and energy technologies.... 265
Figure 8.3 Positive feedback loop involving Energy Utility movement into the ESCo market................ 267
Figure 8.4 Electricity generation mix in the *Thousand Flowers* pathway (Foxon, 2012) 272

List of Acronyms and Abbreviations

AC	Alternating Current
BETTA	British Electricity Trading and Transmission Arrangements
BMI	Business Model Innovation
BIS	Department for Business, Innovation & Skills
CAQDAS	Computer-Assisted Qualitative Data Analysis Software
CCC	Committee on Climate Change
CCS	Carbon Capture & Storage
CEGB	Central Electricity & Gas Board
CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Programme
CFL	Compact Flourescent Lightbulb
CHP	Combined Heat and Power
CHPA	Combined Heat and Power Association
CIC	Community Interest Community
CRC	Carbon Reduction Commitment Energy Efficiency Scheme
CSR	Corporate Social Responsibility
DC	Direct Current
DECC	Department for Energy and Climate Change
DH	District Heat
DNO	Distribution Network Operator
DTI	Department for Trade and Industry
DUKES	Digest of United Kingdom Energy Statistics
ECCC	Energy & Climate Change Committee
ECO	Energy Company Obligation
EEC	Energy Efficiency Commitment
EMR	Electricity Market Reform
EPC	Energy Performance Contract
ESC	Energy Supply Contract
ESCo	Energy Services Company
EUCo	Energy Utility Company
EST	Energy Saving Trust
ESTA	Energy Service & Technology Association
EU	European Union
EUETS	European Union Emissions Trading Scheme
FIT	Feed-in tariff
GD	Green Deal
GDP	Gross Domestic Product
GIB	Green Investment Bank
GHG	Greenhouse Gas
GW	Gigawatt
HMG	Her Majesty's Government
HVAC	Heating, Ventilation, and Air-Conditioning
ICT	Information & Communications Technology
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	International Panel on Climate Change
KW	Kilowatt
LA	Local Authority
LDA	London Development Agency
LED	Light Emitting Diode
LIHC	Lower Income High Cost
LNG	Liquefied Natural Gas
LTS	Large Technical Systems
MLP	Multi-level Perspective
MOZES	Meadows Ozone Energy Services
MPT	Meadows Partnership Trust

MUSCO	Mullti-Utility Service Company
MW	Megawatt
NEA	National Energy Action
NEP	Nottingham Energy Partnership
NETA	New Electricity Trading Arrangements
OECD	Organisation for Economic Co-operation and Development
OFGEM	Office of the Gas & Electricity Markets
OJEU	Official Journal of the European Union
ONS	Office for National Statistics
PFI	Private Finance Initiative
PSS	Product Service System
PV	Photo-voltaic
R & D	Research & Development
REC	Regional Electricity Company
RHI	Renewable Heat Incentive
ROC	Renewable Obligation Certificate
RQ	Research Question
SCOT	Social Construction of Technology
SEB	Strategic Energy Body
SGT	Straussian Grounded Theory
SME	Small to Medium Sized Enterprise
SPV	Special Purpose Vehicle
SSE	Scottish & Southern Energy
SST	Social Shaping of Technology
ST	Socio-Technical
STS	Science & Technology Studies
TEL	Thameswey Energy Limited
TNO	Transmission Network Operator
UK	United Kingdom
WBC	Woking Borough Council

1 Framing the Energy Challenge: The Pressing Need for a Transition to a Sustainable Energy System

1.1 Introduction

This thesis examines how the implementation of innovative business models, designed to satisfy our energy needs in a more environmentally and economically sustainable manner than incumbent business models, could help to facilitate transitions to sustainable energy system states. This line of enquiry has been adopted because even though such models already exist in niche applications, little research to date has explored the reasons why novel, sustainable energy business models have failed to proliferate. Furthermore, little is known about how the wide-scale uptake of novel sustainable energy business models might influence the wider energy system and crucially, how important their role could be in facilitating a transition to a sustainable energy system.

Why ask these questions now? The international and UK national energy system has in recent years begun to exhibit signs of being fundamentally unsustainable, as energy security has waned and energy prices have risen. Furthermore, the energy system constitutes a major emitter of greenhouse gases (GHGs) and consequently an important contributor to anthropogenic climate change, the effects of which could be devastating for the human race. As such there is a pressing need to identify a means of moving towards an alternative energy system that enables us to fulfil our basic human needs (e.g. hygiene, nutrition, warmth etc) in a more sustainable manner than offered by the incumbent system. To help illustrate what characteristics such a sustainable energy system might exhibit, we draw upon Nakicenovic and Grubler's (2000) research to outline how such a system would operate as a means to:

- provide the means and capabilities for present and future generations to satisfy their basic needs, as well as present them with the opportunity to make choices about their lives, beyond the fulfilment of these basic needs
- provide present and future generations with the capacity to adapt to changing social, economic and environmental conditions
- avoid catastrophic events and irreversible changes that threaten the life support functions of the earth

In this introductory chapter we outline the scale of the 'energy challenge' facing the global community, focusing in particular on key sustainability issues relating to climate change, as well as energy insecurity and affordability. Subsequently, we focus in particular on (1) how this challenge has affected the UK, (2) the ways in which the UK government has sought to address these issues through coordinating the activities of key energy stakeholders and (3) the effectiveness of this response in addressing this challenge. We then discuss the potential importance of sustainable energy business models in facilitating a transition towards a sustainable energy system, outlining how further research in this area would make a valuable contribution to the sustainability transitions literature and in doing so, helping to make the case for the project reported here.

Subsequently, we introduce the Energy Service Company (ESCo) business model, which forms the unit of analysis for this research considering that it has come to be considered by a number of scholars as one that constitutes a significantly more environmentally and economically sustainable way of fulfilling our energy needs (Fawkes, 2007, Marino et al., 2011, Vine, 2005, Hansen, 2009) even though it has enjoyed only niche applications in the UK to date. In contrast, the incumbent Energy Utility Company (EUCo) model remains dominant despite major concerns having been raised in relation to its own sustainability credentials (Eyre, 2008, Steinberger et al., 2009, York and Kuschler, 2011). Drawing on these insights we identify the key research questions this thesis seeks to answer, with the view of ultimately improving our understanding of the role the ESCo model is likely to play in the transition to a sustainable UK energy system. Finally, we outline the overall structure of the thesis.

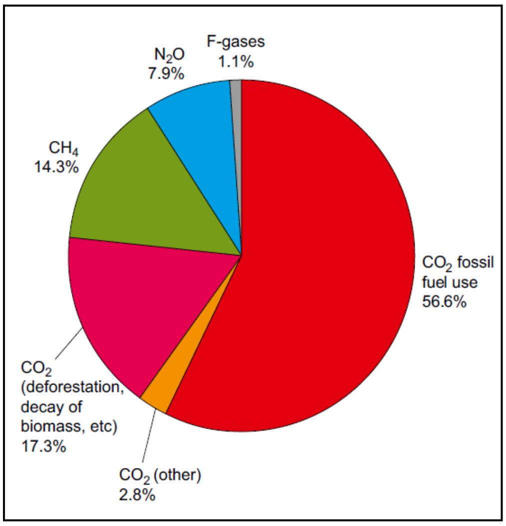
1.2 The Global Energy Dilemma

Globally we are facing a triumvirate of energy related challenges that together pose not only a threat to the welfare of the human population but also to the health of our natural environment. These challenges include growing energy insecurity, the rising cost of energy services (and the associated increasing incidence of fuel poverty) and the effects of climate change and environmental degradation, which have recently been referred to as the ‘energy trilemma’ (WEC, 2011, E.On, 2012). We proceed to explore each of these and the threat they represent.

1.2.1 Climate Change

Climate change has steadily come to be recognised by the international community as a serious threat to the welfare of the humankind, as mounting evidence indicates that the release of anthropogenic GHGs into the atmosphere will lead to an increase in global average surface temperatures, the contraction of snow and ice cover, rising sea levels, a greater frequency of extreme weather events (e.g. flooding, droughts etc) and significant changes in precipitation levels for different areas (IPCC, 2007a). These climatic perturbations are likely to undermine the integrity of the various ecosystems humans rely on to survive, which are for instance likely to lead to major disruptions to both food and water supply.

Today we are extremely reliant on the combustion of fossil fuels to obtain the necessary energy to satisfy a broad range of our human needs. For instance, in 2010 approximately 87% of global primary energy consumption was sourced from coal, gas and oil (BP, 2012). The release of CO_2 from the combustion of fossil fuels has been identified as the largest source of anthropogenic GHG emissions and thus a key driver of climate change. For example in 2004, 56.6% of anthropogenic emissions were made-up of CO_2 from fossil fuel use (IPCC, 2007b)(Figure 1.1). As illustrated by Figure 1.2 (IEA, 2012b), the energy supply sector represents the largest emitting sector, contributing to 25.9% of global GHG emissions in 2004 (IPCC, 2007b). The combustion of fossil fuels has also been linked to other adverse environmental effects, such as air pollution attributable to the release of gases such as sulphur dioxide and nitrogen oxide (Skea et al., 2011), which have also been associated with ecosystem degradation.



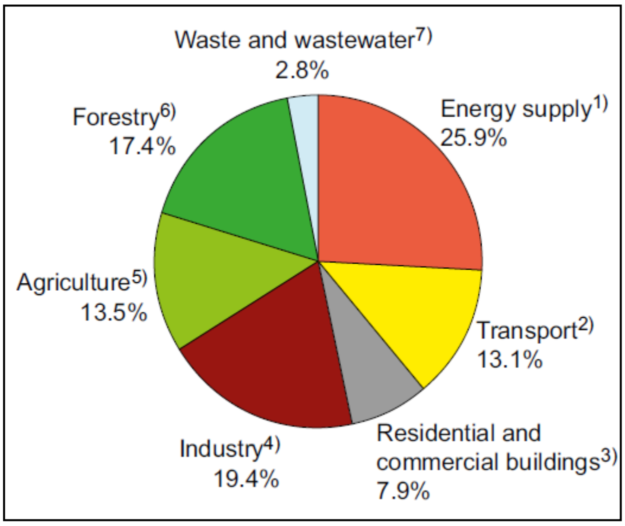


Figure 1.1 Global anthropogenic GHG emissions in 2004 (IPCC, 2007b)

Figure 1.2 Global GHG emissions by sector in 2004 (IPCC, 2007b)

1.2.2 Energy Insecurity

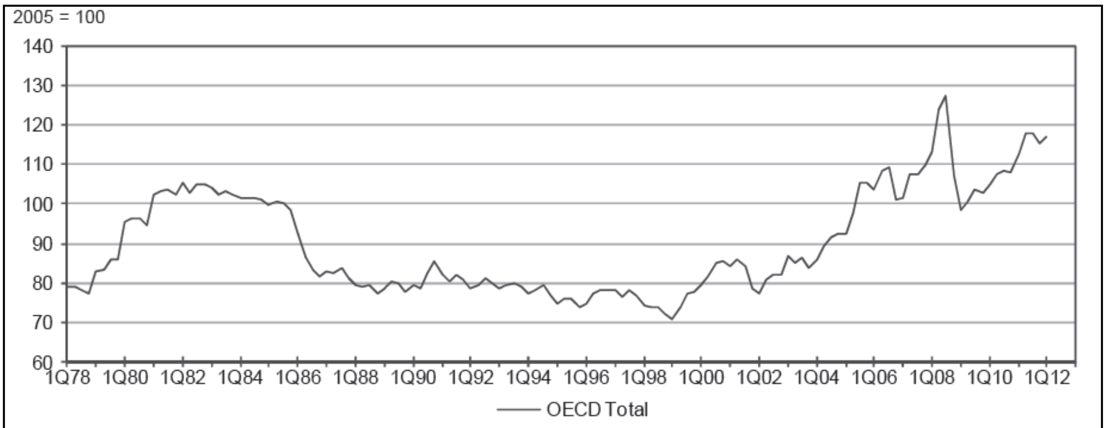
As outlined in Section 1.2.1, globally we are extremely reliant on fossil fuels to satisfy our energy needs, however reserves of these fuels are finite. Furthermore, levels of energy consumption have risen dramatically in recent decades and this trend is expected to continue. For instance, global primary energy consumption increased by a factor of 20 since the middle of the nineteenth century (Nakicenovic and Grubler, 2000) and if the current trend of energy consumption continues, by 2030 global energy consumption is expected to have increased by a further 39%, compared to 2010 levels (BP, 2012). Together these developments mean that we are fast approaching a time at which we will be unable to satisfy global levels of energy demand by continuing to rely on fossil fuel derived energy. This has resulted in a drive towards identifying alternative methods to source fossil fuels in order to address this looming gap between supply and demand, such as hydraulic fracturing for shale gas and deep-sea oil extraction. However, many of these represent relatively immature forms of fossil fuel extraction, which have proven in recent years to be potentially hazardous, as illustrated by the shale-gas 'fracking' induced earthquakes in Blackpool (Green et al., 2012) and the Deep Water Horizon incident in the Gulf of Mexico (NOAA, 2012). Furthermore, even if we assume that these technologies will ultimately be successful, they still represent only a short-term solution because fossil fuels represent a finite resource. Consequently, if we remain reliant on fossil fuels, energy insecurity will grow once again in the future as the availability of these reserves once again diminishes.

In addition to this, energy security is closely aligned with the stability of geopolitical relationships between net energy importer and exporter nations. Political instability within or between such nations is not normally conducive to energy security as these tend to lead to volatility in the energy markets and in some cases, significant disruptions in energy supply. For example, the Yom Kippur war and the Iranian revolution played an important role in the emergence of the global energy crises in the 1970s (BP, 2011, Thomas, 1996). Political instability and strained geopolitical relations between key energy importer and exporters continue to exist today, as illustrated by the recent Iraq war and sanctions imposed again Iran. It is expected that similar developments are likely to emerge in the future, considering that 'as oil and gas become more expensive and scarce, boundary disputes in resource-rich areas rise in importance' (Renner, 2006 p.58), thus placing further strain on the energy security of nations that are reliant on imports in the future.

These examples serve to illustrate the scale of the energy security challenge we face, consequently underlining the need to utilise a wider range of energy sources and implement energy efficiency measures in order to reduce our reliance on these finite energy reserves.

1.2.3 Affordability of Energy Services

Alongside the growing scarcity of fossil fuels we have witnessed large increases in some energy prices in recent years. Figure 1.3 illustrates this global trend and how since the late-1990s energy prices have broadly increased. Heinberg (2011) explains that the era of cheap, easy energy is over and that this can in part be explained by the growing scarcity of fossil fuels, encapsulated by the era of Peak Oil[1]. These price rises have had the effect of making some energy services sufficiently expensive that some consumers will find it difficult to afford to fulfil many of their basic human needs associated with access to energy (e.g. nutrition, warmth, hygiene).



Key point: Consumer prices fell dramatically between the third quarter of 2008 and the first quarter of 2009, but have been climbing steadily since then.

Figure 1.3 Total energy real end-use price index for industry and households (IEA, 2012b)

To summarize, there is mounting evidence to indicate that the global energy system is exhibiting signs of being fundamentally unsustainable when we consider the mounting challenges of energy insecurity, rising energy prices and climate change. These developments have led to a call from both environmental groups (e.g. Greenpeace, Friends of the Earth) and numerous national governments (e.g. European Union, Australia, Japan etc) to move away from this system towards a fundamentally more sustainable one, which is considerably less reliant on the combustion of fossil fuels than the present energy system. Having outlined these challenges globally, we now turn to the UK to explore how it has been affected by these developments, as well as the ways in which key energy stakeholders have sought to address these challenges and the level of success the UK has had in doing so.

1.3 The UK's Energy Dilemma

The UK has broadly been subject to the same triumvirate of issues outlined in the previous section, consequently having an important bearing UK energy policy (Figure 1.4):

> 'We face two long-term energy challenges [in the UK]: (1) tackling climate change by reducing carbon dioxide emissions…and (2) ensuring secure, clean and affordable energy as we become increasingly dependent on imported fuel' (DTI, 2007 p.6)

[1] Peak Oil 'is a term that summarizes the concept that the production of crude oil —as well as that of most finite resources in a market economy grows, reaches a maximum (peak),and then gradually declines to zero' (Bardi, 2009 p.323)

These pressures have placed a significant pressure on the UK government to initiate a radical transformation of its energy system in order to address these issues:

> 'In Britain, as our own reserves in the North Sea decline, we have a choice: replace them with ever-increasing imports, be subject to price fluctuations and disturbances in the world market and stick with high carbon; or make the necessary transition to low carbon, [which is] right for climate change, energy security and jobs' (HMG, 2009 p.v)

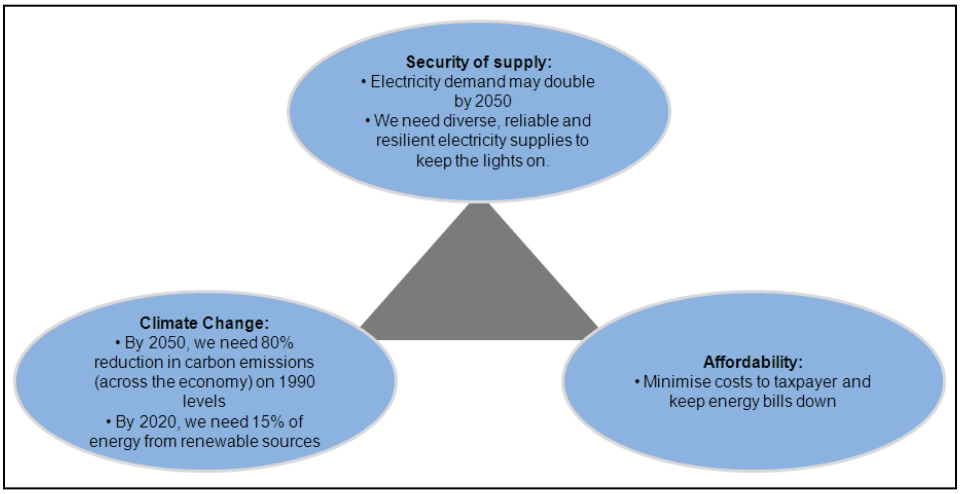


Figure 1.4 Triumvirate of UK energy dilemmas and policy solutions (DECC, 2012e)

In this section we outline how these issues have manifested themselves in the UK and briefly describe the approach the UK government has adopted to tackle these. We outline the progress the UK has so far made in addressing these challenges and crucially, that change is not currently happening at the rate required to ensure these long-term energy challenges are addressed in a timely manner. Consequently, in the subsequent section we identify one particular area of innovation that could help to accelerate the transition to a more sustainable energy system: the development and implementation of novel business models, designed to satisfy our energy needs in a sustainable manner.

1.3.1 Carbon Intensity of Energy System

1.3.1.1 Current Situation

As has been the case globally, the UK's energy supply sector represents the single largest contributor to the UK's anthropogenic GHG emissions, accounting for approximately 40% of total emissions in 2011 (DECC, 2012b) (Figure 1.5). This can also be attributed to the UK's dependence on fossil fuels to satisfy its energy needs, with gas and coal accounting for approximately 70% of the UK's electricity generation in 2011 (DECC, 2012i) (Figure 1.6). Consequently the energy sector has become a focal point for government policy designed to drive decarbonisation.

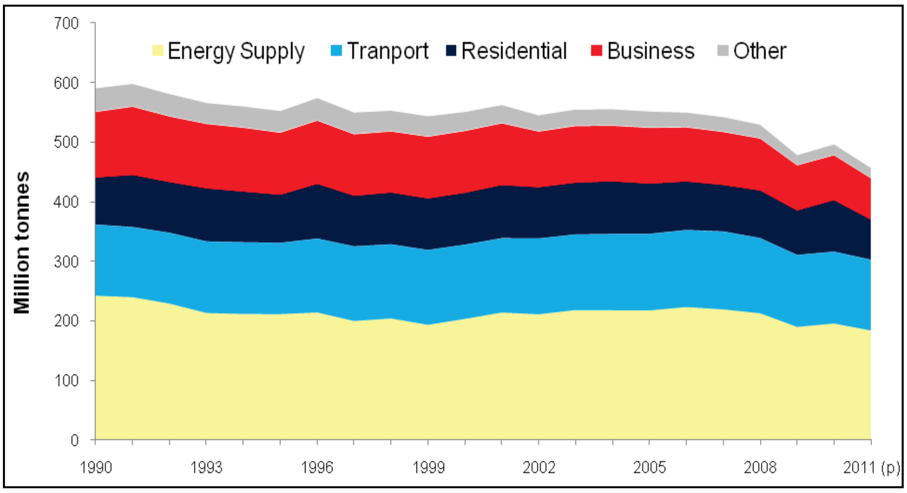


Figure 1.5 Carbon dioxide emissions by source, 1990-2011 (DECC, 2012b)[2]

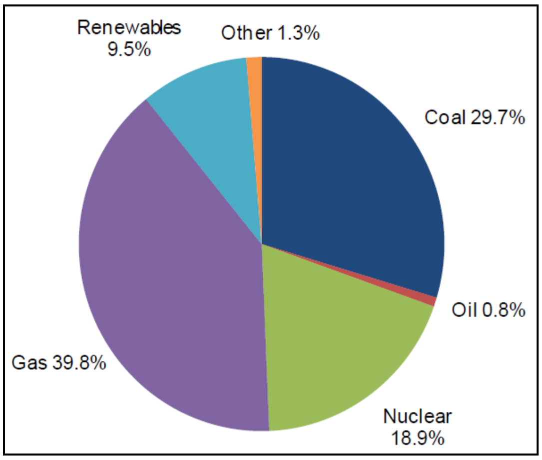


Figure 1.6 Electricity Generation Mix for 2011 (DECC, 2012i)

1.3.1.2 Progress Towards Decarbonisation

In 2008 the UK introduced the Climate Change Act, which mandated the government to achieve a 34% reduction in UK Greenhouse Gas (GHG) emissions by 2020 and an 80% reduction by 2050, compared to 1990 levels (Crown, 2008 p.509). These reductions are enforced through a series of carbon budgets, set up to 15 years in advance, which are designed to help the UK meet its 2020 and 2050 GHG reduction targets (Figure 1.7).

[2] Data for 2011 is provisional

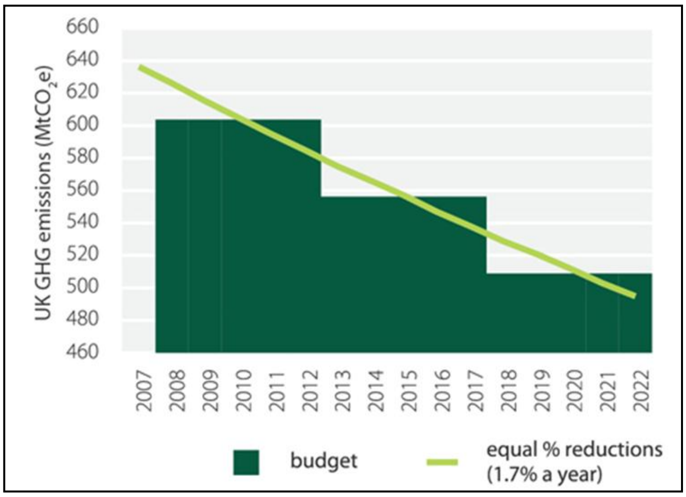


Figure 1.7 Indicative annual percentage emissions reductions required to meet the legislated carbon budgets (CCC, 2012a)

As part of the strategy to decarbonise the energy system and achieve these targets, the UK government has sought to improve the efficiency of the UK's energy conversion, distribution, and transmission infrastructure, as well as encourage changes to user practices, which are both concomitant with reducing energy consumption (Section 5.4). Efficiency measures are especially important considering that fossil fuels are likely to remain an important part of the UK's energy mix for the foreseeable future and so a reduction in energy consumption will equate to a reduction in fossil fuel consumption (HMG, 2010). One example of a government policy designed to promote energy efficiency are the 'ambitious minimum performance requirements (in terms of carbon emissions) for new buildings were introduced in 2010 and will be gradually made stricter so that by 2016, all new-built dwellings will be zero-carbon' (IEA, 2012a p.13). Obligations on energy suppliers to reduce the carbon emissions associated with their domestic energy supply represent another example (Section 5.4).

The UK's overall energy efficiency levels for households improved by 14.4% between 2000 and 2009 (Odyssee, 2012). This increase can in part be attributed to major improvements in household energy efficiency level where between April 2008 and 2012 an extra 47% of homes were fitted with loft insulation and another 31% with cavity wall insulation (DECC, 2012v)[3] (Figure 1.8). However, to date only 2% of homes with wall cavities had been fitted with solid wall insulation (DECC, 2012j). These statistics reveal that although progress has been made to improve the energy efficiency of the UK's housing stock, millions of homes remain without these basic forms of efficiency measures.

[3] It is estimated that 60% of homes had been installed with loft insulation and 59% of homes with cavity wall insulation by the start of 2012 (DECC, 2012j)

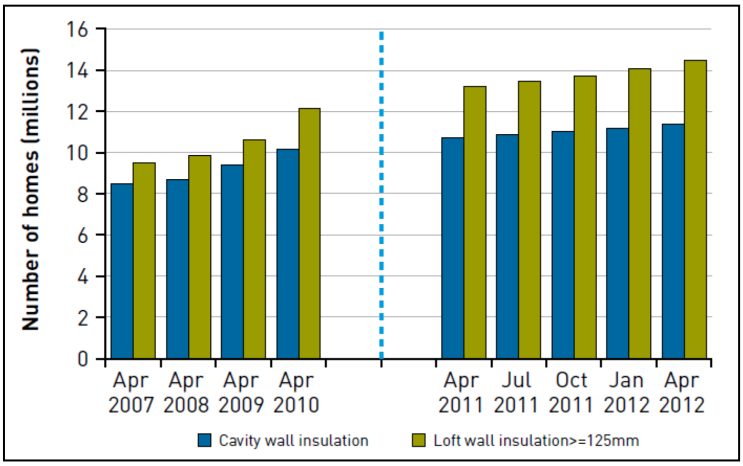


Figure 1.8 Homes in Great Britain with cavity wall insulation and loft insulation: April 2007 to April 2012 (Thousands) (DECC, 2012v)

The UK government has also sought to initiate a shift towards satisfying our energy needs via less carbon intensive fuels. Consequently, 'the share of renewable energy in the United Kingdom's total primary energy supply (TPES) has increased significantly in recent years, from 1.5% in 2003 to 3.7% in 2010' (IEA, 2012a p.103), largely due to a growth in renewable generation, which represented 9.4% of total electricity generation in 2011. Despite these gains, the UK is making slow progress towards meeting the EU Energy Directive target of meeting 15% of its energy needs (for electricity, heating and transport) from renewable energy sources by 2020. For instance, in 2010 the UK missed its interim renewable electricity generation target of 10%, achieving only 6.5% (Constable and Moroney, 2011).

Provisional figures indicate that the UK has so far delivered a 24% reduction in its energy supply sector's CO_2 emissions by 2011, compared to 1990 levels (DECC, 2012a) (Figure 1.5). However, this achievement cannot be wholly attributed to the UK government's low-carbon strategy, but to other developments such as the severe economic downturn in the UK, which reduced economic activity and thus the demand for energy (CAMECON, 2011, CCC, 2011). Additionally, this reduction can also be explained by the UK's 'dash for gas' during the 1990s (Green Alliance, 2011), which arose predominantly due to the government's privatization and liberalisation strategy (Parker, 1996) (Sections 5.2 & 5.3), and resulted in significant replacement of generation of electricity from coal with generation from gas.

1.3.1.3 The Challenge Ahead

Despite the reductions in GHG emissions described in the last section, both Cambridge Econometrics (2011) and the Committee on Climate Change (CCC) (2011) have in recent years expressed major concern that the current pace of decarbonisation will be insufficient to ensure the UK meets its 2020 and 2050 GHG emissions reduction targets, as illustrated in Figure 1.9..

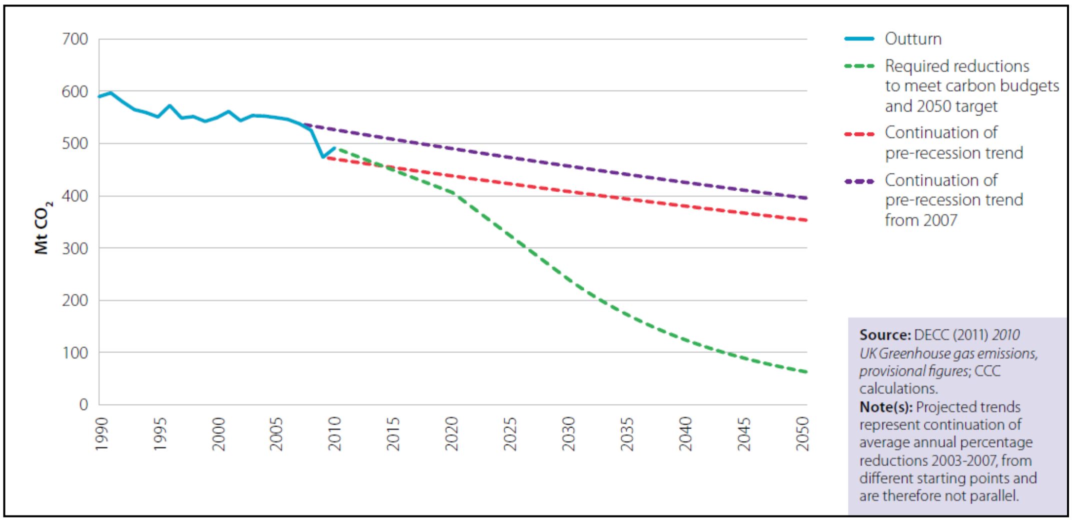


Figure 1.9 CO_2 emissions under pre-recession trend versus required reductions (1990 – 2050) (CCC, 2011)

In the CCC's *Progress Report to Parliament*, they indicated that the UK has to date made valuable progress towards meeting both its first and second carbon budgets. However, they were clear that a step change in the UK's approach was urgently needed if it was to remain on track to meet its future carbon budgets. In particular, they emphasised the need for the UK to initiate a move from its low-carbon transition policy development phase to its low-carbon transition delivery phase (CCC, 2012c).

1.3.2 Energy Insecurity

The UK government's Energy and Climate Change Committee (2012) define a secure energy system as one 'that is able to meet the needs of people and organisations for energy services such as heating, lighting, powering appliances and transportation, in a reliable and affordable way both now and in the future' (p.1). In this sub-section we focus on reliability of supply and in the subsequent sub-section (Section 1.3.3) we focus on affordability of supply.

1.3.2.1 Current Situation

The UK used to be a net importer of energy during the 1970s. However, following the discovery of oil and gas in the North Sea and the subsequent development of the infrastructure necessary to capture and refine these fuels, it became a net exporter during most of the 1980s and 1990s, as well as the first half of the 2000s (DECC, 2011g) (Figure 1.10). This began to change when the North Sea oil and gas reserves began to dwindle and production consequently fell, meaning that it returned to being a net importer of energy in 2004 and has remained so since (DECC, 2011g).

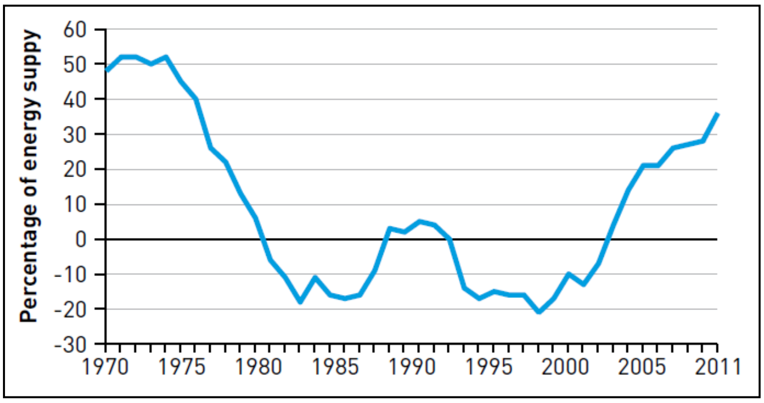


Figure 1.10 UK Energy Import Dependency 1970 to 2011 (DECC, 2012v)

The UK's energy demand has increasingly been met by imports, such as Norwegian and Continental gas via pipeline, as well as liquefied natural gas (LNG) via tanker (DECC and OFGEM, 2011). However, 'import reliance, although neither new to the UK nor uncommon around the world, can bring additional risks of disruption to supply sources' (DECC and OFGEM, 2011 p.29) because geopolitical disputes between countries, which may or may not involve the UK, can interrupt fuel supply through conflict, trade embargos etc. For example, the conflict between Russia and Ukraine in 2009 (ECCC, 2011) and the Libyan war in 2011 (Allen, 2012), resulted in disruption of fossil fuel supplies.

The UK's energy security concerns are compounded by the prospect of 19 GW of its existing electricity generation capacity being discontinued by 2020 (DECC and OFGEM, 2011). This will largely be a result of many existing coal and oil fired power plants failing to meet modern environmental standards and a number of nuclear plants being decommissioned (DECC and OFGEM, 2011). Therefore, the UK will have to make swift arrangements to replace this generation capacity over the coming decade and also stimulate significant reductions in electricity demand to improve the security of its energy supply.

1.3.2.2 Progress Towards Improving Energy Security

The government's strategy to address the UK's energy insecurity has in recent years predominantly revolved around forming (1) international supply agreements, (2) renewing and diversifying the UK's generation capacity portfolio, as well as (3) reducing energy demand via energy efficiency measures (ECCC, 2012, DECC, 2012h, Allen, 2012). Focusing on the first of these, the UK has moved to avoid potential disruptions of energy supply from other countries by forging bi-lateral and multi-lateral international agreements with key suppliers that the UK has traditionally shared healthy international relations with. For example, the UK has signed agreements with: Iceland for the supply of geothermal power (DECC, 2012u), France for nuclear electricity (DECC, 2012f) and Norway for gas (DECC, 2012q).

The government has also moved to improve the UK's energy security by improving the energy efficiency of its generation, transmission, distribution and end-use infrastructure, as a means of helping to reduce the UK's energy demand. The logic employed here is that 'the most secure energy is the energy you do not use' (ECCC, 2012 p.2), i.e. the UK's energy needs will be easier to satisfy if it requires less energy, as this means that less energy has to be sourced either nationally or internationally (see Section 1.3.1.2. for examples of efficiency improvements).

The government has also sought not only to renew but to diversify the UK's energy supply portfolio as 'the key to secure energy supplies is to have in place a diverse range of reliable sources of supply' (ECCC, 2012 p.5). This strategy is designed to ensure that the UK does not become over-reliant on certain technology and fuel types, which may prove problematic in the future due to unforeseen circumstances (e.g. disruption to fuel supply, technological malfunctions, impact of external events etc). Furthermore, diversification will enable the UK to take full advantage of its abundant, indigenous renewable energy resources, such as wind, wave and tidal power (ECCC, 2012). The UK has already signalled its intent to install 21.5GW of new electricity generation capacity by 2020, which will more than replace the 19GW due for decommissioning and include a mix of fossil fuel, nuclear and renewable generation (DECC and OFGEM, 2011). Approximately, 4.3 GW of gas generation and 3.6 GW of renewable generation capacity is currently being built with a further 13.2 GW granted planning permission, of which 8.7 GW is gas-fired generation and 3.7GW is renewable (DECC and OFGEM, 2011). Plans are also in place to deliver approximately 16GW of nuclear capacity by 2025 (DECC, 2012p).

1.3.2.3 The Challenge Ahead

Despite the strides the UK has made towards improving its energy security, a secure supply of energy is by no means assured for the UK as it continues to be predominantly reliant on fossil fuels to fulfil its energy needs (Figure 1.6), which are typically sourced from other countries (Figure 1.10). Looking forward, the withdrawal of E.On and RWE Npower's from Horizon Nuclear Power, a private-sector led scheme designed to deliver an additional 6.6GW of new nuclear capacity to replace much of the capacity due for decommissioning, has cast doubts upon the prospects of the UK moving away from its dependence on fossil fuel (DECC, 2012g). However, the Horizon scheme has recently been purchased by Hitachi Ltd of Japan, consequently improving the prospects of new nuclear generation capacity being constructed in the UK over the next decade (Horizon Nuclear Power, 2012).

With respect to reducing the UK's demand for energy, some minor progress has been made towards reducing its total energy consumption in the last couple of years (DECC, 2012v) but concerns have been raised that the regulatory and market arrangements currently in place do not present sufficient incentives for industry to deliver the necessary measures to improve levels of energy security (DECC and OFGEM, 2011), nor do they cultivate sufficient incentives for households and businesses to engage with such measures (Wicks, 2009).

Considering the UK's slow progress towards diversifying its energy supply portfolio and reducing its energy demand, it seems very likely the UK will continue to be reliant on imports of fossil fuels for many years to come. However, the UK sources much of its energy from countries that have a history of politically instability and/or with whom the UK has had a history of strained international relations with, such as Libya and Yemen for oil, Egypt for gas and Russia for coal (DECC, 2011b, DECC and OFGEM, 2011). It is likely that intra and international conflict will continue to be a feature of the global political landscape in the future, meaning that the UK will remain exposed to the risk of disruptions to supply for the foreseeable future. This emphasises the need to identify innovative ways of providing market actors with a lasting incentive to engage in measures that will help to diversify the UK's portfolio of energy generation; harness indigenous sources of non-finite, renewable energy and deliver efficiency measures that will ensure demand is kept at a sustainable level, which can be realistically met by secure energy sources.

1.3.3 Affordability of Energy

1.3.3.1 Current Situation

In recent years energy prices have risen dramatically in the UK. For instance, between 2001 and 2011 real prices for domestic energy rose by 82% (Figure 1.11), whilst industrial electricity prices rose by approximately 77% and gas by 95% (DECC, 2012v). This has meant that the cost associated with satisfying a variety of basic human needs (e.g. warmth, lighting, communication etc) has increased, which has made it difficult for some consumers to afford to satisfy these needs despite previously being able to do so. Rising energy prices coupled with a fall in real wages due to the severe economic downturn in the UK (Fender, 2012), has meant that millions of households have been plunged into fuel poverty[4] in recent years. For instance, between 2004 and 2010 there was an increase of 2.75 million households in fuel poverty[5] (DECC, 2011g). These households are often faced with the dilemma of having to choose

[4] A household is fuel poor if 'in order to maintain a satisfactory heating regime, they need to spend more than 10% of their income on all household domestic fuel use' (DECC, 2011g p.17)
[5] In 2010, this figure stood at 4.75 million households (DECC, 2011g)

between which of their basic needs they will satisfy. This dilemma is often referred to as the 'heat or eat'[6] phenomenon (see Beatty et al., 2011).

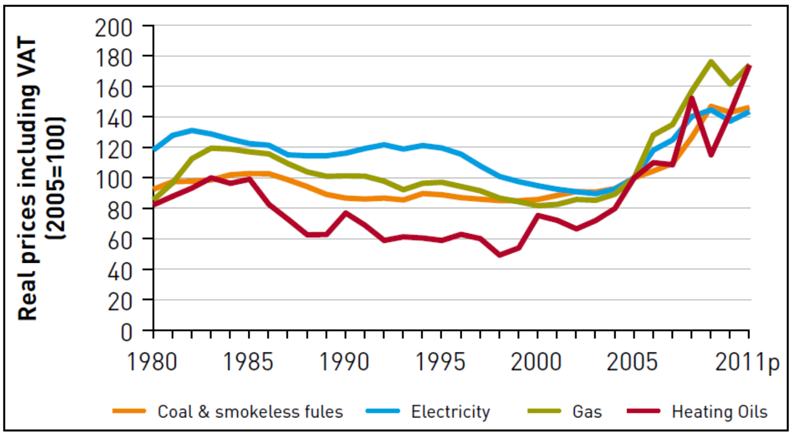


Figure 1.11 Fuel price indices for the domestic sector in the UK: 1980 – 2011 (DECC, 2012v)[7]

1.3.3.2 Progress Towards Making Energy More Affordable

The UK has made some recent progress towards alleviating fuel poverty, having reduced the number of households in fuel poverty by 750,000 between 2009 and 2010. DECC has partly attributed this fall in fuel poverty to improvements in the energy efficiency of the UK's housing stock such as the installation of loft and cavity wall insulation (DECC, 2012m) (Section 1.3.1.2). These measures have meant that many households are now able to satisfy their energy needs at a lower cost, as the efficiency gains have meant that they can purchase less energy but still enjoy the same quality and quantity of energy services (e.g. light, heat etc).

The UK government has also sought to make energy more affordable by promoting competition in the UK energy markets via privatisation and liberalisation as a means of encouraging the cost-effective supply of energy (Allen, 2012, ECCC, 2012, Wicks, 2009) (Sections 5.2 & 5.3):

> 'In competitive markets companies have less power to influence market prices through their own individual actions, and therefore they are less able to pass through cost increases [to their customers]. They therefore have a constant incentive to reduce costs in order to increase the margin on their sales and/or extend their market share' (Wicks, 2009 p.91)

[6] This specifically refers to a fuel poor householder having to choose between maintaining a comfortable room temperature or enjoying a healthy diet

[7] Data for 2011 is provisional

1.3.3.3 The Challenge Ahead

The cost of fossil fuels (i.e. oil, gas and coal) is projected to either increase or remain high until 2030 (DECC, 2011a), partly due to an increased demand for energy from emerging economies (Allen, 2012) such as China, Brazil and India. Furthermore, energy bills are also expected to rise due to the cost associated with the UK government's proposed energy policies to tackle the UK's energy dilemma (DECC, 2010d). Projections for economic growth also remain bleak (IMF, 2012), placing a downward pressure on real-term wages. Taking these factors into account it is expected that fuel poverty will rise over the coming years, with the central projection of a high-profile, fuel poverty focused research project envisaging that 8.1 million households will be considered fuel poor by 2016 (Hills, 2012a) (Figure 1.12), compared to 4.75 million in 2010 (DECC, 2011g).

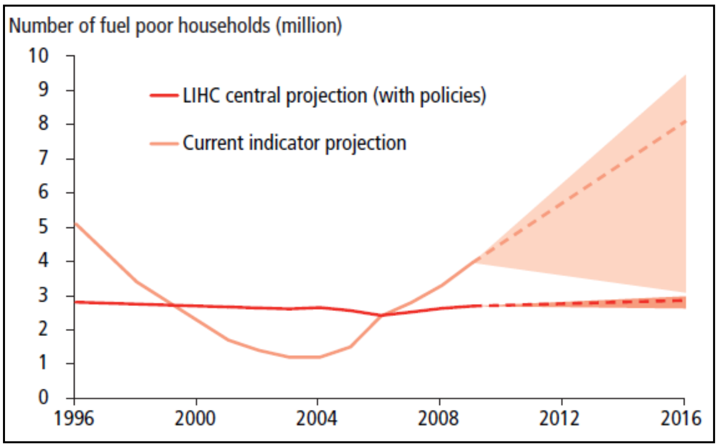


Figure 1.12 Baseline projections of the number of households in fuel poverty under the Lower Income High Cost (LIHC) and fuel poverty indicators 1996 to 2016 (millions) (Hills, 2012a)

Despite the scale of the challenge facing us, Hills (2012b) explains that there is a way forward to address these issues:

> 'This daunting problem is one with solutions. Our analysis shows that improving the housing of those at risk is the most cost-effective way of tackling the problem, cutting energy waste, with large long-term benefits to society as a whole. We need a renewed and ambitious strategy to do this' (p.2)

This underlines the need to identify innovative methods in the future that will encourage the uptake of demand management measures, such as the installation of more efficient boilers, insulation and double glazing, alongside the promotion of more frugal energy consumption behaviour via education schemes, which will help to reduce or at least, stabilize the cost of energy to consumers.

1.4 Accelerating the Transition to a Sustainable UK Energy System via the Implementation of Sustainable Energy Business Models

The UK government has moved to address this triumvirate of energy challenges, i.e. carbon intensity, insecurity and affordability of the UK's energy supply (Section 1.3), primarily by taking steps to increase the UK's renewable energy generation capacity and energy efficiency levels (Ekins, 2010). Despite some valuable progress having been made towards a sustainable energy system in the UK, the transition has not yet gone far enough to have resolved these issues, as outlined in Section 1.3. The pace of this transition remains too slow and must be quickened if we are to ensure that the UK will meet its mandatory GHG emissions reductions targets to avert irreversible climate change (CCC, 2011), as well as to ensure that we 'keep the lights on and avoid blackouts becoming a feature of daily life' (Davey, 2012). The message is clear, if the UK is to achieve a transition to a more sustainable energy system within the timescale required, it must identify and implement a suite of innovative policy, market and technological solutions that will help to facilitate this transformation.

To date much of the research exploring the factors driving system change and sustainability transitions has centred upon the role of technological innovation (Holtz et al., 2008, Edquist, 2005). However in recent years, a growing number of scholars have emphasised the potential for non-technological innovation to play an important role, alongside technological innovation, in driving forward system change and thus sustainability transitions (Steward, 2008, Steward, 2012, Witkamp et al., 2011, Bergman et al., 2010, Edquist, 2005):

> 'Traditionally, innovation studies have, to a large extent, focused upon technological process innovation and to some extent upon product innovations, but less on non-technological and intangible ones, i.e. service product innovation and organizational process innovations…non-technological forms of innovation deserve more attention' (Edquist, 2005 p.185)

Steward (2008, 2012) explains that in order to successfully deliver sustainability transitions we should focus on the development and implementation of 'system innovations', which incorporate a multitude of complementary technological and non-technological innovations (e.g. institutional, social, cultural etc), and which involve a myriad of societal actors. He argues this mix of innovation is required if we are to fundamentally change the way people think about production and consumption, and most importantly reconfigure the 'normal way of doing things' (2008 p.5). Making reference to past system transitions such as the Industrial Revolution and the emergence of today's IT centric society, Steward (2008, 2012) explains that an important aspect of these system innovations will be the design and implementation of novel business models:

> 'In practice the most significant emission reducing innovations in the decade to 2020 will draw on existing technologies. Therefore innovation that embraces novelty which is non-technological in nature, such as business models and services will be of primary importance.' (Steward, 2012 p.337)

Extending this logic we briefly introduce the concept of sustainable business models before explaining their relevance to a sustainability transition of the UK energy system.

1.4.1 Business Models for Sustainable Development

As we explore in detail in Section 2.4.1, a business model represents a story of what it is an organisation believes their customers want, how they want it, how it believes it should organize itself and interact with others to best meet those desires, and in turn, how it will generate revenue by being compensated for doing so (Johnson et al., 2008, Teece, 2010, Magretta, 2002, Johnson, 2010). In essence, a 'business model describes the rationale of how an organization creates, delivers and captures value' (Osterwalder and Pigneur, 2010 p.14) by fulfilling the needs or desires of its customers.

A sustainable business model can be defined as one where sustainable development plays an integral role in shaping the core objectives of the firm and consequently its decision making (Wicks, 1996, Stubbs and Cocklin, 2008). Such business models therefore incorporate a value proposition that reflects a balance between economic, ecological and social needs (Boons and Lüdeke-Freund, 2012) and organisations practicing such models therefore seek 'to deliver economic, social and environmental benefits…through core business activities' (Wilson et al., 2009 p.1). A business operating a sustainable business model typically creates, delivers and captures value in a truly sustainable way by providing products and services that improve the quality of people's lives but do so within environmental limits (Uren, 2010). We elaborate upon the concept of a sustainable business model in Section 2.5.

A number of scholars have emphasised the need to incorporate the development and implementation of novel business models into strategies designed to promote sustainable development (Johnson and Suskewicz, 2009, Nidumolu et al., 2009, Wells, 2006), which has been echoed by high-profile institutions such as the European Commission and McKinsey & Company (Bonini and Gorner, 2011, COWI, 2008):

> 'Greater spread and application of innovation in business models that reduce resource use has the potential to create multi-billion euro markets in the EU and overseas and bring very substantial environmental and economic benefits' (COWI, 2008 p.3)

> 'Companies should integrate environmental, social, and governance issues into their business model—and act on them…Our research finds that a handful of companies are capturing significant value by systematically pursuing the opportunities sustainability offers' (Bonini and Gorner, 2011 p.12)

Considering the potential of novel business models to promote sustainable development, the development and implementation of novel business models for energy provision has been considered as a means of helping to address the challenges facing the UK and global energy system, as outlined in Sections 1.2 and 1.3.

1.4.2 Sustainable Energy Business Models

The design and implementation of novel sustainable energy business models has been considered by a number of leading scholars (Wüstenhagen and Boehnke, 2008, Szatow et al., 2012, Saunders et al., 2012, Munns, 2008) and energy institutions (Valocchi et al., 2010, IEA, 2010, COWI, 2008) who emphasise the range of economic, social and environmental benefits that the implementation of innovative, sustainable business models could provide, by reconciling the traditionally divergent objectives of sustainable development and the fulfilment of our energy needs. Specifically, the International Energy Agency has highlighted how the design of novel business models could represent a particularly important factor in promoting the uptake of sustainable energy technologies:

> 'A large proportion of breakthrough innovations come from new firms that challenge existing business models [and so the] growth of new firms may have an important part to play in low-carbon energy technology development…and the transition from demonstration to commercial deployment' (IEA, 2010 p.7-8)

This view is echoed by Wüstenhagen and Boehnke (2008) who emphasise that novel business models could help to commercialize innovative, low-carbon energy technologies by overcoming key barriers to adoption such as (1) the power of incumbent energy companies; (2) the capital intensity and long-lead times of new energy technologies and (3) the failure to internalize the cost of environmental degradation in market prices. More broadly they underline their importance in promoting sustainable energy production and consumption practices:

> '[We emphasise] the importance of new business models for enhancing sustainable production and consumption in the energy sector, particularly with regard to successful commercialisation of distributed energy systems' (Wüstenhagen and Boehnke, 2008 p.77)

We now discuss the extent to which the development and implementation of sustainable energy business models has been considered in the context of the UK energy system to date.

1.4.3 Sustainable Energy Business Models in the UK

At present the dominant business model for satisfying consumers' energy needs in the UK is the Energy Utility (EUCo) model. A EUCo's business model dictates that their revenue increases with the number of units of energy they sell to their customers, which is often referred to as a volume-sales driver (Eyre, 2008). Energy Utilities are therefore not incentivised to minimize their customers' energy throughput via energy efficiency gains or behavioural change (Eyre, 2008, Steinberger et al., 2009, York and Kuschler, 2011) because investment in such measures would reduce their revenue and thus not provide a return on investment (York and Kuschler, 2011). This disincentive is reflected in the tariffs most Energy Utilities offer their customers, in which the latter are invited to pay a lower rate for any energy they consume beyond a predefined level of consumption (Hulme and Summers, 2009). Additionally, the Utilities also source the majority of their energy supply from fossil fuels, such as gas and coal (Friends of the Earth, 2011), meaning their energy supply has a high GHG emissions content. These examples help to illustrate how the EUCo model does not satisfy consumers' energy needs in a sustainable manner.

Considering the failure of this incumbent energy business model to reward the fulfilment of consumers' energy needs in a sustainable manner, and the potential economic, social and environmental benefits associated with the application of novel, sustainable energy business models, scholars examining the transition to a sustainable UK energy system have also called for the need for further examination of this topic:

> 'Making fuller use of renewable energy means capitalising on the diversity of scales, technologies and business models for deployment, so socially beneficial solutions suited to local and regional circumstances can be found' (Watson et al., 2010 p.12)

> 'Seeking out cost effective efficiency is vital because there could be major welfare losses associated with forcing down energy demand through the price mechanism…a careful look at the business models for delivering energy efficiency, particularly the

role of the utilities vis-à-vis local authorities and others, is needed' (Ekins et al., 2010 p.352)

We now outline the need for further research on this topic and how this thesis will seek to address these requirements.

1.4.4 The Need for Further Research

Despite the range of environmental, economic and social benefits novel sustainable business models could potentially provide, they have to date only 'been utilised to [a] limited extent, with a very unequal distribution, between different countries and industries' (COWI, 2008 p.3). The reasons for this are not well understood and neither are the ways in which the proliferation of such models could promote sustainable development predominantly because 'despite its fundamental significance, the business model has been neglected in academic and practitioner-oriented literature on corporate sustainability and corporate sustainability management' (Schaltegger et al., 2011 p.15-16). Consequently, 'the design and management of sustainable business models [represents] an important but yet insufficiently researched area' (Boons and Lüdeke-Freund p.9). Business models have largely been ignored within the socio-technical transitions literature, where scholars have traditionally focused on the interplay between niche technological innovations and socio-technical systems, as opposed to non-technological innovations, such as business models (Section 1.4). The potential role of business models has also been neglected by scholars engaged in sustainable energy (Johnson and Suskewicz, 2009), providing us with little insight into the role these models could play in facilitating transitions to sustainable energy systems. Consequently, we find that the business management, sustainability transitions and energy literature would all benefit from further research into the development and implementation of sustainable energy business models.

We argue that in order to help address the deficiencies in the literature, it is important to begin by developing a more detailed understanding of the characteristics of specific sustainable energy business models. Amongst other insights, this will better equip us to understand the strengths and weaknesses of these models, from the perspective of both the firms operating these models, as well as their key partners and crucially, their customers. This insight is essential if we are to understand whether or not these models are likely to proliferate in the future. Additionally, a clearer understanding of these models' characteristics will afford us the opportunity to then explore the extent to which these business models have co-evolved with the key dimensions of the wider energy system (e.g. institutions, technologies, user practices, ecosystems and business models). In turn this would provide us with valuable insight into not only the factors that enable and inhibit the uptake of sustainable energy business models but crucially, the influence such models could have on transitions to more sustainable energy system states. In summary, we argue that there is a pressing need to explore (a) the core characteristics of novel, sustainable energy business models; (b) their strengths and weaknesses; (c) the factors responsible for enabling and inhibiting the uptake of such models and finally, (d) how their uptake could help to facilitate sustainability transitions. In order to help address these deficiencies in the literature, we examine one business model in particular; the Energy Service Company (ESCo) model.

The EU Directive 2006/32/EC on Energy End-use Efficiency and Energy Services (EU, 2006) defines an ESCo as follows:

> 'A natural or legal [entity] that delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria' (p.6)

We select this model as our unit of analysis because it has been identified as a potentially financially viable means of fulfilling our energy needs in such a way that is sympathetic to the challenges of climate change, energy security and affordability (Fawkes, 2007, Marino et al., 2011, Vine, 2005, Hansen, 2009, Fang et al.) as outlined in Sections 1.2 & 1.3. Unlike an Energy Utility, an ESCo's revenue is not predicated upon the sale of units of energy (e.g. gas and electricity), but on the provision of energy services; i.e. the physical benefit, utility or good people derive from energy (EU, 2006). So ESCos provide *useful energy streams* (e.g. hot water, coolant etc) and/or *final energy services* (e.g. light, heat, motive power etc) to their customers via energy service contracts (Sorrell, 2007). They traditionally deliver these services by engaging in a range of sustainable energy supply and demand management measures that provide significant production cost savings (e.g. equipment and fuel costs) on their customer's energy bill (Sorrell, 2007), enabling ESCos to fulfil their customers' needs at a similar or lower cost compared to passively buying energy units via energy utilities. These measures entail an increase in levels of renewable energy generation and/or energy efficiency, leading to a significant reduction in the GHG emissions associated with fulfilling their energy needs (Marino et al., 2011).

In the context of the UK, the ESCo model was first introduced in the mid-1960s (Fawkes, 2007, Iqbal, 2009). However, despite the ESCo model having received significant attention from both industry and academia as a means of promoting sustainable energy production and consumption practices (Bertoldi et al., 2006b, Fawkes, 2007, Marino et al., 2011, Smith, 2007a, Sorrell, 2007) (Section 5), the ESCo model has so far failed to become a major component of UK energy system. However, the UK energy landscape and thus the selection environment of both ESCos and the Energy Utilities are beginning to change from one which has traditionally favoured the incumbent Energy Utility Company (EUCo) model. The current and emerging selection environment appears to be more conducive to ESCo operation than was once the case due to recent developments in the UK, such as the emergence of a low-carbon regulatory framework as outlined in Section 1.3. Taking this situation into consideration, it is possible that the ESCo model could proliferate in the future and thus play a more important role in the UK energy system over the coming years than at present.

Some valuable research has already examined the core characteristics of the ESCo model (see Fawkes, 2007, Marino et al., 2011, Smith, 2007a, Sorrell, 2005, Sorrell, 2007), its strengths and weaknesses (Sorrell, 2007, Ellis, 2010) and the drivers and barriers to its adoption (Marino et al., 2011, COWI, 2008, Vine, 2005, Westling, 2003, Ellis, 2010) and with respect to the UK, the role it could potentially play in a transition to a sustainable energy system (Foxon, 2012, Sorrell, 2005). One of our major criticisms of the current literature is the lack of research that applies in-depth, rigorous empirical methodologies for examining ESCo activity (Fawkes, 2007, Smith, 2007a, Boait, 2009). Another is the lack of research focusing on ESCo activity specifically in the UK. Furthermore, much of the research that does meet these two criteria was conducted some years ago (Sorrell, 2005, Chesshire and Watson, 2000), meaning that despite its high-quality, it is somewhat out-of-date considering the pace with which the regulatory framework has changed in recent years. Through an in-depth and up-to-date empirical investigation of ESCo operation in the UK energy system, this thesis seeks to make a series of important contributions to the ESCo literature by examining following:

- the core characteristics of the ESCo business model via a holistic analysis of the interdependent activities, components and the linkages between these that enable an ESCo to create, deliver and capture value for the provision of sustainable energy services. The thesis also outlines the different types of ESCo operating in the UK
- the strengths and weaknesses of the ESCo model and its variants from the perspective of the organisation operating the business model and the customers it engages with
- the enabling and inhibiting factors the ESCo model and its variants are subject to
- the co-evolutionary relationship between the ESCo population and the wider energy system to help provide insight into (a) how the UK energy system has causally influenced the evolution of the ESCo population, particularly the uptake or selection of the ESCo model and (b) how the ESCo model has causally influenced the evolution of

the various dimensions that make-up the UK energy system and thus the impact it has had on the transformation of the UK energy system

- how the co-evolutionary dynamic between the ESCo population and the UK energy system is likely to change in light of emerging development and crucially, the role the ESCo model is likely to play in a transition to a sustainable UK energy system

An examination of the above would also make an important contribution to the following theoretical approaches, for the following reasons (we explore these discourses in Section 2):

- **Sustainable business model and Product Service System (PSS) literature** – A detailed examination of a sustainable, service-based business model (i.e. the ESCo model) will provide insight into (1) the core characteristics; (2) the strengths and weaknesses; (3) the factors supporting and inhibiting its take up, as well as (4) the contribution this model could make to sustainable development. More broadly this insight could help to improve our understanding of the characteristics of other similar, service-based sustainable business model, the extent to which these are likely to proliferate and the scale of the contribution they could potentially make to sustainable development
- **Business model innovation literature** – Beyond sustainability, an examination of the uptake and operation of an innovative business model in a heavily regulated, traditional sector such as the UK energy industry will provide insight into (1) the factors enabling and inhibiting business model innovation; (2) how business model innovation co-evolves with other forms of innovation (e.g. technological) and (3) how business model innovation can shape the business environment it is applied within
- **Co-evolutionary, socio-technical transitions and sustainability transitions literature** – A clearer understanding of the co-evolutionary relationship between organisational populations operating novel business models and the various dimensions of socio-technical systems will provide insight into the (1) factors (e.g. positive feedbacks, misalignment with regime etc) responsible for limiting the up-take of innovative, sustainable business models; (2) the environmental conditions that are necessary for them to proliferate and (3) how the uptake of such models could characterize socio-technical system change

1.5 Research Questions

The above ideas suggest that the development and wide-scale implementation of novel, sustainable business models, such as the ESCo model, could potentially play an important role in accelerating the transition to sustainable socio-technical system states because they possess the potential to ensure that consumers' basic human needs are satisfied in a more sustainable manner than incumbent business models, such as the EUCo model, whilst ensuring that businesses and their partners are also rewarded financially. Therefore, taking the ESCo model as our unit of analysis, the overarching research question of this thesis is as follows:

> **What role could the development and adoption of the Energy Service Company (ESCo) business model play in the transition to a sustainable UK energy system?**

This is an important, albeit broad question to answer and one that would therefore benefit from being divided into a number of sub-questions to help structure our enquiry and ensure this over-arching question is answered effectively, as follows:

1. What are the core characteristics of the ESCo business model and key variants of this model?

Here we seek to identify the system of interdependent activities and components that enable ESCos to create, deliver and capture value by satisfying their customers' energy needs. To highlight how the ESCo model is characteristically distinct from traditional energy business models, we examine the core characteristics of the incumbent EUCo model, comparing these with the ESCo model. We also seek to identify the core characteristics of key variants of the ESCo model, which share some characteristics common to all ESCos but are also characteristically distinct in other respects.

2. What are the strengths and weaknesses of the ESCo model and the key variants of this model?

Having identified the core characteristics of the ESCo model we explore the strengths and weaknesses of this model primarily from the perspective of the ESCo (or organisation considering becoming ESCos) and its customers. The same line of enquiry is explored for each of the ESCo variants identified, to understand their particular strengths and weaknesses.

3. How have the various key dimensions of the UK energy system causally influenced the evolution of the ESCo population?

4. How has the ESCo population causally influenced the evolution of the various key dimensions of the UK energy system?

Questions 3 and 4 are designed to examine the co-evolutionary relationship the ESCo population shares with the various key dimensions of the UK energy system (i.e. technologies, institutions, user practices, ecosystem, business models etc). Question 3 is designed to help provide valuable insight into the way in which these dimensions have causally influenced the evolution of the ESCo population, i.e. the factors responsible for characteristic variations in the ESCo population (*variation*); the extent to which the ESCo model has been adopted (*selection*), and the manner in which the characteristics of the ESCo model have been 'preserved, duplicated, or otherwise reproduced so that the selected activities are repeated on future occasions' (Aldrich and Ruef, 2006 p.23) (*retention*). Conversely, question 4 examines how the ESCo population has causally influenced the evolution of these various dimensions of the UK energy system.

5. How is the co-evolutionary relationship between the ESCo population and the UK energy system likely to change in the future?

Question 5 looks to the future and examines both recent and emerging developments in the UK energy system to provide clarity in relation to how the co-evolutionary relationship between the ESCo population and the various dimensions of the UK energy system is likely to change over the coming years. Drawing on this insight, we seek to address the overarching research question relating to the role the ESCo model could potentially play in a transition to a sustainable UK energy system.

1.6 Thesis Structure

Chapter 2 constitutes a detailed and critical review of the various literatures that provide valuable insight into to our research questions. The chapter begins with a review of the socio-technical transition literature and the associated evolutionary approaches to technological, industrial and economic system change, focusing in particular on the insight co-evolutionary approaches can provide into the nature of system change. The review highlights the lack of attention that has been paid by system change scholars to the role novel business models could potentially play in socio-technical transitions. Consequently, we turn to the business model and literature, focusing in particular on business model innovation, sustainable business models and Product Service Systems, to identify research that illuminates the role novel, sustainable business models could potentially play in sustainability transitions. Finally, we introduce the literature associated with our unit of analysis; the ESCo business model (as outlined in Section 1.5). The key purpose of this chapter is to identify the key gaps in these different literatures and how this research seeks to bridge these.

Chapter 3 presents our analytical framework, which integrates aspects of business model, socio-technical transitions and co-evolutionary theory outlined in the previous chapter. This develops an approach capable of providing insight into the co-evolutionary relationships between populations adopting novel, sustainable business model and the various dimensions of the wider socio-technical system. Here we also highlight the potential strengths and weaknesses of applying this framework.

Chapter 4 introduces the methodology this research employs to apply empirically the analytical framework, which employs a combination of qualitative methods for data collection and analysis, as well as Straussian Grounded Theory as an approach for theoretical development.

Chapter 5 explores the empirical context in which the research methodology will be applied by examining how the ESCo population has evolved historically, alongside key developments in the broader UK energy system.

Chapter 6 introduces the findings from our empirical investigation. Based on Phase 1 of the research, the sector level investigation of the UK ESCo market, we outline the core characteristics of the ESCo business model and compare these with the incumbent EUCo model. Subsequently, we highlight the strengths and weaknesses of the ESCo model, as well as the external factors that have served to enable and inhibit ESCo operation in the UK. We then identify how emerging developments are likely to impact upon the ESCo market before we introduce the key variants of the ESCo model that currently exist in the UK ESCo population. Finally we describe Phase 2 of the research, which relates to the case-study investigation of 4 characteristically distinct ESCos operating in the UK. This chapter addresses questions 1 & 2.

Chapter 7 applies our analytical framework to the evidence generated by our empirical investigation, presented in *Chapter 6,* to examine how the various dimensions of the UK energy system (ecosystem, institutions, user practices, technology and incumbent EUCo population) have causally influenced the evolution of the ESCo population and conversely, how the ESCo population has causally influenced the evolution of these dimensions. This chapter addresses questions 3, 4 & 5.

Chapter 8 draws on the insights generated from *Chapter 6 & 7* to discuss how recent and emerging developments are likely to alter the co-evolutionary relationship between the ESCo population and the UK energy system. The purpose of this discussion is to highlight the role the ESCo model is likely to play in a transition to a sustainable UK energy system. Here we also present a number of policy recommendations designed to promote uptake of the ESCo model

Chapter 9 reflects on the research's findings and situates these in the wider literature to illustrate the contributions this thesis has made to on-going debates in the wider literature.

Chapter 10 is the concluding chapter, where we concisely address our research questions, reflect upon the strengths and weaknesses of the research strategy and the analytical framework this research has employed and in turn introduce a number of potential avenues for future research.

2 Literature Review: Perspectives on Socio-Technical System Change and the Importance of Business Model Innovation

2.1 Chapter Introduction

The purpose of this chapter is to provide a critical review of the various literatures relating to the key perspectives on socio-technical system change, focusing in particular on the insight these provide into the factors responsible for shaping system transitions and specifically how novel, sustainable business models are capable of shaping sustainability transitions. Subsequently, we review the literature relating to business models and business model innovation, as well as sustainable business models and Product-Service Systems, primarily in order to provide insight into how these concepts could improve our understanding of the factors responsible for driving or inhibiting sustainable system change, as outlined by the socio-technical transitions and co-evolutionary literatures.

This chapter presents a critical review of these different literatures and in turn highlights how this research seeks to contribute towards the development of these approaches, particularly with respect to improving our understanding of the co-evolutionary relationship between novel business models and the various dimensions that make-up socio-technical systems. Consequently, this chapter acts as a necessary precursor to Section 3 where we introduce the analytical framework this research employs in order to address the research questions outlined in Section 1.5.

2.1.1 Structure of Literature Review

We begin by reviewing the socio-technical and evolutionary approaches to system change that explicitly deal with the processes responsible for triggering and shaping change within systems that have been developed by humans to fulfil societal functions, such as transport, communication, housing (Geels, 2004). Although related, we address the two bodies of literature separately as the socio-technical literature favours sociological explanations of system change, whilst the evolutionary economics literature emphasises the importance of evolutionary explanations (Foxon, 2011). Consequently in Section 2.2 we examine the socio-technical transitions literature, where we begin with an introduction to the Science and Technology Studies (STS) and Social Shaping of Technology (SST) literature, which laid the foundations for the socio-technical transitions literature. We follow this by exploring the multi-level perspective (MLP) on transitions, as well as its applications, strengths and weaknesses.

Following this we introduce the evolutionary and coevolutionary perspectives on system change in Section 2.3. Here we begin by outlining the key differences between approaches examining the evolution of biological system change versus other forms of system change. We also present some examples of how this approach has been applied before we turn to the coevolutionary literature and discuss how this has been applied to inform our understanding of socio-technical system change.

In Section 2.4 we turn to the business model literature and begin by defining the concept of the business model, also identifying the various criticisms that the business model concept has attracted. Next, we introduce the concept of business model innovation, which refers to the development of novel business models for satisfying our needs and desires. We also consider not only the factors that inhibit and support this form of innovation but also those that shape it. In line with the review of the literature on socio-technical system change we then explore the research that has analysed how business models can shape their environment. Finally, we combine these insights to explain how business models share a co-evolutionary relationship with their environment.

In Section 2.5 we narrow our focus to explore the sustainable business model and Product Service System (PSS) literature, to identify the types of sustainable models that have been developed to satisfy our human needs in a sustainable fashion. We discuss the impetus to align economic and environmental objectives within a single business model, as well as the barriers organizations may face in doing so. Subsequently, we identify opportunities for further research on the topic of sustainable business models and PSSs.

Finally, in Section 2.6 we turn our attention to the Energy Service Company (ESCo) model, which constitutes the unit of analysis for this research. Here we introduce the concept of energy service contracting and its associated strengths and weaknesses.

2.2 Socio-Technical Approaches to System Change

In this sub-section we critically review the socio-technical transitions approach and discuss the ways in which it has provided insight into how and why socio-technical systems undergo transitions from one system state to another. As this research considers how we might facilitate transitions to more economically and environmentally sustainable system states, we pay particular attention to how this approach has been applied to inform our understanding of the processes at play in transitions towards sustainable socio-technical system states.

As Figure 2.1 serves to illustrate, there are a large number of different but complimentary literatures that make-up the sustainability transitions field. The figure depicts a field that is still undergoing an intense period of development, particularly in light of the pressing need to develop sustainable socio-technical systems, such as in the context of energy (Section 1).

Consequently, it is not possible to provide a particularly coherent picture of the entire field because the literature is still in its formative stages. We therefore focus only on the strands, which we consider most relevant to this research, most notably the Multi-Level Perspective (MLP), which constitutes the main focus for this review of the sustainability transitions literature. We begin however, by introducing the Science and Technology Studies (STS) and Social Shaping of Technology (SST) literature, which the MLP can be considered to have emerged from.

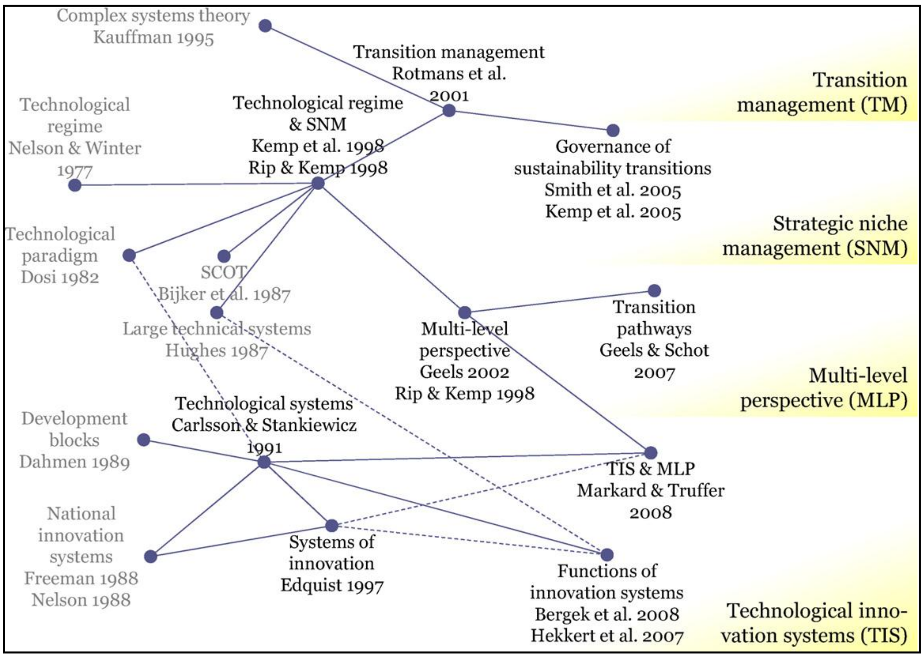


Figure 2.1 A map of key contributions and core research strands in the field of sustainability transition studies (Markard et al., 2012)

2.2.1 Social Shaping of Technology

The socio-technical approach to system change can be traced back to the emergence of the STS field, which 'starts from an assumption that science and technology are thoroughly social activities' (Sismondo, 2010 p.11). This approach emphasises that the individuals responsible for developing technologies (i.e. scientists, engineers etc) are members of communities, which exhibit certain institutions (e.g. practices, rules, conventions). These play an important role in determining the behaviour of these individuals and therefore, the characteristics of the technologies they develop. This jars with the technological essentialist position, which reduces technologies to their functions and raw materials (Feenburg, 1999). Instead STS teaches us that 'the actors in science and technology are…not mere logical operators, but instead have investment in skills, prestige, knowledge, and specific theories and practices' (Sismondo, 2010 p.11) and it is the purpose of STS to investigate 'how scientific knowledge and technological artefacts are constructed' (p.11). This approach therefore frames knowledge and artefacts as human products, which are indelibly marked by the circumstances under which they were produced and therefore we should be sensitive to the social world if we are to accurately understand the factors responsible for characterising technological change and its effects (Sismondo, 2010)

The Social Shaping of Technology (SST) approach (MacKenzie and Wajcman, 1985, Williams and Edge, 1996), emerged from Science and Technology studies, to focus on the social influence on technology as opposed to science. This development has come to be known as the 'turn to technology' (Woolgar, 1991). This body of literature also takes an anti-essentialist position, broadly rejecting the notion of the technological determinism, which is comprised of two key ideas, namely that technological development is autonomous and that societal development is determined by technology (Bijker, 1995). Mackay and Gillespie (1992) provide a comprehensive definition that helps to situate the anti-deterministic SST:

> 'Technological determinism is the notion that technological development is autonomous with respect to society: its shapes society, but is not reciprocally influenced. Rather, it exists outside society, but at the same time influences social change. In more extreme varieties of technological determinism, the technology is seen as the most significant determinant of the nature of a society' (p.686)

Rejecting the notion of technological determinism, the SST approach emphasises that both social and technical dimensions are intertwined (Bijker, 1995). Therefore, technology constitutes a social product, which is patterned by the conditions of its creation and use (Williams and Edge, 1996) and vice versa. Howcroft et al. (2004) explain that:

> 'SST both examines the content of technology and offers an exploration of the particular processes and context that frame the technological innovation. It achieves this with the provision of explanatory concepts that delve into a range of factors – organizational, political, social, economic and cultural – that pattern the design and use of technology' (p.329)

Specifically SST investigates the ways in which this range of factors shapes (1) the direction and rate of innovation; (2) the content of technological artefacts and practices; (3) and the social impact of technological change (Williams and Edge, 1996). It emphasises in particular how the social context in which technologies are developed not only shapes the characteristics of these technologies but also the impact they have on society (Williams and Edge, 1996).

One particular sub-strand of this approach that emerged was the Social Construction of Technology (SCOT) discourse, which has sought to identify how actors' choices between different technical options have helped to explain how certain technical designs have triumphed over others (Williams and Edge, 1996, Pinch and Bijker, 1984). Pinch and Bijker (1987) take the case of the bicycle to help illustrate this phenomenon and explain that the form of the modern bicycle cannot be entirely explained by the triumphing of technically superior designs over inferior designs but also the different meanings that various users attached to each of the bicycle designs, termed *interpretive flexibility*. In this case, actors' emphasis on a bicycle's function shifted from speed to safety over the years, which in turn had an important bearing on its evolution.

Hughes (1983, 1987) developed another sub-strand of the SST approach, which he termed Large Technical Systems (LTS). This approach investigates the 'seamless webs' of socio-technical elements that make-up infrastructure systems. These webs are composed not only of physical artefacts (e.g. electric transmission lines) but also organisations (e.g. manufacturing firms, investment banks, research and development laboratories), as well as natural and scientific resources (e.g. books, articles, regulation, university teaching programmes etc) (Hughes, 1987). Furthermore, LTS seeks to identify the system builders that are responsible for weaving these socio-technical components into a seamless web and consequently, a functioning whole.

Williams and Edge (1996) consider SST to represent a broad church, brought together by the critique of 'the linear model of innovation, deterministic concepts of the dynamic of technological development, and of its societal outcomes' (p.892), one which has been influential in emphasising the importance of the social in determining the nature of technical or technological change and vice versa. This discourse teaches us that these two dimensions are intertwined and that without considering these elements as an inter-dependent system, we run the risk of failing to understand the true nature of system change. In light of this Howcroft et al. (2004) explain that:

> 'There is no such thing as a social problem that does not have technological components; nor can there be a technological problem that does not have social components, and so any attempt to make such a division is bound to fail' (p.330)

Making reference to Fleck (1993), Geels (2005a) makes a similar point:

> 'Artefacts by themselves have no power, they do nothing. Only in association with human agency and social structures and organisations do artefacts fulfil functions. In real-life situations (e.g. organisations, houses, cities) we never encounter artefacts per se', but artefacts-in-context. For the analysis of functioning artefacts, it is the

> combination of 'the social' and 'the technical' that is the appropriate unit of analysis' (p.365)'

We argue that this approach provides a useful starting point for thinking about how business models shape and are shaped by their environment, considering that these not only represent constellations of socio-technical elements (e.g. technologies, values, routines, knowledge etc) but also operate within socio-technical contexts (e.g. systems of energy, transport, food etc).

We now turn to the multi-level perspective (MLP) on socio-technical system change, which also emphasises the convoluted nature of both the social and technical to help explain not only why socio-technical system states can persist for a long-period of time but how they can also rapidly shift from one system state to another.

2.2.2 Multi-Level Perspective on Socio-Technical Transitions

The socio-technical approach to system change emerged in response to the need to develop an analytical perspective that was capable of taking into account not just market, scientific and economic factors but also social, cultural and institutional factors when explaining system change (Smith et al., 2010). Consequently, the multi-level perspective (MLP) on socio-technical system change was developed, which in a similar vein to the SST literature, emphasised the inter-connectedness and mutual dependence of social and technical elements (Geels, 2002b, Geels, 2005c, Geels and Schot, 2007, Rip and Kemp, 1998). It applies this logic to help explain socio-technical system change.

The key difference of the MLP compared to the SST approach is that the MLP focuses on the factors responsible for shaping socio-technical system-wide change, as opposed to that of an individual or group of technologies. The MLP pays particular attention to the processes operating at multiple levels, which are responsible for stabilization and destabilization of socio-technical systems (Markard et al., 2012), the latter constituting an important pre-cursor to a systemic transition. In recent years this approach has been applied to help inform our understanding of how we might achieve transitions to more sustainable system states and is thus extremely relevant to the focus of this research. Another important difference to the SST approach is that the MLP seeks to combine insights from other bodies of theory, namely:

> 'concepts from evolutionary economics (trajectories, regimes, niches, speciation, path dependence, routines), science and technology studies (sense making, social networks, innovation as a social process shaped by broader societal contexts), structuration theory and neo-institutional theory (rules and institutions as 'deep structures' on which knowledgeable actors draw in their actions, duality of structure, i.e. structures

are both context and outcome of actions, 'rules of the game' that structure actions)' (Geels, 2011 p.26)

We begin by explaining the term socio-technical system before we introduce the multi-level perspective and the three levels it incorporates: landscape, regime and niche. Throughout this review, we assess the extent to which this literature has provided insight into how business models have co-evolved with the socio-technical systems within which they are operated.

2.2.2.1 Socio-technical systems

A socio-technical system can be understood as a seamless web of interlocking artefacts, institutions, organisations, natural resources, knowledge etc that combine to fulfil particular societal functions via production, distribution and consumption processes (Figure 2.2) (Geels, 2004, Markard et al., 2012, Markard, 2011, Weber, 2003, Geels, 2005c). A socio-technical system is defined as:

> 'The linkages between elements necessary to fulfil societal functions (e.g. transport, communication, nutrition). As technology is a crucial element in modern societies to fulfil those functions, it makes sense to distinguish the production, distribution and use of technologies as sub-functions. To fulfil these sub-functions, the necessary elements can be characterised as resources. ST-systems thus consist of artefacts, knowledge, capital, labour, cultural meaning, etc' (Geels, 2004 p.900)

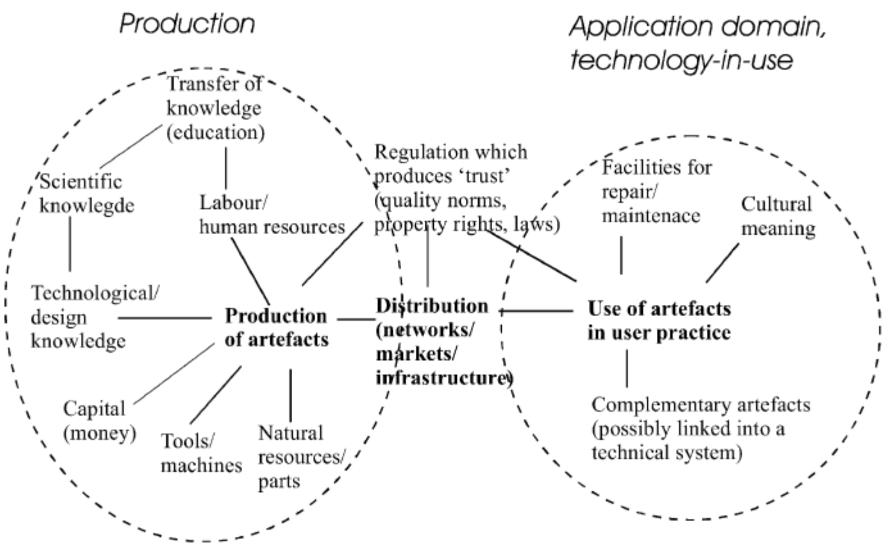


Figure 2.2 The basic elements and resources of socio-technical systems (Geels, 2004)

Smith et al. (2010) take the case of the automobility socio-technical system to illustrate how the systems capable of fulfilling our mobility needs are comprised of both social and technical elements, such technology designs, road planning authorities, driving licence & motor insurance institutions, the lobbying capacity of multi-national firms and the cultural significance of the automobile.

2.2.2.2 The Multiple Levels of the Multi-level Perspective

The MLP teaches us that socio-technical systems are embedded in socio-technical regimes, which represent the 'semi-coherent set of rules that orient and coordinate the activities of the social groups that reproduce the various elements of socio-technical systems' (Geels, 2011) and ultimately characterize the very nature of socio-technical systems. Consequently, transitions are understood to stem from the destabilisation of the socio-technical regime, in which the system is embedded. Destabilisation occurs through the inter-play of dynamics between three different socio-technical 'levels' of increasing stability (Geels, 2004, Markard et al., 2012): *landscape, regime and niches* (Geels, 2002a, Geels, 2005c, Geels, 2011, Schot and Geels, 2008, Rip and Kemp, 1998, Kemp et al., 1998). Each of these levels represent a heterogeneous configuration of elements, whereby the 'higher' levels are considered to be more stable than the 'lower' levels, particularly in terms of the degree to which the elements that make-up these levels are aligned with one another (Geels, 2011) (Figure 2.3).

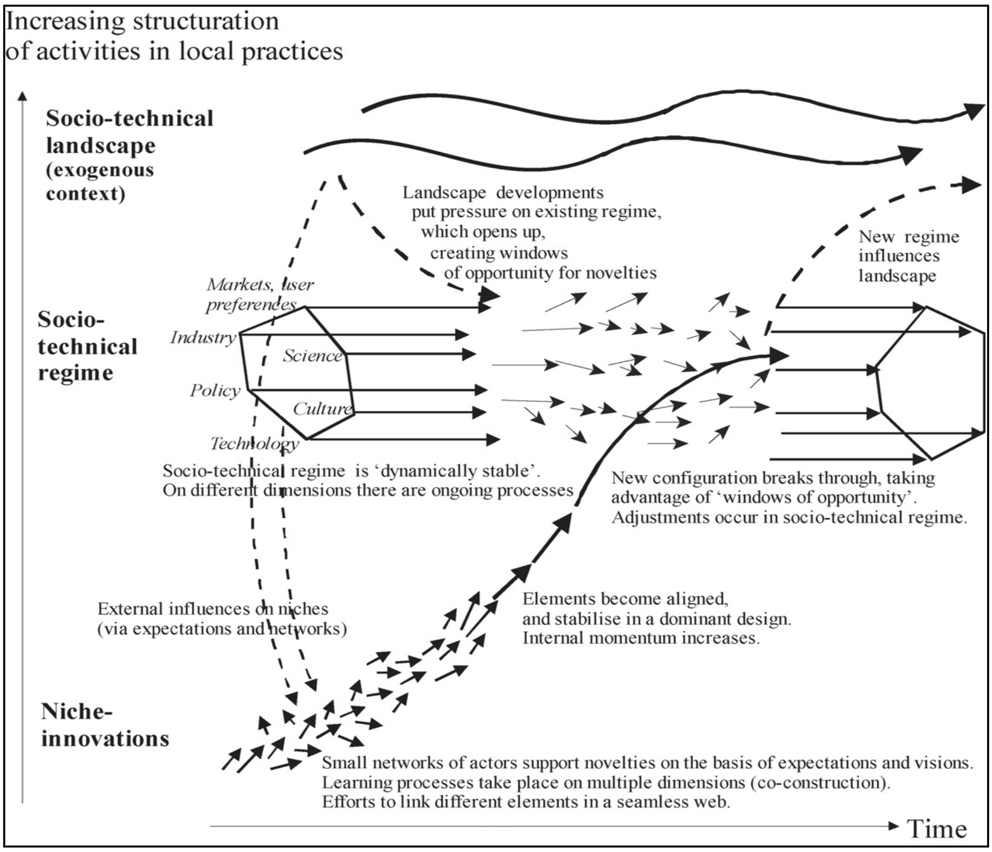


Figure 2.3 Multi-level perspective on transitions (Geels and Schot, 2007)

Regime

Prior to the conceptualisation of the socio-technical regime, the concept of a *technological regime* was introduced by Nelson and Winter (1977), which Genus and Coles (2008) explain refers to 'the beliefs and prevailing successful designs which predispose innovators in firms towards development of certain apparently marketable or feasible options but away from other less attractive options' (p.1437). Also making reference to Nelson & Winter's work, Kemp (1994) explains that the 'concept of a technological regime relates to technicians' beliefs about what is feasible or at least worth attempting' (p.1025), highlighting the example of the DC3 aircraft in the 1930s, which 'defined a particular technological regime: metal skin, low wing, piston powered planes'(p.1025). Similarly Dosi (1982) conceptualised the *technological paradigm* as an outlook, i.e. a set of procedures combined with a definition of the relevant problems and the knowledge required to deliver solutions to these problems. Dosi argues that within each technological paradigm, different definitions of progress are provided, relating to specific technological and economic trade-offs, which ultimately result in technological trajectories.

These concepts of a technological regime or paradigm were developed further still to encompass a much greater emphasis on the intertwined nature of social and technical system components (Kemp et al., 1998, Rip and Kemp, 1998):

> 'A technological regime is the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems; all of them embedded in institutions and infrastructures' (Rip and Kemp, 1998 p.340)

The concept of the *socio-technical regime*, as introduced by Geels (2002b), shares a great deal of similarity with the technological regime. Smith et al. (2010) explain that Geels extended a sociological sensibility to the concept of the regime, which meant that it now paid much greater attention to institutions, user relations, and social expectations.

Drawing upon his earlier work, Geels defines the socio-technical regime as 'the locus of established practices and associated rules that stabilize existing systems' (Geels, 2011 p.26). In terms of content, it encompasses elements of the technological, user & market, socio-cultural, policy and science regimes but not their entirety. Consequently, it serves to 'capture the meta-coordination between different sub-regimes' (Geels, 2011 p.27), emphasising not just the links within the regime but between regimes.

To help differentiate between the socio-technical system and regime we draw upon the comparison provided by Geels (2011):

> **Socio-technical system** – the tangible and measurable elements, such as artefacts, infrastructure, regulations and consumption patterns
>
> **Socio- technical regime** – the intangible and underlying deep structures, such as engineering beliefs, routines, heuristics, social expectations and visions

Socio-technical systems are embedded within these regimes, which form the 'deep structure' that shapes the activities of the actors that reproduce the various aspects of ST systems (Geels, 2011, Geels, 2004). It is this structure that encourages path dependent, incremental innovations, as opposed to disruptive radical innovations, thus lending stability to socio-technical systems and supporting the emergence of prevailing means by which particular societal functions are realised (Geels, 2002b, Smith et al., 2010). However, the regime can become destabilized and reconfigured as a consequence of developments at both the landscape and niche levels.

Landscape

The *landscape* represents the socio-technical regime's wider, exogenous context (Geels, 2002a, Rip and Kemp, 1998) and normally changes very slowly. Examples include demographic trends, political ideologies or societal values (Geels, 2011, Smith et al., 2010). The term landscape is used to imply hardness and durability in order to emphasise the manner in which this abstract level is 'beyond the direct influence of actors and cannot be changed at will' (Geels, 2005c p.684). The landscape spans different societal functions and unfolds autonomously of specific socio-technical regimes (Smith et al., 2010). Quoting Geels and Schot (2007), Smith et al. (2010) explain that:

> 'Landscapes provide an influential backdrop with ramifications across a variety of regimes and niches: providing gradients and affordances for how to go about establishing socio-technical configurations that serve societal needs' (p.441)

Landscape developments can exert pressure on the existing regime, which can in some cases prompt the regime to become destabilised and consequently, create 'windows of opportunity' for novelties to gain traction (Geels and Schot, 2007) (Section 2.2.2.5). The landscape can also influence change at the niche level by externally influencing the perceptions of niche actors and the size of support networks that are responsible for characterizing niche innovations (Geels and Schot, 2007). It is also worth noting that the MLP teaches us that change in the socio-technical regime can influence change at the landscape level (Geels and Schot, 2007)(Figure 2.3).

Niche

The *niche* level is predominantly where radical innovations emerge, which are typically mis-aligned with the socio-technical regime (Smith et al., 2010). It is these innovations that provide the seeds of systemic change (Geels, 2011). Niches represent sheltered spaces (e.g. R&D laboratories, subsidised demonstration projects, small market niches) within which these radical innovations can be protected from the hostile selection environment prevailing in the regime (Rip and Kemp, 1998). It is within these spaces that radical innovations mature via three important processes (Geels, 2011, Elzen et al., 1996, Geels and Schot, 2007, Kemp et al., 1998):

1) Articulation of expectations and visions, which help to provide legitimacy and direction to the niche
2) Building of social networks to encourage stakeholder interaction and micro-market development, which is instrumental in growing the resource base of the niche)
3) Learning and articulation mechanisms or processes to develop new rules and design heuristics (e.g. user preferences, business models, policy instruments etc)

Through the progression of these three processes niches can gain sufficient momentum to challenge the dominance of key elements within the socio-technical regime, particularly during periods of regime destabilization (i.e. windows of opportunity). It is the culmination of these processes that can trigger a re-configuration of the socio-technical regimes and thus the transformation of socio-technical systems.

2.2.2.3 Transition Pathways

Geels (2011) explains that socio-technical transitions typically tend to follow a similar pattern to one another, where niche-innovations build up internal momentum in niches; landscape changes exert pressure on the regime; and the subsequent destabilisation of the regime creates windows of opportunity for niche innovations to enter mainstream markets and compete with the established regime, potentially leading to its reconfiguration (Geels and Schot, 2007, Geels, 2005c). However, it is considered that although often similar, transitions can characteristically differ from one another and thus follow different pathways. For instance, they can differ with respect to the timing of multi-level interactions, as well as the nature of multi-level interactions, which may be competitive or symbiotic (Geels and Schot, 2007). Consequently, 5 key transition pathways have been identified and these are as follows (Geels, 2002b, Geels and Schot, 2007, Geels, 2011):

- **Reproduction** – No external landscape pressure means the regime remains dynamically stable and continues to produce itself
- **Transformation** – Landscape developments destabilize the regime but niche-innovations are immature. No breakthrough for niche innovations but experiences from these are translated and accommodated in the regime
- **Substitution** – Landscape developments destabilize the regime when a niche-innovation is mature. Window of opportunity emerges for the niche innovation to replace the regime
- **De-alignment/re-alignment** – Landscape developments destabilize regime when multiple niche-innovations are mature. These all take advantage of this window of opportunity, creating uncertainty around which will become dominant until alignment eventually occurs around a single one
- **Re-configuration** - Landscape developments destabilize the regime when a niche-innovation is mature, which is symbiotic to the regime. This enables incumbent actors to adopt this as an add-on, which may subsequently trigger other adjustments and change the regime's basic architecture

2.2.2.4 Applications of the MLP

The MLP has been applied to a number of historical, contemporary and forward looking empirical case studies, in order to provide insight into the processes responsible for driving systemic change. With respect to historical studies, the MLP has been applied to improve our understanding of a multitude of important historical transitions in socio-technical systems, in relation to shipping (Geels, 2002b), cargo handling (Van Driel and Schot, 2005), land transport (Geels, 2005b), hygiene (Geels, 2005a) etc. Contemporary studies of socio-technical system change include transitions of animal husbandry (Elzen et al., 2011), organic food (Seyfang and Smith, 2007) and housing (Seyfang and Smith, 2007) socio-technical systems. Of particular relevance to this research project are the numerous studies that have explored a wide range of contemporary energy system transformations (Geels and Raven, 2006, Raven, 2004, Raven and Verbong, 2009, Verbong and Geels, 2007).

The MLP has also been applied to examine how we might facilitate transitions to socio-technical system states in the future, which are in synthesis with current normative goals, such as realising sustainable development. This approach is known as Transition Management (Rotmans et al., 2001, Smith et al., 2005). Studies of this type have typically examined the conditions that would most likely enable us to shift towards more sustainable socio-technical system states in the future, representing a form of 'problem-oriented thinking for sustainable transitions' (Smith et al., 2010 p.439). Studies of this ilk have examined how transitions to more sustainable transport systems (Köhler et al., 2009, Nykvist and Whitmarsh, 2008, van Bree et al., 2010) or cities (Hodson and Marvin, 2010) might take place. The MLP has also been applied to explore plausible transitions to more sustainable energy systems (Verbong and Geels, 2010, Hofman and Elzen, 2010, Foxon et al., 2010).

2.2.2.5 Critique of the MLP

Much of the allure of the MLP can be attributed to the way in which it rejects simple causality in socio-technical transitions. It seeks to identify the various non-linear processes, across multiple dimensions and levels that are responsible for triggering and characterizing socio-technical system change (Geels, 2011). Smith et al. (2010) commend the MLP for seeking to package this complexity into a single, relatively straightforward framework, which is able to provide insight into system transformations. However, they warn that it could be over simplistic and fail to capture the complexity inherent in system change.

A key strength of the MLP is that it presents a framework through which causal narratives of transitions can be told. These stories help to illustrate the sequence of events that are responsible for triggering and shaping socio-technical transitions: 'reality occurs not as time-bounded snapshots within which "causes" affect one another…but as stories, cascades of events' (Abbott, 1991 p.227). The MLP therefore represents an effective means of illustrating how sequential and inter-related events are responsible for systemic change.

The MLP also underlines how the *timing* of multi-level interactions has an influence on the type of system change that takes place: 'If landscape pressure occurs at a time when niche-innovations are not yet fully developed, the transition path will be different than when they are fully developed' (Geels and Schot, 2007 p.405). This has given rise to the term 'windows of opportunity' that relate to a period of regime destabilization during which niche innovations have a much better chance of gaining wide-scale traction, compared to before or after this period. Consideration of this temporal dimension means the MLP lends itself well to explanations of lock-in and path dependency, emphasising the importance historical developments in shaping future system change.

Despite the various strengths of this approach, it has also been subject to criticism, which has to some extent been subsequently addressed by exponents of this literature. The approach has in the past been criticised for being niche-bias, i.e. placing undue emphasis on the importance of bottom up dynamics in system change (Berkhout et al., 2004, Smith et al., 2005). This was addressed to a large extent by Geels and Schot (2007) with their typology of transition pathways that emphasises the critical role the regime and landscape levels also played in triggering and shaping system change. Geels (2011) explains that broader change models, such as political revolutions, could potentially provide ‘fruitful terrain for future research on large-scale transitions, which goes beyond an exclusive bottom-up bias’ (p.33), as illustrated by Dahle (2007).

The MLP has also attracted criticism for being difficult to apply to empirical studies, mainly due to confusion around how abstract concepts such as niche, regime and landscape should be applied empirically (Berkhout et al., 2004, Genus and Coles, 2008). For instance, what may seem to represent the regime at one scale may only constitute a critical aspect of the structure of a wider regime. This can be partly attributed to the way in which the ‘role of places and spatial scales in these transition processes has not been an explicit issue of concern’ (Smith et al., 2010). It is for these reasons the MLP has struggled to not only be tractable to policy-makers (Shove and Walker, 2007) but also empirical researcher seeking to identify specific causal factors that shape socio-technical transitions. The inaccessibility of the MLP to empirical researchers has been exacerbated by the lack of methodological coherence within this approach, as exhibited by the unsystematic approach taken to application of the MLP, which must be addressed if the approach is to go beyond illustration and exploration, and towards systematic research (Genus and Coles, 2008).

The MLP has also attracted criticism for failing to accommodate the role critical actors play in shaping or managing transitions (Genus and Coles, 2008, Shove and Walker, 2007, Smith et al., 2005, Smith et al., 2010). The approach has been accused of ‘undervaluing the role of agency and politics’ (Genus and Coles, 2008) in socio-technical transitions, i.e. the ‘playing out of power’ (Shove and Walker, 2007). In response, Geels (2011) explains that the MLP is ‘shot through’ with agency[8] but would benefit from greater attention to the different types of agency that is responsible for shaping transitions. Particularly relevant to this study is Geels’ suggestion that the MLP could benefit from incorporating insight from the literature on business studies, strategic management and corporate alliance as a means of improving our understanding of how incumbent regime actors can retain their dominant position via different forms of agency and power or even collaborate with new entrants to develop niche-innovations.

Finally, the last key criticism of the MLP, which is particularly relevant to this research, is the lack of attention it has paid to the role of non-technological innovation in transitions. Holtz et al. (2008) explain that despite the attempts to incorporate the ‘social’ dimension into our

[8] Agency in this context refers to the capacity of an individual or organisation to make their own free choices and consequently, act independently. It is often referred to as the counterpoint for structure, which constrains actors ability to make their own choices and act accordingly

explanations of system change, ‘the focus of “socio-technical regimes” remains centred on technological development’ where soft factors (e.g. institutions, culture, behavioural patterns etc) are only included ‘when necessary to explain technological change’ (p.625). In the socio-technical transitions literature ‘it is commonplace for studies to take a technical artefact as an entry point’ (Witkamp et al., 2011 p.669), even though some radical innovations do not necessarily revolve around artefacts, such as business models (Witkamp et al., 2011). This means that transitions with important cultural and societal aspects or units of analysis may have been neglected (Geels, 2005a), where technology has not been the most important factor responsible for shaping socio-technical system change (Holtz et al., 2008). This research’s focuses on business model innovation seeks to address this criticism of sustainability transitions research to some extent by providing valuable insight into the role non-technological niche innovations play in socio-technical transitions, as well as the relationship between non-technological and technological niche innovations.

In summary, the MLP represents a valuable heuristic device for understanding socio-technical system transitions as multi-level processes (Genus and Coles, 2008), where the timing and nature of interactions are critical to the trajectory of a transition. However, we argue that the MLP does not constitute an analytical framework that is designed to identify the causal mechanisms that might be responsible for supporting or inhibiting the proliferation of novel, sustainable business models, as well as the ways in which the adoption of these models could influence the evolution of the socio-technical system. Although the MLP may one day present a fruitful means of exploring these questions, its current lack of methodological rigour, as well as its neglect of different forms of agency and techno-centric focus means that whilst we seek to draw insight from this literature, we do not regard it as an appropriate framework for an investigation into the co-evolutionary relationship between innovative energy business models and their energy systems. Consequently, we turn to the complimentary (MacKenzie, 1992) but conceptually distinct ‘evolutionary’ approach to technological, industrial and economic system change, which places a much greater emphasis on variation, selection and retention processes, as opposed to sociological concepts of alignment between heterogeneous system components in order to explain socio-technical transitions (Foxon, 2011).

2.3 Evolutionary Approaches to Technological, Industrial and Economic Change

The principles of biological evolution have been extended and applied to non-biological contexts to help explain the factors that have been responsible for socio-technical system change. This approach has been termed Universal Darwinism (Dawkins, 1983) or Generalised Darwinism[9] (Hodgson and Knudsen, 2004a, Dennett, 1995) and the central thrust of this approach is that 'the core Darwinian principles of *variation, replication*, and *selection* may apply not only to biological phenomena but also to other open and evolving systems, including human, cultural or social evolution' (Hodgson, 2005 p.899). In this sense the evolution of biological systems constitutes a special case of evolution, as opposed to the sole case. However, evolutionary theory is only considered to provide insight into the mechanisms of non-biological system change if the system contains at least one population 'of replicating entities that makes imperfect copies of themselves, and not all of these entities have the potential to survive' (Hodgson, 2005 p.900). According to Generalised Darwinism (Dennet, 1995, Hodgson and Knudsen, 2006, Aldrich and Ruef, 2006) a population is said to evolve:

> 'as long as many different entities (variation) are created, whether these entities are simple actions of individuals or entire organizations, as long as consistent selection pressures eliminate ill-adapted entities (selection), and as long as the entities have stability across time (retention), the surviving entities will be well-adapted to their environments' (Murmann, 2012 p.2)

Importantly however there are some key differences between applying evolutionary principles to help explain biological and non-biological phenomena (Buenstorf, 2006, Hodgson, 2002). We take care to highlight these in the following sub-section, with reference to the three core evolutionary processes: *variation, selection and retention*.

2.3.1 Variation, Selection & Retention of Non-biological Populations

2.3.1.1 Variation

Non-biological variation is understood to be generated through innovation processes that arise in a population of heterogeneous actors, which are consequently responsible for the characteristic diversity in such populations (Suurs, 2009, van den Bergh et al., 2006). In the context of organisational change, Aldrich and Ruef (2006) explain that variation manifests itself as a 'change from current routines and competencies [and/or a] change in organizational forms' (p.17).

[9] These two terms are inter-changeable and we make reference to Generalised Darwinism to refer to both

With reference to Campbell's (1960) concept of *blind variation*, Simonton (1995) explains that in a similar way to evolution processes in the natural world, human actors can often lack a significant degree of foresight in the production of non-biological variations or innovations, consequently hindering their ability to purposively generate the most adaptive variations. Importantly, 'in social systems the generation of variation is sometimes partly guided, while in biological systems it is accidental through mutations' (Kallis and Norgaard, 2010 p.690). For instance, whilst genetic variations are the product of random re-combinations and mutations, non-biological variation can emerge in response to the needs of the organism (Mayr, 1991). Variations can be the result of conscious design, where novelties are designed to meet the needs of actors (Cordes, 2006). Consequently, non-biological variation is often anything but random because they have been designed with a purpose in mind: 'a variant's features are bound to be correlated with their intended purpose for its maker' (Cordes, 2006 p.533). Therefore, in the context of non-biological evolution, variation and selection are not necessarily independent of one another (Khalil, 1995, Ziman, 2000).

Another important difference is that non-biological variety is introduced by populations that are not completely blind to the ultimate fate of the variation they generate (Cordes, 2006). With reference to innovation as a form of variation, actors possess some insight into the degree of fitness their innovations are likely to share with the existing or emerging selection environment. This insight is likely to shape the characteristics of the innovations actors generate as they seek to structure the design of these innovations in a bid to ensure they share a strong degree of fitness with the wider selection environment.

2.3.1.2 Selection

As in biological contexts, selection of non-biological variants is conducted through a selection environment, which relates to the multitude of forces that differentially select or selectively eliminate variations (Aldrich and Ruef, 2006). It is via selection, predominantly in the form of adoption, imitation and diffusion, that the internal variation of populations is reduced (Nelson and Winter, 1982). With respect to firms we are able to draw a distinction between internal and external selection environments, which are responsible for influencing their routines and competencies (Glynn, 2002, Aldrich and Ruef, 2006). Here the internal environment relates to forces internal to the organization, whilst the external relates to forces external to an organization (Aldrich and Ruef, 2006).

Non-biological evolution differs to biological in the way that humans can evaluate the significance of variations *ex ante*, meaning they are able to opt against the selection of potentially ineffective or undesirable novelties: 'the driving forces of socio-economic evolutionary change involve human cognition, wants and creativity' (Cordes, 2006 p.534). Conversely, biologically evaluation occurs *ex post* via natural selection, as is the nature of random mutations that occur during the process of genetic transmission (Witt, 2005). The key difference here is that humans often determine which types of non-biological variations (innovations) they adopt (Cordes, 2006). This concept is encapsulated by Campbell's (1960) notion of *selective retention*, which refers to the selection of stable configurations and the elimination of unstable configurations by actors (Heylighen, 1992), where actors' perceptions of the performance of past variations has an important influence on whether they select these.

Socio-economic selection is also characterized by the concept of *bounded rationality*, pioneered by Herbert Simon (1955, 1959) and later developed by Nelson and Winter (1982). It teaches us that actors are unable to attain perfect information to base their decision making upon, meaning they are not perfectly rationale entities but are instead limited in their ability to make rational decisions, resulting in sub-optimal development. Consequently, this notion contradicts that of *perfect rationality*, which forms one of the guiding principles of neo-classical economics. In drawing upon Simon's and Nelson & Winter's work, Foxon (2011) explains that actors:

> 'act under conditions of uncertainty within a given institutional context. Rather than being profit-maximising, firms follow routines that 'satisfice' rather than optimise, i.e. that give rise to satisfactory levels of profit or performance and are only changed when outcomes are no longer satisfactory, due to internal or external changes' (p.2260)

Actors therefore do not make decisions entirely rationally but instead, they do so according to routines (e.g. R & D strategy). Drawing upon earlier work on this phenomenon (Dosi, 1982, Nelson and Winter, 1982, Simon, 1969), Suurs (2009) explains that these routines act as a form of search heuristic that limits the possibility space for taking action. These firm-level routines are only likely to change following a process of searching for superior techniques, commenced in order to satisfy an important criteria. As a consequence of their bounded rationality, firms will 'usually look for incremental improvements in techniques or imitation of the practices of other firms' and these search processes 'will be terminated when firms satisfice by attaining a given aspiration level' (Foxon, 2003 p.6). In summary, human actors' selection of variations is not considered to be optimal. It is also worth noting that selection may also be linked with the struggle between populations of organisations for scarce resources (Aldrich and Ruef, 2006): 'In a world of limited resources, only some organizations can obtain the land, labour, capital, and other things they need to survive' (p.26).

2.3.1.3 Retention

'Retention occurs when variations are preserved, duplicated, or otherwise reproduced so that the selected activities are repeated on future occasions or the selected structures appear again in future generations' (Aldrich and Ruef, 2006 p.23). In this sense, habits, routines and institutions do not just persist but are replicated (Hodgson, 2002). However, their replication is often imperfect resulting in the emergence of new variations that are related but characteristically different to others (Hodgson, 2002). Retention can therefore be explained as follows:

> 'Retained variations are passed, with more or less additional variation, from surviving organizations to those that follow, and from old to new founders, employees, and managers. Replication occurs via people observing one another, through training and education, learning appropriate rules of behaviour, and interacting with machines and documents' (Aldrich and Ruef, 2006 p.24)

Hull (1989) explains that in order to explain retention one must identify an interactor and a replicator. Here the *replicator* is defined as 'an entity that passes on its structure largely intact in successive replications' and the *interactor* as 'an entity that interacts as a cohesive whole with its environment in such a way that this interaction causes replication to be differential' (p.96). In the context of biological sciences, the human organism would represent the interactor, whilst the human's genes would represent the replicator. In the spirit of Generalised Darwinism, Dawkins (1976) applied the principles of evolution to explain transmission of units of cultural replication and selection, which he refers to as *memes*. He explained that cultural replicators, such as a tune or an idea, are passed on from generation to generation via human interactors. In the context of the evolution of organisational populations, the habits and routines of a firm constitute replicators, whilst the firm and other organisations constitute the interactors (Hodgson and Knudsen, 2004b).

This sub-section has served to illustrate how the evolutionary processes of variation, selection and retention that shape non-biological populations are similar but differentiated from those applied to biological populations. We now briefly explore how an evolutionary approach has been adopted to help explain technological and industrial change.

2.3.2 Evolutionary Approaches to Non-Biological System Change

Born from Schumpeter's (1934, 1942) early work on waves of creative destruction and later developed by Nelson and Winter (1982), the field of evolutionary economics emerged, which has sought to explain economic change through the application of evolutionary theory. Importantly, this field forms a critique of neoclassical economics, and drawing upon

Schumpeter's work, it stresses that economies and markets are not in static equilibrium but are in fact in continuous turmoil, subject to the 'perennial gale of creative destruction' (Schumpeter, 1942 p.87), which means their structural conditions are in constant flux. Consequently, evolutionary economics teaches us that these represent thoroughly unpredictable environments, a point of view which jars with neoclassical economic thinking (Suurs, 2009).

Building on this, van den Bergh et al. (2006) explains that evolutionary economics is characterised by six basic concepts: *bounded rationality, diversity, innovation, selection, path dependency* and *lock-in,* the latter we explore in greater detail later in this chapter. It is important to note that this approach, in a similar fashion to the socio-technical transitions literature evolutionary economics also emphasises the importance of both social and technical dimensions in shaping non-biological systems change. However, it separates socio-technical system components into discrete populations for analytic purposes, because evolutionary explanations are concerned with the processes responsible for characteristic changes in populations (Hodgson, 2005).

Within this field, a group of scholars have focused in particular upon how evolutionary theory can be applied to provide insight into the nature of technological change. Drawing upon the pioneering work of both Dosi (1982) and Nelson and Winter (1982), Foxon (2011) explains that 'industrial innovation is constrained by shared assumptions and decision rules, so that change follows 'technological trajectories' within 'technological paradigms' (p.2260). This approach to system change teaches us not only that technology evolves within a particular social and economic context but also that the types of technologies that are developed and subsequently utilised also shape their environment. Consequently, technological evolution is considered to be *dynamic, cumulative, systemic and uncertain* (Grübler, 1998, Grubler and Gritsevskyi, 2002):

Dynamic – Technological change is characterized by the continuous introduction of variations and continuous improvements/modifications of existing ones

Cumulative – Technological innovations are representative of new forms of technological knowledge that cannot be created without prior knowledge, hence technological change is inherently cumulative

Systemic – A change in a component of a large technological system will result in changes elsewhere in that system

Uncertain - The form and applicability of new technological innovations and the diffusion of these cannot be known beforehand

2.3.2.1 Innovation Systems

One approach that also applies evolutionary principles to socio-technical system change is the Innovation Systems discourse. In its broadest terms an innovation system is understood to incorporate the 'determinants of innovation processes; all important economic, social, political, organisational, institutional, and other factors that influence the development, diffusion, and use of innovations' (Edquist, 2004 p.182). In their review of the literature, Suurs (2009) explain that:

> 'The central idea behind the IS approach is that determinants of technological change are not (only) to be found in individual firms or in research institutes, but also in a broader societal structure in which firms, as well as knowledge institutes, are embedded' (p.35)

Edquist (1997) explains that this approach is not only limited to technological innovations but also non-technological forms of innovation and how the approach situates innovation and learning processes at the centre of its focus. Edquist continues to explain that the approach employs a holistic and interdisciplinary perspective to system change, in conjunction with a historical and evolutionary perspective, which renders the notion of optimality irrelevant. Finally, he emphasises the approach's focus on interdependence, the non-linearity of innovation processes and the significant influence of institutions on innovation. The approach has been applied at various different scales, namely technology specific (Carlsson and Stankiewicz, 1991), sectoral (Malerba, 2002), regional (Cooke et al., 1997) and national (Freeman, 1988).

Both the *Innovation Systems* approach and other similar approaches, including the MLP, have not only incorporated evolutionary but also co-evolutionary concepts to help explain socio-technical system change. We now explore this body of theory in greater detail to outline how it can help to provide insight into the nature of socio-technical transitions.

2.3.3 Co-evolution of Socio-Technical Dimensions

As a strand of evolutionary theory, coevolution has been developed to provide insight into how and why two or more populations can causally influence each other's evolution (Murmann, 2003, Norgaard, 1994), i.e. the fundamental evolutionary processes of variation, selection and retention these populations are subject to (Murmann, 2012). Importantly, co-evolution only occurs between populations and these must be separable (Murmann, 2003). For instance, Thompson (1994) explains that coevolution takes place between some plants and insects, where the plant constitutes food for the insect, whilst the latter serves to spread the plant's pollen. However, more recently this approach has been applied to help explain how the causal inter-relationships between populations of producers, users, technologies, institutions etc and how these have shaped the trajectory of one another's evolution (Kallis, 2007, Kallis and Norgaard, 2010, Nelson, 1994, Norgaard, 1994, Murmann, 2003, Murmann, 2012)

In his earlier work Murmann (2003) explains that coevolution predominantly arises through two avenues: by altering the selection criteria or by changing the replicative capacity of individuals in the population without necessarily altering the selection criteria (Murmann, 2003). However, in his more recent work Murmann (2012) includes changes to variation processes. He explains that in order to prove coevolution, one must be able to demonstrate that reciprocal (bidirectional) causal mechanisms between the two populations influence change in at least one of the three evolutionary processes (i.e. *variation, selection* and *retention*).

2.3.3.1 Path dependency & lock-in

Kallis (2007) emphasises that 'coevolutionary change is path dependent' (p.2) and so, in broad terms, 'what happened at an earlier point in time will affect the possible outcomes of a sequence of events occurring at a later point in time' (Sewell, 1996 p.262-3). In other words history constitutes an important consideration when examining system change (Lovio, 2011). In this sense innovation can be considered 'cumulative', in the sense that current innovations draw upon some of the characteristics of those that preceded them (Nelson, 1994). Consequently, the evolution of systems can follow irreversible pathways, representing 'an important distinction from neoclassical economic theory, which suggests that a system can return to an optimal configuration' (van den Bergh et al., 2006 p.60).

Adopting a coevolutionary approach has proven particularly useful for illuminating the 'on-going positive feedbacks between components of evolving systems' (Norgaard, 1994 p.82) that have led to path-dependent increasing returns to adoption. Drawing on the work undertaken by Maruyama (1968), Murmann (2012) explains that reciprocal causal processes can create positive (deviation-amplifying) or negative (deviation-countering) feedback loops or mechanisms. Positive feedback loops are responsible for amplifying small initial differences between firms or technologies over time, which can help explain the proliferation of certain innovations over others. Hekkert et al. (2007) identified three typical forms of positive feedback in socio-technical systems (Figure 2.4). We focus here on two of these here, feedbacks A & B. The first relates to entrepreneurs lobbying for market formation, or in other words a more 'even playing field' for their organisation's operations, thus helping to support their entrepreneurial activities. In turn this provides them with a greater capacity to lobby other system actors in order to cultivate more favourable market conditions for their own business operations (feedback A). The latter feedback relates to when firms can lobby for greater resources to perform R&D, which can in turn lead to knowledge creation and thus, higher expectations that guide the search for entrepreneurial activities. Ultimately this can lead to greater lobbying power to help secure additional R & D resources, bringing us back to the start of 'feedback B'.

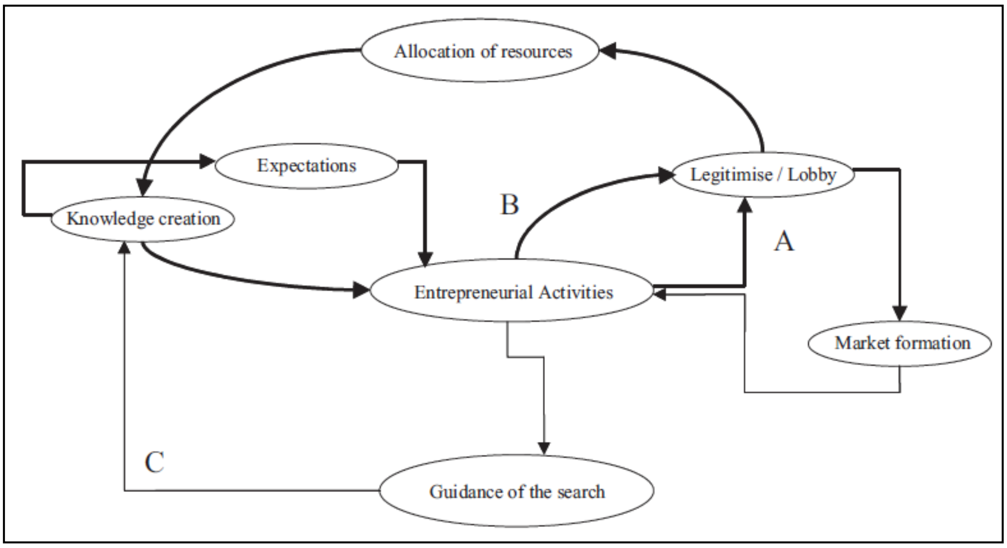


Figure 2.4 Three typical positive feedbacks in socio-technical systems (Hekkert et al., 2007)

One particular group of positive feedbacks that have been associated with such developments are increasing returns to the adoption of a technology, which describe 'the tendency for that which is ahead to get further ahead' and which also explain why 'that which loses advantage [loses] further advantage' (Arthur, 1996 p.100). Arthur (1989, 1994) explored how increasing returns could help to explain the dominance of certain technologies over others, otherwise referred to as 'lock-in'. He introduced 4 types of increasing returns, namely:

Scale Economies - Unit costs decline with increasing output

Learning Effects -The accumulation of specialised skills and knowledge through production and market experience results in the product becoming improved or cheaper

Adaptive Expectations - Increasing adoption of a technology reduces the level of uncertainty surrounding its use, thus potentially reducing the market pull of alternative technologies

Network Economies - When agents benefit from other agents adopting the same technologies

This phenomenon has been illustrated in a variety of ways, of which the QWERTY keyboard case study is probably one of the most well-known (David, 1985). The case highlights the dominance of the QWERTY keyboard layout design, which has become the international standard at a global-scale, despite competition from more efficient alternatives. Another good example is the triumph of the VHS video format over BETAMAX (Arthur 1990). Increasing returns have also been used to explain the lock-in of energy technologies, such as the success of alternating current (AC) over direct current (DC) as a network standard (David and Bunn, 1988) and the market dominance of the light water nuclear reactor (Cowan, 1990). Increasing returns have consequently helped to explain how technologies that gain an early lead from competitors can come to dominate the market.

Path dependency has also been expanded to explain non-technological forms of lock-in, such as institutional lock-in (North, 1990). Pierson (2000) supports North's argument and explains that (1) the central role of collective action, (2) the high density of institutions, (3) the possibilities for using political authority to enhance asymmetries of power; and (4) the intrinsic complexity and opacity of politics makes political institutions particularly prone to increasing returns. In particular, he underlines the importance of the incumbent political power being able to wield its power to enact changes that enhance their power. It is possible that technological and institutional increasing returns can be mutually reinforcing via coevolutionary processes (Foxon, 2011).

2.3.3.2 Coevolutionary explanations of empirical system change

Coevolutionary approaches are considered important to 'illuminate processes of long-term industrial and economic change' (Foxon, 2011 p.2261). One of the most frequently cited studies was led by Murmann (2003, 2012), who has investigated the extent to which coevolutionary interactions between technological development, institutional change and business strategies have been responsible for shaping the early development of the synthetic dye industry, as well as why certain firms and nations captured dominant shares in the market. He identified three causal mechanisms in particular, which were responsible for shaping the evolution of the industry: the exchange of personnel, commercial ties and lobbying (Murmann, 2012). In both Figure 2.5 and Table 2.1 we illustrate how the causal mechanism of personnel exchange between the synthetic dye industry and academia has had an influence on the variation, selection and retention processes of both populations.

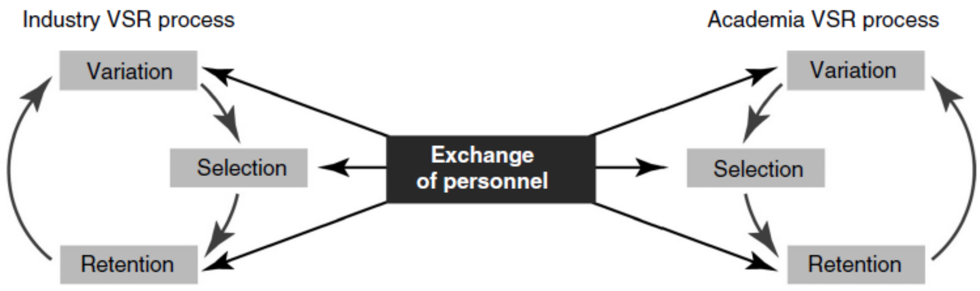


Figure 2.5 Exchange of Personnel as a Causal Mechanism of Evolutionary Change and Its Effect on the Evolution of Industries and Academic Disciplines (Murmann, 2012)

Evolutionary Process	**Exchange of Personnel**	
	Synthetic Dye Industry	**Academia**
Variation	Academically acquired knowledge allows individuals to come up with novel business ideas and increase the founding rate of firms	Industry experience allows academic researchers to come up with novel scientific ideas, applications, and method
Selection	Firms that are able to hire the best talent from an academic discipline are likely to flourish from this access to scarce resources	Academic researchers who are able to recruit talent with useful knowledge from industry will increase their access to scarce resources and be more productive
Retention	Firms that recruit personnel from a particular academic discipline will more readily retain knowledge related to the cognitive structure and methodologies of the disciplines	Academic disciplines that recruit personnel from industrial firms will more readily retain knowledge that is relevant for practical application

Table 2.1 Exchange of Personnel as a Causal Mechanism of Evolutionary Change and Its Effect on the Evolution of Industries and Academic Disciplines (Murmann, 2012 p.17)

Coevolutionary studies of energy system change have also been conducted. For example, Stenzel and Frenzel (2008) have examined how incumbent energy companies coordinated the development of their technological capabilities and their political activities in order to shape their regulatory environment, which can have a significant impact upon the take-up of renewable energy technologies, such as wind power. Other work has examined the coevolutionary processes that shape innovation in the UK electricity distribution network industry, highlighting the importance of the interplay between institutional structures and technical infrastructure in shaping the energy industry (Bolton and Foxon, 2011).

Turning to sustainable energy transitions, numerous scholars have examined how co-evolutionary processes between technologies, institutions and organisations have resulted in positive feedbacks that have served to lock-in modern, carbon based energy systems, predicated on large-scale centralised electricity generation (Unruh, 2000, Unruh, 2002, Carillo-Hermosilla, 2006, Marechal, 2007, Foxon, 2007, Unruh, 2006). Their work has also served to understand how lock-in processes have limited the adoption of alternative, low-carbon technologies and processes.

Unruh (2000), who applies co-evolutionary theory to explain the persistence of carbon-based socio-technical systems, explains that carbon lock-in can be explained by the coevolution of technological systems and governing institutions, coining the term *Techno-Institutional Comple*x (TIC) to emphasise this notion. It is the expectations and preferences that these institutions represent that 'co-evolve with, and become adapted to, the dominant technological system in an endogenous path-dependent manner' (p.824). Technological systems and governing institutions thus become intimately inter-linked and feed off one another in a self-referential system, helping to explain the resilience of today's carbon-based energy systems to change. He adds that lock-in is initiated by technological increasing returns but is 'perpetuated by the emergence of dominant technological, organizational and institutional designs' (p.826). Unruh turns to the US to illustrate how positive feedbacks between the technological, social, institutional and organisations dimensions have served to lock-in the current electricity system (Figure 2.6).

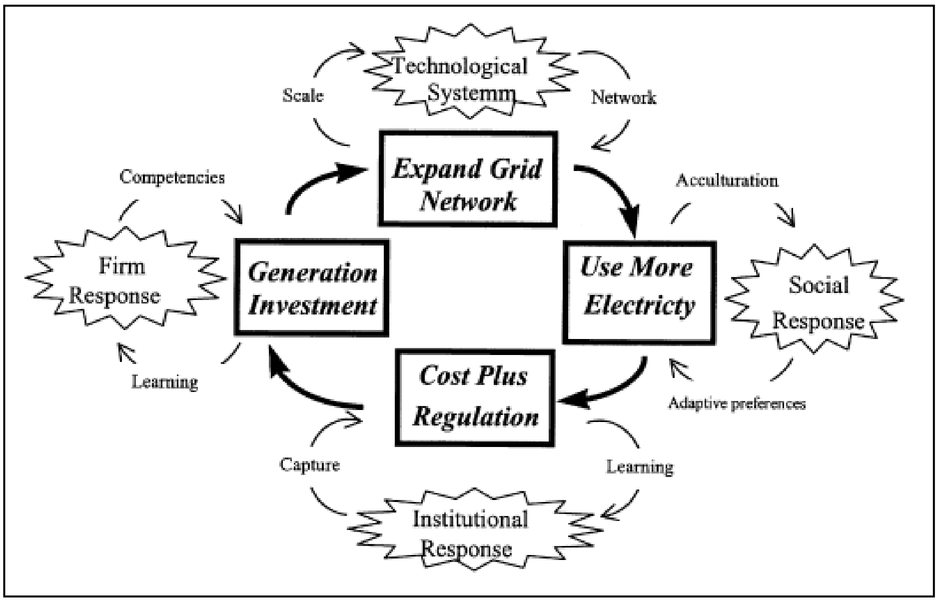


Figure 2.6 An illustration of the techno-institutional complex that fosters lock-in in electric power networks

2.3.3.3 Coevolutionary frameworks for system change

A handful of scholars have developed analytical frameworks for non-biological coevolutionary change. These have been designed to provide insight into the types of bidirectional relationships that exist between populations in socio-technical systems and the way in which these causally influence one another's evolution. Norgaard (1994) introduced a coevolutionary framework that made an analytical separation between five different dimensions that were considered to represent the core building blocks of socio-technical or socio-economic systems. These included *values, organization, technologies, environment* and *knowledge*. The decision to analytical separate these dimensions is in synthesis with the logic of Freeman and Louca

(2001) who explain that these different systems evolve under their own dynamic, however their evolution is also causally influenced through interaction with other systems.

This framework was recently developed by Foxon (2011) who sought to combine insight from coevolutionary theory with that from the socio-technical transitions theory to develop a coevolutionary framework for analysing a transition to a sustainable low carbon economy. Through his review of the literature, he emphasises the importance of the coevolution between technologies, institutions and business strategies, which were not adequately accommodated for in Norgaard's framework. Consequently, he altered the dimensions of the coevolutionary framework presented by Norgaard (1994) so that attention is focused upon the causal interactions between five heterogeneous key sub-systems that include *ecosystems, institutions, user practices, business strategies* and *technologies* (Figure 2.7).

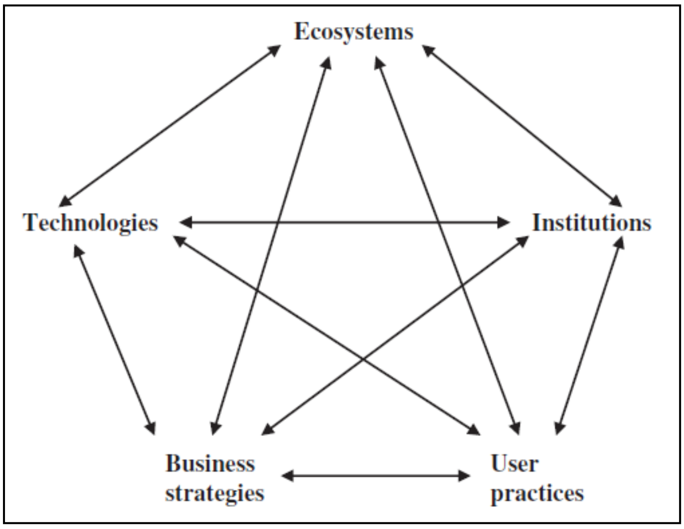


Figure 2.7 Foxon's (2011) coevolutionary framework

We now briefly define each of these dimensions according to Foxon:

- **Technologies** – 'systems of methods and designs for transforming matter, energy and information from one state to another in pursuit of a goal or goals' (p.2262)
- **Ecosystems** – 'systems of natural flows and interactions that maintain and enhance living systems' (p.2262)
- **Institutions** – 'ways of structuring human interactions' (p.2262)
- **User Practices** – 'routinised, culturally embedded patterns of behaviour relating to fulfilling human needs and wants' (p.2263)
- **Business Strategies** – 'the means and processes by which firms organise their activities so as to fulfil their socio-economic purposes' (p.2262)

2.3.3.4 Critique of Coevolutionary Theory

Section 2.3 has sought to identify how the application of evolutionary and coevolutionary theory presents a compelling, population focused approach to explaining the nature of socio-technical system change and systemic transitions (Kemp and van den Bergh, 2006). We argue that the frameworks presented by Norgaard (1994) and Foxon (2011) present an attractive framework for tracing how the evolution of each of these five dimensions is causally linked to the evolution of the other dimensions and vice versa.

It is however worth noting that this approach has drawn some criticism. For instance, Murmann (2003) warns that 'not everything that looks like coevolution is really coevolution' (p.23) because coevolution may be mimicked by other processes such as sequential adaptations from different causes or even simultaneous adaption of two populations to the same environment (Nitecki, 1983). Murmann (2003) therefore explains that 'the only way to establish true coevolution as opposed to spurious coevolution is to gather evidence of cross-flows among the alleged coevolving systems' (p.23). However, Kallis (2007) warns that identifying two or more potentially co-evolving populations and the fitness criteria these are subject to, constitutes a particularly challenging process.

Other concerns relate the notion that coevolution occurs at various different levels, between and within nested hierarchies of different types of system (e.g. social, biological, technical etc): 'Complexity explodes as coevolution within hierarchical systems (i.e. among interacting hierarchical levels) combines with coevolution between different biological and social hierarchical systems'(Kallis and Norgaard, 2010 p.696). This degree of complexity can make co-evolutionary studies of socio-technical systems very challenging. Furthermore, the boundaries and geography of these interacting systems also represents an important consideration as these will ultimately influence the types of interactions that take place. Kallis and Norgaard (2010) explain that to date, space and isolation remain under-theorized in coevolutionary studies of socio-technical system change. They also warn that coevolutionary approaches tend to fail to fully account for the power relationships between human agents, which can naturally influence not only the type but the strength of the causal influences between populations.

As in the socio-technical transitions literature, we argue there is also significant scope for additional research to examine the coevolutionary relationship between business models and the various different dimensions of socio-technical systems, to build upon the excellent work undertaken by Murmann (2003, 2012). Such a focus would provide valuable insight into the causal mechanisms responsible for inhibiting or enabling sustainable business models ability to gain traction and how such models would causally influence the evolution of the various dimensions that make up the wider socio-technical system. Additional research into this co-evolutionary relationship would also help to elucidate our understanding of whether positive feedbacks also subject business models to lock-in, in a similar way to technologies and institutions. This will in turn elucidate our understanding of the factors behind the persistence of unsustainable, incumbent business models and the marginalisation of novel, sustainable business models.

Having identified the lack of attention paid to the role business models play in the evolution of socio-technical systems and consequently, the role they might play in system transitions, we now turn to the business and management literature to illustrate how business models both shape and are shaped by their wider environment.

2.4 Business Models, Business Model Innovation and System Change

2.4.1 The Business Model Concept

Zott et al. (2011) explain that the concept of the business model emerged from the e-Commerce, Strategy and Technology & Innovation Management literature. The concept was applied in e-Commerce to 'describe new gestalts and Internet-based ways of 'doing business'(p.17), as well as to provide taxonomies of businesses. Within the Strategy literature it has been applied to 'explain new network- and activity system–based value creation mechanisms and sources of competitive advantage' (p.17). Finally, within the Technology and Innovation Management literature it emerged to explain how technology is commercialized, as well as new networked modes of innovation.

In their review of the literature, Zott et al. (2011) explain that some confusion continues to exist around what exactly constitutes a business model. To help address this they recently conducted a detailed review of the business model literature in order to identify a number of common themes relating to conceptualisation of business models. The first theme was that business models provide an explanation of how firms do business, i.e. how they create and capture value. Osterwalder & Pigneur (2010) explain that a 'business model describes the rationale of how an organization creates, delivers and captures value' (p.14) by fulfilling the needs or desires of its customers, because 'at its most basic level, a company exists to deliver value in return for compensation' (Johnson, 2010 p.6). A business model symbolizes what it is an organisation believes their customers want, how they want it, how it believes it should organize itself and interact with others to best meet those needs, and in turn, how it will generate revenue from doing so (Johnson et al., 2008, Teece, 2010). Business models therefore represent stories that illustrate how an enterprise entices consumers to pay for the value it creates, and how it converts these payments into profit (Teece, 2010, Magretta, 2002).

The second key emergent theme was that a business model represents a systemic representation of how firms create, deliver and capture value (Dubosson-Torbay et al., 2002, Timmers, 1998, Zott and Amit, 2010, Afuah and Tucci, 2000, Chesbrough, 2007, Osterwalder and Pigneur, 2010). The term *activity system* has been coined to refer to the system of interdependent activities, centred upon the focal firm, designed to create value for its customers, whilst appropriating a share of that value for itself and others (e.g. investors), usually in the form of profit (Afuah and Tucci, 2000, Zott and Amit, 2010, Porter, 1996). A system-level perspective illustrates the 'components, linkages between [these] components, and dynamics' (Afuah and Tucci, 2000 p.4) that constitute a business model and highlights the activities a firm performs, how it performs them and when it performs them (Afuah and Tucci, 2003, Afuah and Tucci, 2000). Importantly, although the activity system is centred upon a focal firm (i.e. the company practicing the model), its boundaries transcend the firm to include other actors who sit outside the organisation (e.g. customers, partners, invertors etc) (Mason and Spring, 2011, Chesbrough, 2007, Zott and Amit, 2010, Zott et al., 2011).

Although a number of valuable definitions of business models exist (as outlined above), these lack any great detail regarding the specific components that make up a business model: 'business models are frequently mentioned but rarely analysed: therefore, they are often poorly understood' (Teece, 2010 p.192). Recently, research has begun to identify the various key components and interrelationships that make-up business models, to inform our understanding of not only what constitutes a business model but the basis on which different business models are characteristically distinct from one another (Mason and Spring, 2011, Shafer et al., 2005, Morris et al., 2006, Hedman and Kalling, 2003, Afuah and Tucci, 2003, Alt and Zimmermann, 2001, Stähler, 2002, Johnson et al., 2008, Voelpel et al., 2004). For instance, the concept of the *activity system*, as defined by Zott and Amit (2010), indicates that the core elements of a business model include components relating to activities of the business (*content*), how these activities are linked (*structure*) and who performs these activities (*governance*). Figure 2.8 provides an illustration of the *activity system* or business model for Southwest Airlines.

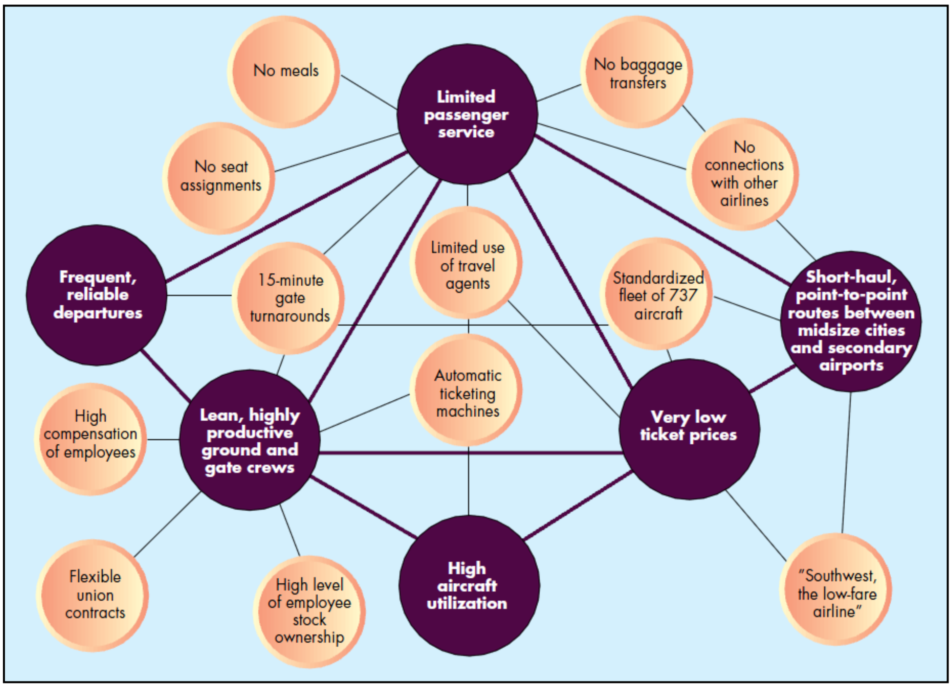


Figure 2.8 Southwest Airlines' activity system (Porter, 1996)

The most recent and comprehensive of these frameworks for business model characterization has been developed by Osterwalder & Pigneur (2010), which presents the 9 building blocks common to all business models (see Table 2.2). Figure 2.9 subsequently provides an example of how this framework has been used to populate Apple's business model:

Key Partners *The network of suppliers and partners that make the business model work*	**Key Activities** *The most important things a company must do to make its business model work* **Key Resources** *The most important assets required to make the business model work*	**Value Proposition** *The bundle of products and services that create value for a specific Customer Segment*	**Customer Relationships** *Relationships a company establishes with its Customer Segments* **Channels** *How a company communicates with and reaches its Customer Segments*	**Customer Segments** *The different groups of people or organizations an enterprise aims to reach and serve*
Cost Structure *All cost incurred to operate a business model*		**Revenue Streams** *The money a company generates from each Customer Segment*		

Table 2.2 The 9 Building Blocks of a Business Model (adapted from Osterwalder & Pigneur 2010)

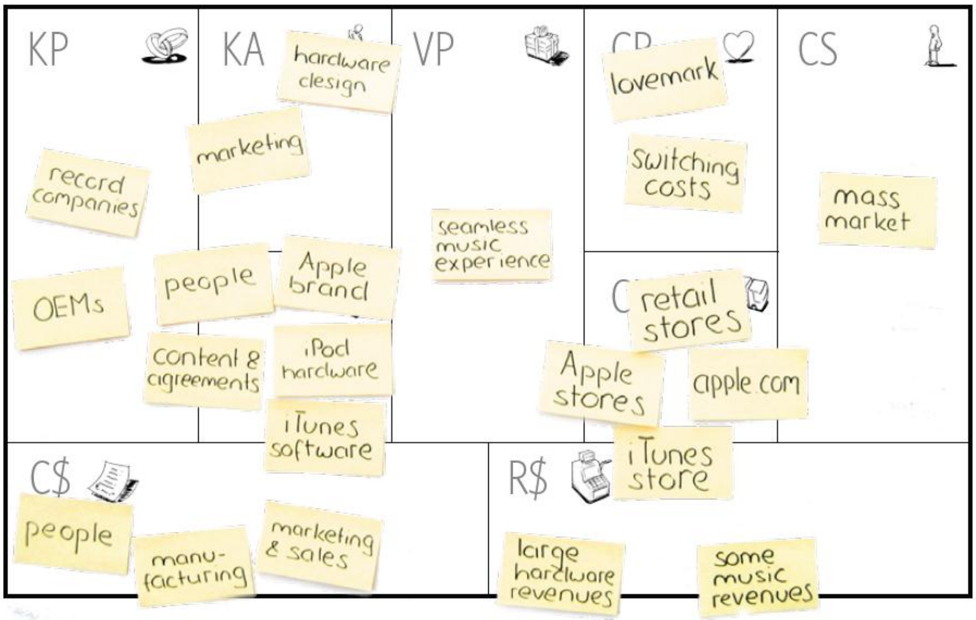


Figure 2.9 Apple's Business Model (Osterwalder and Pigneur, 2010)

Many business and management scholars are quick to point out that a business model is conceptually different from a business strategy (Casadesus-Masanell and Ricart, 2010, Osterwalder et al., 2005, Shafer et al., 2005). Casadesus-Masanell and Ricart (2010) have paid much attention to the difference between these two concepts and explain that a business strategy can be understood as the 'choice of business model through which the firm will compete in the marketplace' (p.196) and therefore a business model is the realization or manifestation of a firm's business strategy. Shafer et al. (2005) lends support to this definition, claiming that a business strategy relates to the choices that businesses make and that a firm's business model ultimately reflects these choices and their operating implications. Osterwalder et al. (2005) explain that a business strategy also takes into consideration how a firm is going to implement its business model.

2.4.1.1 Criticisms of the Business Model Concept

Despite the strength of the concept of the business model in helping to illustrate how firms create, deliver and capture value by fulfilling the needs or desires of their customers, it has also been the subject of criticism for some scholars. One of the major criticisms levelled at this conceptualisation of business activity is how theoretically underdeveloped the discourse is at present (Zott et al., 2011, Porter, 2001). Specifically, concerns have been raised about the extent to which the concept is differentiated from other 'related concepts such as new organizational forms, ecosystems, activity systems, and value chains or value networks' (Zott et al., 2011 p.1038):

> 'It is unclear whether the concept can be meaningfully distinguished from other, already established concepts…As a result, the business model concept remains polysemic and ambiguous' (Perkmann and Spicer, 2010 p.8-9)

Even between those scholars who agree the business model represents a separate theoretical concept, there is still debate with regards to the meanings that should be associated with the concept (Morris et al., 2005), making the application of the business model concept in the context of empirical research particularly challenging (Porter, 2001).

Perkmann and Spicer (2010) have expressed concern relating to the construct validity of the business model concept, which also raises questions about its application to empirical research. They explain that 'it is unclear whether the concept refers to something that actually exists' (p.9). However, we argue that almost all of the components of business models are empirically identifiable, particularly via qualitative research (Figure 2.9).

Another criticism is that the concept provides only a snapshot of an organisation's business logic at a specific moment in time (Mason and Spring, 2011, Osterwalder et al., 2005):

> 'an important limitation of the business model literature is that it only creates a description of the firm at a single point in time and in so doing, fails to take account of the influence of the business network on the business model and vice versa' (Mason & Spring 2011 p.1033)

This means that the approach does not readily accommodate analysis of how businesses change over time and the factors that are responsible for this. However, we argue that through carefully designed qualitative research, one can identify and compare the characteristics of an organisation's current business model with those it applied in the past, and then investigate the internal and external factors that were responsible for these changes. We now examine the phenomenon known as business model innovation (BMI), which refers to the emergence and adoption of novel business models.

2.4.2 Business Model Innovation

Business model innovation (BMI) represents a new frontier in innovation research, one that goes beyond just product or service innovation (Koen et al., 2011). Markides (2006) explains that BMI is not merely the discovery of new products or services, although it may 'redefine what an existing product or service is and how it is provided to the customer' (Markides, 2006 p.20). Nor is BMI simply the modification of an existing product or service, which may make an existing activity cheaper, faster or of a higher quality (Amit and Zott, 2012). Instead BMI relates to the development of a novel activity system for the creation and capture of value (Amit and

Zott, 2010), which can be achieved via a change to at least one of the following; the *content, structure* and *governance* of the activity system (Amit and Zott, 2012). *Content* refers to the selection of activities to be performed and can be innovated via the addition of novel activities. *Structure* refers to how the activities are linked together and in what sequence and innovation can occur here by linking activities in novel ways. Finally, *governance* relates to the parties that perform these activities. Innovation of this dimension involves a change in one or more of these parties: 'Business model innovation can consist of adding new activities, linking activities in novel ways or changing which party performs an activity' (Amit and Zott, 2012 p.41)

It is important to note that the key word here is novel. In order for the transformation of a firm's business model to count as a form of BMI, the new model must not only be novel to the firm but also to other firms and actors throughout the wider socio-technical system. In essence, the model must be original. We do not classify the adoption of an innovative model by a firm, which is already being operated by another firm as a form of BMI. Instead this constitutes a form of business model imitation (Teece, 2010) or replication, which we emphasise constitutes an essential process if a novel business model is to proliferate across multiple organisations[10]. However, imitation may be imperfect, either on purpose or by accident, which may lead to the emergence of an innovative business model (Section 2.3.1.3). In this sense business models are analogous with templates or recipes, which we explore in further detail in Section 2.4.4.1.

So far BMI has received attention primarily from the business and management community (Chesbrough and Rosenbloom, 2002, Johnson et al., 2008, Teece, 2010, Amit and Zott, 2010, Chesbrough, 2007, Chesbrough, 2010), focusing on how BMI represents an effective means of improving a firm's competitive advantage. There are numerous examples of BMI from existing companies who have radically altered their business models, such as Xerox's shift away from the sale of photocopiers towards the leasing of them (Chesbrough, 2010) and Apple's move towards the sale of digitally recorded music, MP3 players and mobile phones, in addition to its traditional business of selling personal computers (Johnson, 2010). There are also multiple examples of start-up organisations, operating novel business models. For example, Wal-Mart's model of putting large stores into relatively small towns which had traditionally been ignored by other retailers (Magretta, 2002) and Google's business model which generated advertising revenue by allowing internet users to navigate the internet via their search engine (Osterwalder and Pigneur, 2010, Teece, 2010).

[10] Not to be confused with business model replication as defined by (Winter and Szulanski, 2001), which relates to the design of a business model that hinges upon the replication of numerous similar retail outlets, i.e. a chain, such as McDonalds or Starbucks

2.4.2.1 The Value of Innovative Business Models

Having defined business model innovation and provided some illustrative examples, we now explore the factors that are responsible for determining whether or not a firm seeks to develop an innovative business model. We do so to provide insight into the reasons why incumbent firms, which may currently practice a distinctly unsustainable but financially successful business model (e.g. Energy Utilities), may choose to transform their model. Amit & Zott identify four key reasons why a firm would decide to develop an innovative business model: *novelty, lock-in, complementarities and efficiency* (Amit and Zott, 2012, Zott and Amit, 2010, Amit and Zott, 2001):

- **Novelty** - There can be substantial first-mover advantages for organisations who are the first to enter a market with a novel business method. For instance, the firm is able to develop brand awareness and reputation before other firms. It is also able to develop benefit from learning experiences and secure scarce resources, providing it with an advantage over organisations adopting the model after them (Amit and Zott, 2001). The novelty associated with the development and implementation of innovative business models is generally considered to be more difficult to replicate than a product or process innovation, thus representing a form of sustainable competitive advantage for business model innovators (Amit and Zott, 2012, Teece, 2010, Zott and Amit, 2010)
- **Lock-in** - Build in elements to retain business model stakeholders, e.g., customers, by introducing 'business model activities that create switching costs or enhanced incentives for business model participants to stay and transact within the activity system' (Amit and Zott, 2012 p.45). An oft cited example is that of the 'razor-razor blade model' pioneered by Gillette, which involved the pricing of razors inexpensively but marking-up the cost of the consumable blades (Teece, 2010)
- **Complementarities** – Bundling activities together to generate more value. For example, some diamond businesses house their management, polishing and distribution activities under one roof, enabling them to tailor stones to the particular demands of each market segment (Zott and Amit, 2010)
- **Efficiency** – Reorganisation of key activities to reduce transaction costs. For instance, Wal-Mart designed its business model to support its low-cost retail strategy, whereby it developed 'highly sophisticated process, such as cross-docking, unrivalled in the industry' (Amit and Zott, 2012 p.46), consequently helping it to gain competitive advantage

2.4.2.2 *Barriers to Firms Adopting New Business Models*

Despite the potential value a business can accrue from engaging in business model innovation and replication, the adoption of a novel business model is not necessarily easy to achieve for a firm or organisation. Chesbrough (2010) highlights for instance the conflict between a firm's existing business model and the novel model they are seeking to adopt. A firm usually needs to continue to operate their existing model effectively, whilst they develop their new model and undertake the transition towards this. This is no easy task and represents a serious organizational challenge as the move towards a new business model requires the firm to 'perform well in their current business (and business model), while at the same time undertaking the experiments necessary to nurture a new model' (p.361).

A firm may be disinclined to overhaul their business model because they might feel uncomfortable about 'venturing into the unknown', considering they are likely to be unfamiliar with the new processes and structures associated with the novel business model. For instance, many companies are prepared to adopt models that have been employed successfully by others but may not be prepared to run the risk of being the first to do so (Roudtable, 2006). Self-preservation is a related factor whereby many 'managers are likely to resist experiments that might threaten their on-going [personal] value to the company' (p.358), meaning that they are disinclined to transform their firm's traditional business model if it continues to work for them because any radical change to that model could undermining their on-going success. Teece (2010) refers to this kind of reaction as the 'cannibalization concern', whereby an incumbent firm may be reluctant to transform its business model if it is likely to entail the cannibalization of its existing profits and/or disrupt important business relationships.

Drawing on the concept of *dominant logic* developed by Prahalad & Bettis (1986, 1995) Chesbrough explains that the dominant logic of the firm can act as a barrier to business model innovation and replication because it is due to this phenomenon that the firm normally seeks to identify and absorb information that 'fits with this logic and eschew that which conflicts with it' (p.358). Consequently, this means that a firm can often ignore information, such as the novel use of technology, which can play a critical role in influencing its decision to either remain with its existing business model or initiate the move towards a different model.

Typically the implementation of an innovative business model will involve the firm-level implementation of systems, processes and assets, which are fundamentally different from those it currently employs. Consequently, the firm may not possess the necessary resources, capabilities or partnerships to successfully make the transition to this new business model

(Teece, 2010). Another important internal barrier are the rules, norms and culture that have become established within the organisation during the operation of their traditional business model, which can often be at odds with the logic associated with the new business model (Johnson, 2010). Even if a firm possesses both the resources and the internal institutional support to implement a new business model, it may still fail to 'understand in sufficient detail how a business model is implemented, or which of its elements in fact constitute the source of the customer acceptability' (Teece, 2010 p.182). This phenomenon is often referred to as 'uncertain imitability' (Lippman and Rumelt, 1982).

2.4.3 Factors That Shape Business Models

We have explored the factors responsible that both enable and inhibit firms to transform their existing business model. In this sub-section we review research that has examined how both internal and external factors firms are responsible for shaping the characteristics of the business models they develop and ultimately employ.

2.4.3.1 Internal Factors

Osterwalder (2004) indicates that the following organisational, strategic and technological characteristics of a business play an important role in shaping firms' business model:

- **Organisation** – The material form a business model assumes (e.g. organisational structure, processes)
- **Strategy** - The company's vision and core objectives
- **Technology** – The various technologies crucial to the firm's business model (e.g. hardware, software, information systems)

Turning to the organisational literature, Nadler and Tushman (1980) explain that both *formal* and *informal* forces, internal to the organisation, are responsible for shaping the characteristics of the firm. Drawing on their work Senior and Fleming (2006) explain that the *formal* sub-system is comprised of the organisation's strategy, goals, and the means of achieving these through operational activities. The *informal* subsystem relates to the more hidden elements of the organization's culture and the politics within that organisation. It also relates to the direction the individuals that manage the company take and the relationship they share with their employees. In essence, factors internal to the organisation are important in shaping an organisation's business model, as well as those external to the organisation.

2.4.3.2 External Factors

Osterwalder (2004) explains that a firm's external environment plays a critical role in shaping an organisation's business model, as it subjects them to constant change. These forces include but are not restricted to environmental factors such as *competition, legal, social, technological change* and *changes in customer demand*:

Technological Change: Firms are normally extremely reliant on technology to operate their business model and achieve their objectives. Technological innovations often present companies with the opportunity to create, deliver or capture value in innovative ways. For example, the advent of the internet constituted a critical factor that was for the emergence of new forms of business (Calia et al., 2007), such as search engine providers (e.g. Google) and social networking sites (e.g. Facebook). Conversely, innovative technologies can also undermine the dominance of incumbent business models by creating such opportunities for novel models to emerge. The case of the internet again serves to illustrate this, as it enabled on-line book retailers such as Amazon to become dominant, at the expense of high-street book retailers, such as Borders.

Competitive Forces: Firms may adapt their business model in reaction to the strategy their competitors have taken in their market. This is particularly true with respect to new entrants threatening the dominance of incumbents, who may change their model to retain their market share (Christensen and Raynor, 2003, Christensen, 1997)

Customer Demand: Changes in user practices, wealth and fashion can place pressure on a company to alter its business model. He cites the example of the move from land-line to mobile telephony, in reaction to consumers desire to communicate outside whilst on the move

Social Environment: The social acceptability of a firm's actions may change over time. If society deems their actions to be unacceptable, potentially for moral reasons, then the company will be under pressure to alter its business model, which happened in relation to Nike's clothing operations in Vietnam (Kahle et al., 2000)

Legal Environment: Regulatory changes can mean a business is forced to transform its business model. For instance, making a business's key activities illegal or alternatively, increasing their overheads or reducing their revenue, which could mean the business is no longer financially viable. Alternatively, regulatory changes could encourage a business to diversify its operations to take advantage of new regulatory incentives

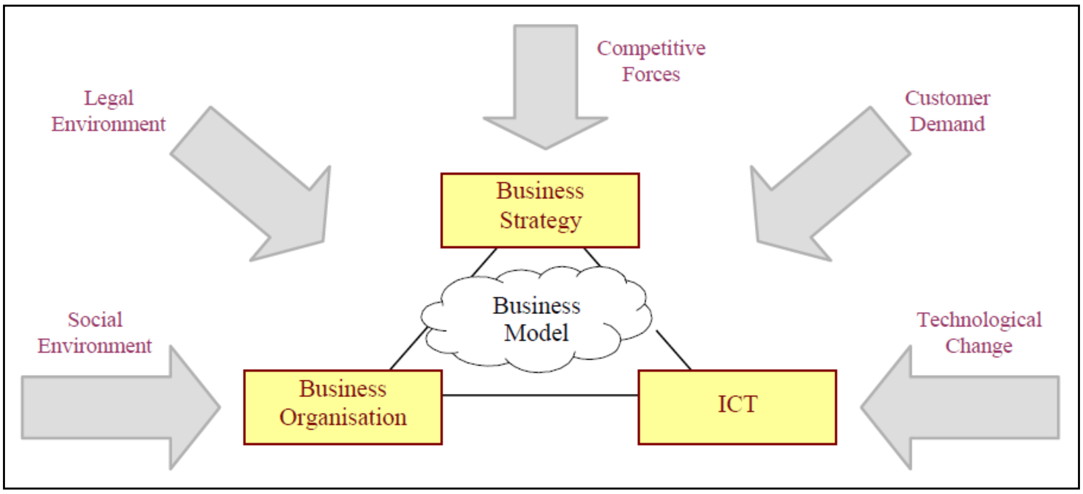


Figure 2.10 Environmental factors that determine business model characteristics (Osterwalder, 2004)

Teece (2010) also emphasises the extent to which a firm's environment influences the characteristics of a firm's business:

> 'Superior technology and products, excellent people, and good governance and leadership are unlikely to produce sustainable profitability if business model configuration is not properly adapted to the competitive environment' (p.174)…'Good business model design and implementation involves assessing such internal factors as well as external factors concerned with customers, suppliers, and the broader business environment' (p.192)

There are many parallels between the work that explores the environmental factors shaping business models and those factors responsible for shaping organizational change. In essence, the organizational change literature emphasises the extent to which the organization operates within an environmental context, which plays an important role in determining its characteristics:

> 'Every organization exists within the context of a larger environment that includes individuals, groups, other organizations, and even larger social forces-all of which have a potentially powerful impact on how the organization performs. Specifically, the environment includes markets (clients or customers), suppliers, governmental and regulatory bodies, labour unions, competitors, financial institutions, special interest groups, and so on' (Nadler and Tushman, 1980 p.39)

A number of approaches have been developed to aid analysis of the macro-environmental factors that shape managerial decision making and thus the characteristics of organisation. These have been referred to by a range of acronyms, namely STEP (Goodman, 1995) and PEST (Johnson and Scholes, 1999), which examine the socio-cultural, technological, economic and political factors. A more comprehensive analysis is known as PESTEL, which emphasises how the following forces influence organizational characteristics (Gillespie, 2011, Senior and Fleming, 2006):

- Political (e.g. government policy, political ideology)
- Economic (e.g. interest rates, economic growth, inflation)
- Social (e.g. demographic trends, lifestyle changes, gender equality)
- Technological (e.g. technological advances)
- Environmental (e.g. climate change, pollution)
- Legal (e.g. minimum wage, discrimination legislation, environmental standards)

2.4.4 How Business Models Shape their Environment

In Section 2.4.3 we illustrated how both internal and external factors are responsible for shaping the characteristics of a firm's business model and thus, those which are responsible for determining whether an organisation seeks to transform its business model or not. In this sub-section we briefly consider how the development and implementation of innovative business models can influence the characteristics of the wider socio-technical system, specifically established industries and incumbent firms.

2.4.4.1 The disruptive influence of BMI on established markets and actors

Making reference to the seminal work of Schumpeter (1934) on waves of creative destruction, Hall and Wagner (2011) explain that the introduction of radical innovations can potentially change the entire structure of a market as these can often render incumbents' product, services and business models obsolete. This idea was captured by Christensen's (1997) concept of disruptive innovation, which was subsequently developed by Christensen and Raynor (2003). In their review of the literature on this topic, Yu and Hang (2010) draw upon Christensen's work to define a disruptive innovation as a form of innovation that provides a different value from past innovations and one that is initially inferior to these along the dimensions of performance that are most important to mainstream customers. However, 'despite its inferior performance on focal attributes valued by existing customers, the new product [eventually] displaces the mainstream product in the mainstream market' (Yu and Hang, 2010) (p.437). This can be attributed to two main factors: 'performance overshoot on the focal mainstream attributes of the existing product, and asymmetric incentives between existing healthy business and potential disruptive business' (Yu and Hang, 2010) (p.437).

Initially this conceptualisation was applied predominantly to technological innovations, to explain how new technologies came to surpass seemingly superior technologies in a market (Christensen, 1997). However, since then this form of innovation has been broadened to include business models (Christensen and Raynor, 2003, Markides, 2006). This is because disruptive innovation can in effect paralyze leading, incumbent firms, who often fail to recognise the threat it poses to their market dominance (Christensen, 2006, Christensen and Raynor, 2003): ‘when incumbents are “overthrown”, it is generally by disruptive innovation’ (Schmidt and Druehl, 2008 p.347). However, disruptive innovation can have a major impact on an existing market and its incumbents without entirely displacing them (Schmidt and Druehl, 2008). In some cases, incumbent firms have played the roles of smart disruptors, such as Sony’s success with the Walkman or HP’s success in inkjet printers (Yu and Hang, 2010).

Business model innovation represents an important form of disruptive innovation (Markides, 2006, Markides and Oyon, 2010). Markides and Oyon (2010) explain that when new business models enter the market, they emphasise different product and service attributes compared to the models of incumbent firms. Consequently, these firms become attractive to different customer segments than those who the value proposition of the incumbent firms resonates with. This leads to the formation of new markets around these new competitors. Furthermore, the needs and activities of these firms are characteristically different from those of the incumbents, making it difficult for the incumbent to wholly or partly adopt this model. This is not initially an issue because the incumbent is likely to regard a business model that is characteristically different from its own, and one which courts a different customer base, as unattractive. However, Markides and Oyon (2010) explain that the balance can soon shift towards the innovative business model and it can begin to have an important influence on the decision making of the incumbents:

> ‘Over time, the new business models improve to such an extent that they are able to deliver performance that is sufficient in the old attributes established competitors emphasize and superior in the new attributes. At this point, even established customers begin to find the new way interesting and begin to switch. Inevitably, the growth of the disruptive innovation attracts the attention of established players. As more customers—both existing and new ones— embrace the new business model, the new business receives increasing attention from both the media and the established players. At a certain point, established players cannot afford to ignore this new way of doing business anymore, and they therefore begin to consider ways to respond to it’ (p.21)

Charitou and Markides (2003) explain incumbent firms can react to disruptive innovation in a number of different ways. These include, (1) focusing on and investing in their traditional model, (2) ignoring the disruptive innovation, (3) developing a ‘second business model’ designed to disrupt the disruptor, (4) adopting the disruptive innovation alongside their traditional model and (5) completely adopt the disruptive innovation. The third of these requires some further explanation. Here the incumbent may establish a 'second business model' that is organisational separate and characteristically distinct from both the incumbent's traditional model, as well as that of the disrupter (Christensen and Raynor, 2003, Markides and Oyon, 2010). The objective here is to develop a novel business model that disrupts the new entrant's business model in a similar manner to how the new entrant initially disrupted the incumbent's (Charitou and Markides, 2003). For instance, in response to Seiko and Timex's low-cost watch business models, the Swiss watch industry developed Swatch, which did not conform to the disruptors' value proposition of '*price, features and functionality*'. Instead Swatch's model emphasised '*style*', as a means of disrupting the disruptors (Charitou and Markides, 2003).

As we outlined in Section 2.4.2.2, it is difficult for firms to operate two characteristically different and potentially conflicting business models. Firms that choose to do so and employ multiple business logics can find themselves 'stuck in the middle' between two distinct business models (Porter, 1980). This can have a negative impact upon their profitability because the firm has to invest time and money in operating both models, which can degrade the value of its existing activities (Porter, 1996). Therefore the incumbent is typically faced with the dilemma of which of the strategies to adopt, as outlined by Charitou and Markides (2003) in the previous paragraph.

Sabatier et al. (2012) explain that in some cases the emergence of novel business models, alongside complimentary technological discontinuities, can lead to the transformation of an industry's prevailing dominant logic, i.e. the general scheme of value creation and capture shared by its actors. Consequently, business model innovation has been identified as one means by which new markets or industries can potentially be created (Teece, 2010, Zott and Amit, 2002) or existing ones are reshaped (Johnson, 2010) as they are often considered 'game-changing to the industry or market' (Johnson et al., 2008 p.58).

Take for instance Apple's ground-breaking introduction of both their iPod and iTunes software, where they sought to sell high-volumes of cheap music via iTunes in order to entice customers to purchase the high margin iPod hardware (Teece, 2010, Johnson et al., 2008). Not only did Apple's business model innovation radically transform the focus of Apple's operations and ultimately its fortunes but it also had a major disruptive influence on the wider music industry, for instance accelerating the transition from in-store to on-line music retail. This resulted in a dramatic change in the fortunes of the incumbent companies such as Virgin Megastore (a distributor, which went into administration as the rebranded 'Zavvi') and EMI (a former FTSE 100 record company currently in financial difficulty), who struggled to adjust to the radical change in the music industry's dominant logic.

The disruptive influence of a novel business model on an established industry can be amplified if it is replicated by other firms. We have already outlined the various barriers firms face in doing so (see Section 2.4.2.2) but as Teece (2010) explains 'in practice, successful business models very often become, to some degree, 'shared' by multiple competitors' (p.179), because successful businesses tend to inspire others to imitate their business model (Gambardella and McGahan, 2010). Consequently Doganova & Eyquem-Renault (2009) have likened business models to 'templates', whilst Baden-Fuller and Morgan (2010) refer to them as 'recipes'. Both analogies imply that business models can be imitated by other organisations but that there is also scope for the organisation to make their own variations to the model. For instance, the budget airline business model, pioneered by firms such as Laker Airways and Southwest Airlines in the early 1970s (Teece, 2010), was later imitated by others such as EasyJet and Ryanair. The proliferation of this model had a particularly disruptive effect on the airline industry, making air travel available to customer segments who could not previously afford it. Consequently, incumbent airline operators, such as British Airways, reacted to this disruptive innovative by establishing their own budget airline venture called Go Fly (Chesbrough, 2007, Markides and Oyon, 2010)[11].

2.4.4.2 BMI and technological innovation

We take a moment to consider the interplay between BMI and technological innovation, which currently represents a core focus for transition and innovation scholars. In section 2.4.3.2 we identified how technological innovation can be responsible for shaping business model innovation, however BMI can also influence technological innovation. Chesbrough & Rosenbloom (2002) explain that a business model constitutes a crucial link between technological development and economic value creation, helping to commercialise and thus promote the uptake of an innovative technology, consequently unlocking its potential. Chesbrough (2010) emphasises the importance of business models to technologies, explaining that 'a mediocre technology pursued within a great business model may be more valuable than a great technology exploited via a mediocre business model' (p.355), meaning that it is likely to enjoy higher levels of adoption. Johnson and Suskewicz (2009) illustrate this by using the case of Thomas Edison and his electric light bulb. They explain that the proliferation of this technological innovation can predominantly be attributed to Edison's focus on developing a

[11] See Strategy #4 for dealing with disruptive innovation as introduced by Charitou and Markides (2003) on page 68

coherent commercial system (or business model), i.e. a 'technical platform [which] included generators, meters, transmission lines, and substations, and he mapped out both how they would interact technically and how they would combine in a profitable business' (p.53)

Returning once again to the example of Apple's business model, the intertwining of Apple's iPod and iTunes played an important role in the proliferation of the MP3 player. Johnson (2010) explains that the popularity of the Apple's MP3 player, the iPod, cannot be explained by it being the first player to enter the market. Nor can it be explained by the iPod being significantly superior in terms of functionality or attractiveness compared to other MP3 players, considering that other similarly attractive and functional players were available on the market at the same time such as Diamond's Rio and Best Data's Cabo 64. Neither can its success be explained by its low-price, as it was a relatively expensive product. Johnson explains that the uptake of this particular form of MP3 player was predominantly because:

> 'Apple did something far smarter than wrap a good technology in a snazzy design; it wrapped a good technology in a great business model. Apple's genius lay in its realization that making it easy and convenient to download music to the iPod would fuel demand for its high-priced music player' (p.14)

The proliferation of the iPod can therefore largely be attributed to the technology being wrapped up in a great business model, which combined hardware, software, and service to provide game-changing convenience for the consumer. Subsequently, the proliferation of the iPod also had implications for the nature and popularity of future technological innovations. In terms of characteristics, the combination of the iPod and iTunes music store, which acted as a platform that connected music right holders directly with buyers, constituted the precursor to the development of the Appstore applications platform, as well as iPhone and iPad technologies (Osterwalder and Pigneur, 2010). Consequently, Apple's initial business model innovation has had consequences for the design of smart phone and tablet computer technologies, which have sought to accommodate these software applications. Furthermore, the popularity of the iPhone and iPad can also to some extent be explained by the success of the iPod and iTunes, which helped to improve of Apple's brand and increased the likelihood of its future products selling well.

2.4.5 Business Model Positive Feedbacks

As we have outlined in Sections 2.4.3 and 2.4.4 business models are shaped by their environment but also play an important role in shaping their environment because they characterize the behaviour of the individuals and organisations that engage with them. Consequently, a number of scholars recognise that business models share a co-evolutionary relationship with the socio-technical system they are operated in, both iteratively influencing and being influenced by the development and implementation of business models (Doganova and Eyquem-Renault, 2009, Mason and Spring, 2011, Teece, 2010, Hagberg and Kjellberg, 2010, Casadesus-Masanell and Ricart, 2010):

> 'Business models might be understood as bundles of interconnecting practices that evolve with the context within which they are practiced – but that in turn influence and shape the context' (Mason and Spring, 2011 p.1040)

Mason & Spring explain that business models are able to influence the characteristics of their environment because they represent bundles of practices and routines, which influence and shape both present and future collective and individual action, 'in this way, the business model is understood as having [the] agency to shape action' (p.1032). Doganova & Eyquem-Renault (2009) reinforce this point by explaining that business models represent active constructs or market devices that are capable of shaping the environment in which they are operate, by playing a performative role that frames the way businesses and markets behave, develop and grow.

Developing upon this notion that business models share a co-evolutionary relationship with their environment, Casadesus-Masanell and Ricart (2010) emphasise that 'business models often generate virtuous cycles, feedback loops that strengthen some components of the model at every iteration' (p.199). They provide a handful of examples in relation to Ryanair's low-cost airline business model (Figure 2.11). They elaborate on one of these in particular (see Virtuous Cycle 1):

> 'As Ryanair's volume increases (because of its low fares), its bargaining power with its suppliers (airport authorities, Boeing, Airbus, etc.) grows, resulting in [low fixed costs and] improvements to Ryanair's overall advantage' (p.199)

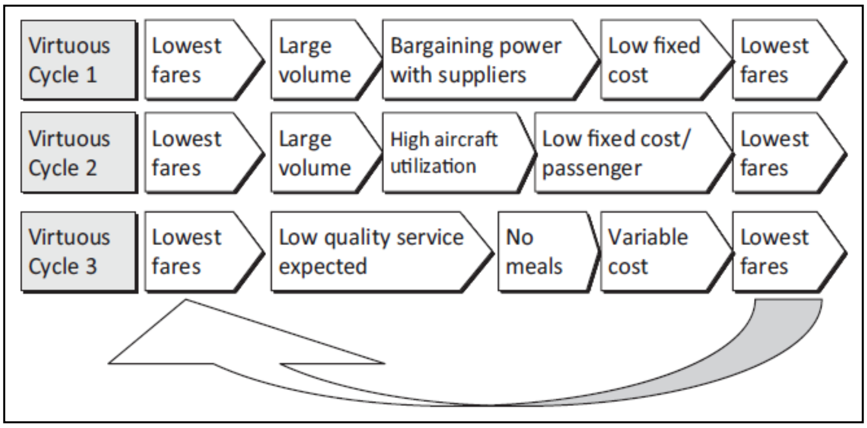


Figure 2.11 Three examples of positive feedbacks in relation to Ryanair's business model (Casadesus-Masanell and Ricart, 2010)

In summary, we find that some valuable research has been undertaken into not only what constitutes a business model but crucially how and why novel business models might emerge and even challenge the prevailing business model within an industry. We also find that research has provided us with some insight into the effect the emergence of alternative business models may have on the wider system, such as its impact on the uptake and design of technological innovations. However, we argue there is a need to analyse the coevolutionary relationship business models share with the various key dimensions of socio-technical systems and not just individual sub-systems (e.g. technology) if we are to fully appreciate the role novel business models play in socio-technical transitions. This is particularly true considering the lack of empirical research into the co-evolution of business models and their socio-technical environment. Additionally, much of the research into the business model innovation has focused on sectors that are not subject to much regulation, such as the entertainment and communications industries. We believe a detailed examination of more highly regulated industries (e.g. transport, energy, water etc), would help to improve our understanding of the factors enabling or inhibiting novel business models to gain traction in sectors where organisations' behaviour is subject to greater constraints.

In the following sub-section we return to the concept of sustainable business models, which we introduced in Section 1.4, to elaborate upon the characteristics such models exhibit. We review the Product Service System (PSS) literature in order to provide some examples of the types of sustainable business models that have been adopted. Following this we discuss why firms may choose to implement such models and the barriers they might face in attempting to do so, before we critique the strength of the relationship between environmental and economic performance. Finally, we identify opportunities for further research into the implementation of sustainable business models. In the following section we introduce the

Energy Service Company (ESCo) model, which represents a potentially sustainable form of energy business model and one that constitutes the unit of analysis for this research.

2.5 Sustainable Business Models

In Section 1.4 we outlined the concept of a sustainable business model as a logic dictating the activities of a business where sustainable development plays an integral role in shaping the firm's decision making (Wicks, 1996, Stubbs and Cocklin, 2008, Wilson et al., 2009). A business adopting such a model creates, delivers and captures value by providing products and services to customers that serve to improve the quality of people's lives but are also sensitive to environmental limits (Uren, 2010). Using a similar framework to Osterwalder and Pigneur (2010), Boons and Lüdeke-Freund (2012) introduce the following characteristics that make-up a sustainable business model:

1. ***Value Proposition -*** 'Provides measureable ecological and/or social value in concert with economic value' (p.5)
2. ***Supply Chain –*** 'Involves suppliers who take responsibility towards their own as well as the focal company's stakeholders. The focal company does not shift its own socio-ecological burdens to its suppliers. This condition requires that a firm actively engages suppliers into sustainable supply chain management' (p.5)
3. ***Customer Interface –*** 'The focal company does not shift its own socio-ecological burdens to its customers [but] also motivates customers to take responsibility for their consumption' (p.5)
4. ***Financial Model –*** 'Reflects an appropriate distribution of economic costs and benefits among actors involved in the business model and accounts for the company's ecological and social impacts (Maas and Boons, 2010)' (p.5)

As illustrated by the *value proposition* above, a successful sustainable business model must deliver not only both environmental and social value but also economic value. Therefore, it must be both environmentally and economically sustainable (Wilson et al., 2009, Stubbs and Cocklin, 2008). Teece (2010) explains that an economically sustainable business model is one that enables a firm to maintain competitive advantage over a long period of time. In summary, 'sustainable organizations must make a profit to exist but they don't just exist to make a profit' (Stubbs and Cocklin, 2008 p.121).

2.5.1 Product-Service Systems

The Product Service System (PSS) literature emerged in response to the perceived need to develop function-oriented business models that are capable of fulfilling societal functions in an economically and environmentally sustainable manner (Tukker and Tischner, 2006, Mont, 2002, Roy, 2000, Stahel, 2007, Tukker et al., 2008). Mont (2004) defines a PSS as 'a system of products, services, networks of actors and supporting infrastructure that continuously strives to be competitive, satisfy customer needs and have a lower environmental impact than traditional business models' (p.iii). Tukker and Tischner (2006) explain that the PSS concept revolves around two key pillars. The first is that it takes the final functionality or satisfaction the consumer desires as a starting point of business development. The second is that development of these systems should take a 'greenfield' mind-set, i.e. ignoring existing structures, routines, firms etc.

The PSS concept has been adopted by scholars as a focus for supporting sustainable development by delivering significant efficiency gains and even decoupling economic growth from resource use (Tukker and Tischner, 2006). This is because firms employing PSS business models are not selling products to consumers, where it is wholly the customer's responsibility to utilise these products to fulfil their needs, thus providing the firm with no incentive to ensure they are utilising these efficiently. Instead, with a PSS business model, the firm is either wholly or partly responsible for fulfilling its customer's needs, thus incentivising them to undertake the various processes necessary to satisfy their needs as efficiently as possible in a bid to minimize their overheads and maximize their profit margin (Tukker, 2004, Tukker and Tischner, 2006).

Three forms of PSS exist, which are as follows (Steinberger et al., 2009, Tukker and Tischner, 2006)(see Figure 2.12 for an example):

> ***Product-oriented***: Provider extends its traditional product-based offer with additional services such as maintenance, take-back and financing schemes. These are relatively easy to implement and require few changes to the firm's business model, consequently providing limited environmental benefits
>
> ***Use-oriented***: Provider sells the use/function of its products as opposed to the products themselves. These may take the form of renting or leasing strategies and may involve sharing or pooling on the customers' side. These services entail some profound business model changes and can result in significant environmental improvements (e.g. Factor 2 decrease in material use)
>
> ***Result-oriented***: Provider contractually guarantees the satisfaction of the customer's needs, without any material consideration. Often based upon radical innovations, it requires drastic changes to the provider's business model, as they assume all the

associated risks and liabilities. Such models can lead up to a Factor 10 environmental improvements

Since its inception, the PSS field has explored a range of different PSS business models to fulfil a range of societal functions. For instance, a number of studies have explored novel automobile business models and their various sustainability credentials (Kley et al., 2011, Wells, 2006, Williams, 2007), such as finance schemes or extended warranties (product-oriented); car sharing, pooling or rental schemes (use-oriented) and pay per mile schemes (result-oriented) (Williams, 2007) (Figure 2.12). Other examples have included chemical management service, resource management and remanufacturing companies (COWI, 2008).

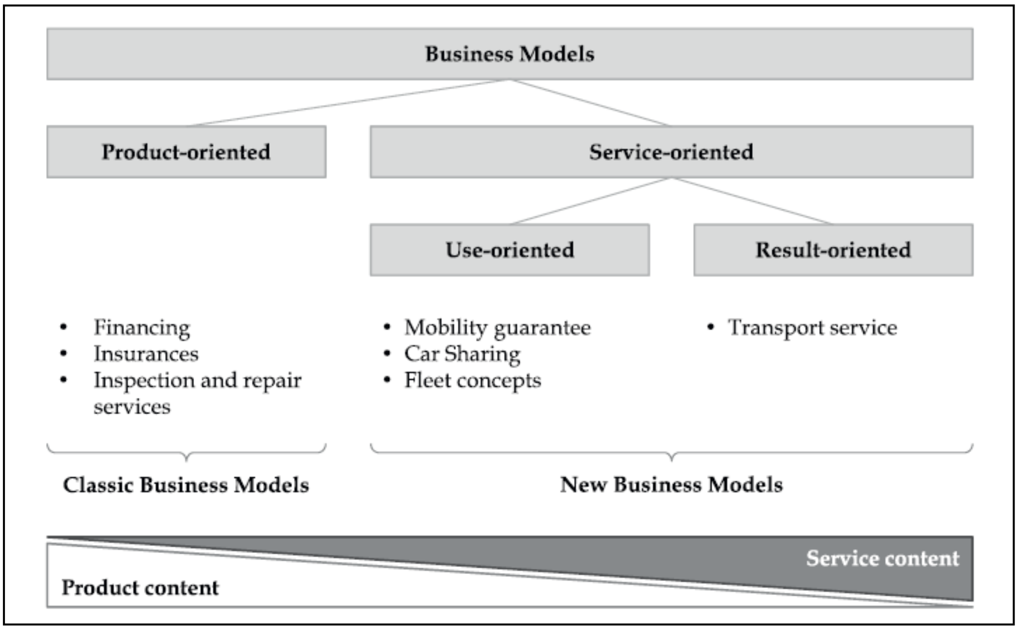


Figure 2.12 Mobility product service systems (Kley et al., 2011 adapted from Tukker 2004)

2.5.2 The Impetus to Align Economic and Environmental Objectives

Having defined what a sustainable business model is and introduced a number of examples in the form of PSSs, we now ask the question 'why would a firm choose to transform its business model in order to integrate both economic and environmental objectives into a coherent and financially viable business?' First and foremost we would argue that firms might be compelled to act in a sustainable manner to ensure there are sufficient resources (e.g. fuel, water, food) available in the future for them to continue to operate effectively. However, many firms do not typically think along such long-term time horizons and are often more interested in short-term financial gains (Charter et al., 2008).

Porter (1991) and Porter and Vanderlinde (1995) explain that strong environmental performance can in fact improve firms' economic performance, which they term 'win-win' situations. This approach teaches us that a firm, through appropriate design of their business model, is able to help conserve the natural environment whilst also enhancing its profits and competitiveness through the improvement of products/services, their production process or through enhancement of product/service quality. This work has come to be referred to as the 'pays-to-be-green' literature (see Hart and Ahuja, 1996, Jaggi and Freedman, 1992, Wagner, 2007, Telle, 2006), which examines the strength of the positive relationship between environmental and economic performance and thus, the extent to which integrating sustainability into a firm's business model represents 'the right thing to do as well as the smart thing to do' (Stubbs and Cocklin, 2008 p.121). This view jar with the neo-classical economic paradigm, which teaches us 'that any additional efforts to improve a firm's environmental performance inevitably yield…lower profits' (Telle, 2006 p.195).

As part of their review of the literature on sustainable business models, Schaltegger et al. (2011) present a list of the various factors that are likely to encourage firms to develop a more sustainable business model, i.e. the business case for sustainability. These are as follows[12]:

- Cost reduction
- Improved sales and profit margin
- Risk and risk reduction
- Improved reputation and added brand value
- Greater attractiveness as employer
- Greater capability for innovation

Drawing on the first of these, some scholars explain that by operating in accordance with the principles of sustainable development, firms can improve economic performance by identifying inefficiencies that translate into cost savings (von Weizsacker et al., 2009, Porter and Linde, 1995). For instance, Ambec and Lanoie (2008) explain that better environmental performance can result in a reduction in the costs associated with the firm's risk management, materials, utilities, capital and labour.

Moving beyond efficiencies, environmental performance can also improve a firm's competitive advantage. According to the resource-based theory of the firm, 'competitive advantage can be sustained only if the capabilities creating the competitive advantage are supported by resources that are not easily duplicated by competitors' (Clarkson et al., 2011 p.126). Some studies have supported the notion that integrating sustainable development into a firm's business model can be an effective means of creating valuable, novel and difficult-to-imitate resources that are essential for the company to gain long-term competitive advantage over

[12] See Schaltegger et al. (2011) paper for references relating to each of these bullet points

their rivals (Hart, 1995, Sharma and Vredenburg, 1998, Hart and Sharma, 2004). For instance it can lead to the firm differentiating its products and/or services, which may result in better access to certain markets (Ambec and Lanoie, 2008).

Competitive advantage can be improved via product and service innovation, which some scholars have explained can be increased if firms embrace the guiding principles of sustainability in their business model (Cohen and Winn, 2007). For instance, Luo and Du (2012) find that companies that have developed comprehensive Corporate Social Responsibility (CSR) programmes have become more innovative. They argue that developing their CSR agenda did not represent a peripheral activity but a pivotal component of competitiveness and growth:

> 'In an era of open innovation and rapidly diversifying knowledge, companies can no longer rely solely on internal resources; they must find ways to bring external ideas into the firm. CSR can be a powerful catalyst for doing that' (p.28)

In essence, integrating the principles of sustainable development into one's business model can in some cases also lead to a range of economic benefits too.

2.5.3 Barriers to Sustainable Business Models

Many of the barriers to developing and implementing innovative business models can also be applied to novel, sustainable models (see Section 2.4.2.2). We briefly identify some others that are considered more specific to sustainable models:

- **Risk adversity**: 'New [business] models carry new risks – to which people are often more risk averse than more familiar risks' (COWI, 2008), i.e. a fear of the unknown. Charter et al. (2008) explain that firms may be concerned that a shift to a sustainable business model may damage the organisation's brand or reputation, which has been built on their traditional model.
- **Short-termism**: Charter et al. (2008) explain that most publicly owned corporations focus on short-term financial gain, typified by the quarterly results PLCs have to provide their shareholders with. This can serve to limit the organisation's decision making and scope to adopt sustainability principles that may require a longer-term perspective to yield a return
- **Lack of awareness and understanding**: A distinct lack of awareness and understanding of sustainable business models amongst both providers and consumers can serve to limit the demand from these parties to engage with such models. This lack of awareness and understanding can also manifest itself as a lack of trust from

consumers in the firm practicing the sustainable business model (Charter et al., 2008, Steinberger et al., 2009, COWI, 2008)

- **Profitability of Existing Business Model**: Many firms are financially successful in their current form and in the current environment, therefore they may be unwilling to change as they have a vested interest in the maintaining the status quo' (Charter et al., 2008)
- **Lack of a Supportive Regulatory and Infrastructural Environment**: A lack of supportive regulatory incentives and/or essential infrastructure can pose a significant barrier to the successful development and implementation of sustainable business models (Charter et al., 2008, COWI, 2008, Steinberger et al., 2009)

Despite the various benefits that have been identified in aligning economic and environmental objectives, a number of academics have hastened to add that it may be premature or even incorrect to simply equate improved environmental performance with better economic performance. Drawing on existing literature (Schaltegger and Synnestvedt, 2002, Steger, 2004, Wagner, 2007), Schaltegger et al. (2011) explain that 'it is an illusion to believe that any kind of automatic relationship exists between voluntary societal [and environmental] activities and business success' (p.7), whilst Tukker and Tischner (2006) explain that 'one simply has to accept that win-wins [do] not always exist' (p.1555). As part of their literature review, Clarkson et al. (2011) support this argument and explain that to date studies on this topic have not established consistent evidence that a proactive environmental strategy enhances firm financial performance (Jaffe and Palmer, 1997, Margolis and Walsh, 2003).

2.5.4 Scope for Additional Research

We concur with Tukker and Tischner (2006) that 'having and depicting sustainable PSS-dreams in themselves will not save the earth', consequently we require a better 'understanding [of] what it takes to realise such dreams' (p.1555). This represents the focus of this research, where we explore one PSS model in particular (the ESCo model) and explore the reasons why it has enjoyed only niche-level applications to date, as well as the nature of developments that could enable it to proliferate. In addition to this, we believe that further research is necessary to understand the factors that might encourage unsustainable but profitable incumbent firms (e.g. Energy Utilities) to move towards novel, sustainable business models, as well as the barriers they are likely to face:

> 'Barring studies on sustainability-oriented service companies described in Halme et al. (2008), there have been few studies that have provided useful insights into how 'stale' business models (Hart and Milstein, 2003) can be transitioned towards more

> sustainable models in firms providing goods and services to domestic and regional markets. In other words, how do firms change their business models to integrate stringent sustainability policies?’ (Hall and Wagner, 2011 p.185)

Finally, we concur with Boons and Lüdeke-Freund (2012) that the literature would benefit from examining the extent to which sustainable business models can facilitate system innovations or socio-technical transitions.

Consequently, we believe a more thorough investigation of the drivers and barriers to sustainable business model adoption is necessary, one which goes beyond a focus on environmental regulation (Porter, 1991) and improved financial performance (Schaltegger et al., 2011), to examine the societal, cultural and political factors that might encourage firms to satisfy their customers’ needs in a sustainable manner. Furthermore, we argue there is pressing need to understand how the implementation of such models could facilitate sustainability transition. As outlined in Section 1.5, we seek to address these needs by investigating the co-evolutionary relationship of the Energy Service Company (ESCo) business model with the various dimensions of the UK energy system. Consequently, as part of this literature review, we now turn to the energy service contracting literature to explore the characteristics, as well as the various strengths and weaknesses of the ESCo model, with a view to providing valuable context for our empirical investigation.

2.6 Energy Service Contracting

Energy services relate to the physical benefit, utility or good people derive from energy (EU, 2006), such as comfort, illumination and mobility. Energy services can be provided to consumers via energy service contracts, which are managed by Energy Service Companies (ESCos). Sorrell (2005) defines energy service contracting as ‘the transfer of decision rights over key items of energy equipment under the terms and conditions of a long-term contract, including incentives to maintain and improve equipment performance over time’ (p.96). The energy service contracts they provide fall into two categories: energy supply contracting and energy performance contracting.

2.6.1 Energy Supply Contracting

As part of an energy supply contract (ESC), an ESCo provides *useful energy* streams to its customers, which Sorrell (2007) refers to as energy streams which have already been converted by primary conversion equipment (e.g. a boiler or CHP plant), such as hot water, coolant and electricity. Here the customer is usually charged per unit of useful energy (Sorrell, 2007) or a fixed price for the supply of a pre-determined level of energy service (Marino et al., 2011)[13]. ESCos take control over the primary conversion equipment necessary to generate these useful energy services in an ESC. This control provides the ESCo with the opportunity to reduce its customer's demand for *delivered energy* (i.e. imported fuel or electricity), predominantly by improving the technical and operational efficiency of its primary conversion equipment (Sorrell, 2007), which in turn helps to reduce the production costs[14] associated with fulfilling its customer's energy needs. However, even though ESCs may provide energy savings, the ESCo does not normally guarantee energy savings as part of an ESC because 'it lacks control over both the efficiency of secondary conversion equipment and the demand for final energy services' (Sorrell, 2005 p.17).

2.6.2 Energy Performance Contracting

Energy performance contracting (EPC) involves the provision of *final energy services* (e.g. lighting, heating, motive power), which represent energy streams that have been converted by secondary conversion equipment (e.g. radiators or fluorescent lighting) and can thus be enjoyed directly by customers, without the need for additional conversion processes (Sorrell, 2007, Sorrell, 2005). Here the ESCo assumes control over the secondary conversion equipment, as well as the distribution (e.g. heat pipes) and associated control equipment (e.g. thermostats, light sensors)[15], meaning it possesses a significant degree of control over the customer's demand for final energy services, as well as useful and delivered energy (Sorrel 2007). The scope of an EPC may also incorporate control of the primary conversion equipment, affording it even greater overall control over the quantity of energy required to satisfy its customer's needs. This arrangement is sometimes referred to as *Total Energy Management* (Sorrell, 2007).

The control an ESCo possesses as part of an EPC, over the conversion, control and distribution technologies required to satisfy its customer's energy needs, enables it to provide certain guarantees relating to the standard (i.e. quality and quantity) of energy service it provides. For instance, the intensity and coverage of lighting, or room temperature and humidity (Sorrell, 2007, EU, 2006). This high degree of control also affords the ESCo the opportunity to identify, deliver and maintain savings on the production and transaction[16] costs associated with fulfilling their customer's energy needs. Consequently, many ESCos guarantee a certain

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[13] This is often referred to as Contract Energy Management in the UK (Marino et al., 2011)

[14] Production costs refer to those incurred for the purchase of material inputs that create energy services. These include conversion, distribution and control equipment; as well as energy commodities (i.e. fuel & electricity) (Sorrell, 2007)

[15] Electronic controls monitor and control the flow of energy from conversion to consumption (e.g. thermostat) (Sorrell, 2007)

[16] Transaction costs refer to those associated with organising (or 'governing') the provision of those streams and/or services, e.g. negotiating and writing the contract (Sorrell, 2007)

standard of energy service (e.g. room temperature) at a particular cost, which is typically lower than their current or projected energy bill (Sorrell, 2007, Sorrell, 2005, Marino et al., 2011, Smith, 2007a).

The different aspects of the energy supply chain that fall under the scope of Energy Supply and Performance contracting are introduced Figure 2.13. We compare these with the contracts traditionally provided by Energy Utilities, where they typically sell units of delivered energy such as gas and electricity[17] to their customers. The key differences between Energy Supply and Performance contracting are summarised in Table 2.3.

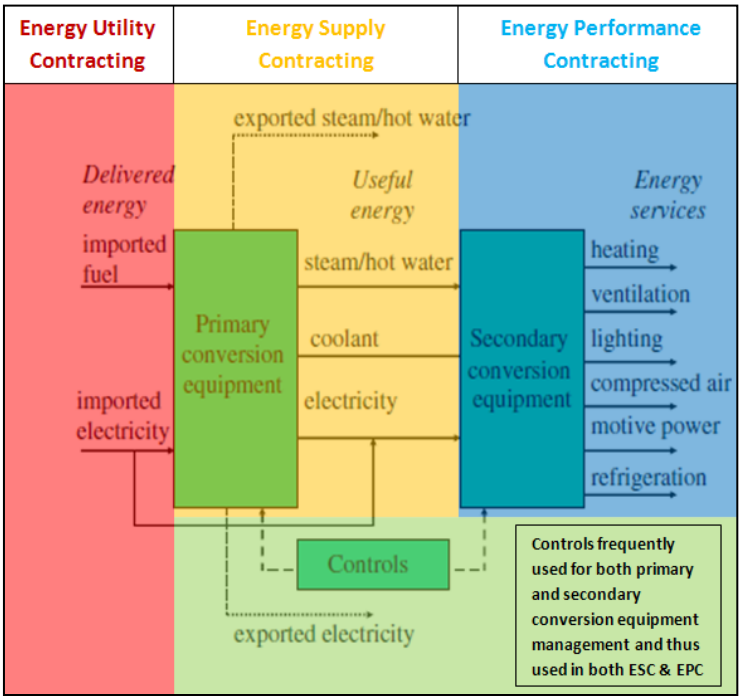

Figure 2.13 Differentiation between forms of Energy Utility and Energy Service contracting (adapted from Sorrell, 2007)

[17] Sorrel makes the differentiation between 'imported electricity' as a form of *delivered energy* and 'electricity' as a *useful energy stream*. We emphasise that both forms of electricity constitute a *useful energy stream* because they have undergone a primary conversion stage. His differentiation instead emphasises the difference between centralised (i.e. 'imported electricity') and decentralised (i.e. 'electricity') electricity generation

Variable	Supply Contracting (ESC)	Performance Contracting (EPC)
Focus	Useful energy streams	Final energy services
Typical technologies	Boilers, CHP, refrigerators etc	HVAC, lighting, building fabric etc
Contract scope	Narrow	Wide
Potential for production cost savings	Low to medium	Medium to high
Anticipated transaction costs	Low to medium	Medium to high
Typical revenue streams	• Unit price for delivered energy • Cost savings achieved on customer's energy bill compared to pre-specified baseline • Capacity charge to cover fixed costs • Government financial incentives (e.g. Feed-in-Tariff) • Sale of energy back to the grid	• Cost savings achieved on customer's energy bill compared to pre-specified baseline • Capacity charge to cover fixed costs

Table 2.3 Comparing energy supply and energy performance contracting (adapted from Helle, 1997, Sorrell, 2007, Sorrell, 2005)

2.6.3 Allocation of Risk and Revenue

As part of any energy service contract, the ESCo will assume some degree or the majority of the technical and financial risk associated with the provision of energy services to their customer (Bertoldi et al., 2006b, Painuly et al., 2003). In terms of *technical risk*, ESCos normally assume responsibility for the design, build, operation, and maintenance of the energy service projects, often guaranteeing the performance of these systems, such as a CHP plant for example (Fawkes, 2007). In terms of *financial risk*, ESCos will either cover the upfront capital costs of the energy service project with their own capital or borrow the necessary funds from a third-party, such as a bank (Bertoldi et al., 2006b, Fawkes, 2007, Smith, 2007a). In both instances financial risk is transferred away from the customer as they are not responsible for the investment. The customer may however choose to part-finance the project with their own capital or borrow the money from a third-party themselves to finance the project (Bertoldi et al., 2006b, Fawkes, 2007, Smith, 2007a). In either case the customer is safeguarded from the financial risk because the customer's investment is normally backed up by the performance guarantee provided by the ESCo (Bertoldi et al., 2006b, CTI, 2003, Smith, 2007a). ESCos often draw on a combination of these funding streams in order to fund their projects.

As part of an EPC, the customer may be offered either a guaranteed or shared savings contract. As part of the former, the customer is normally guaranteed a percentage reduction of the total cost of providing the relevant final energy services compared to a specified baseline level. Here, because 'the ESCo takes over the entire performance risk, it is unlikely to be willing to further assume credit risk' (Bertoldi et al., 2006b p.1821). Therefore, whilst the

ESCo assumes the technical/performance risk for delivering the energy savings, the client will normally have to assume some or all of the financial/credit risk.

As part of a shared savings contract the cost savings are split between both the ESCo and the client according to a pre-arranged percentage (Bertoldi et al., 2006b). The way in which the savings are split between the two parties usually depends upon the cost and length of the project, as well as the degree of risk that each party has inherited. Here, the client takes over some performance risk, because instead of being guaranteed a certain percentage reduction on their energy bill, they are guaranteed a percentage of the value of the energy savings achieved (e.g. 50% of the energy cost savings). This therefore incentivises the client to adjust its own user practices to reduce their energy consumption. As the client assumes some degree of the performance risk, it will consequently try to avoid assuming any credit risk, 'hence a shared savings contract is more likely to be linked with TPF or with a mixed scheme with financing coming from the client and the ESCo (CTI, 2003) whereby the ESCo repays the loan and takes over the credit risk' (p.1822).

The revenue streams differ between supply and performance contracts. As part of an ESC ESCos predominantly recoup the upfront capital costs of the project via the sale of useful energy, whilst as part of an EPC, the majority of their revenue stems from the energy savings they achieve on the customer's energy bill (Marino et al., 2011) (Table 2.3). As these capital costs are normally high and the revenue streams relatively modest, it often takes a number of years to recoup the costs of the project and consequently begin to turn a profit. Therefore, ESCos normally engage in long-term contracts with their customers with supply contracts typically lasting between 20 to 30 years (Fawkes, 2007) and performance contracts between 5 and 25 years (Sorrell, 2005, Smith, 2007a, Westling, 2003).

2.6.4 Weaknesses of Energy Service Contracting

We briefly outline some of the weaknesses of energy service contracting. In the results section, we return to this and present a range of empirically supported strengths and weaknesses of this form of energy service provision.

Sorrell (2007) explains that the viability of energy service contracting is dependent upon a range of variable factors and warns that we should not automatically assume that it represents a financially viable means of fulfilling our energy needs. He identifies 6 factors that help to improve the viability of energy service contracting, without which energy service contracting is likely to be deemed unsuitable:

- A large technical potential for production cost savings for the energy services included within the contract
- Small aggregate production costs for all energy services within the client organisation
- The specificity of the assets required to provide the energy services included within the contract are low
- A low level of task complexity, as measured by the difficulty in specifying and monitoring contractual terms and conditions
- A competitive market for energy service contracts
- An institutional framework that is conducive to contracting

Sorrell (2007) also explains that contracting is normally only financially viable for medium to large-sized businesses, rather than smaller businesses, because they have larger production costs. This is because although contracting may provide a large percentage reduction in the production costs of smaller organisations, these absolute savings are likely to be outweighed by the associated transaction costs. Large organisations may also opt against it because 'the percentage saving in production costs may be less since contracting may offer fewer advantages compared to in-house energy management' (p.520).

One of the major criticisms levelled at energy service contracting and in particular energy performance contracting, is that improvements in energy efficiency can lead to a phenomenon known as the *rebound effect* or *Jevons Paradox* (for review see Herring and Roy, 2007, Hertwich, 2005, Sorrell and Dimitropoulos, 2007). Sorrell (2009) provides an explanation of this phenomenon:

> 'The 'rebound effect' is an umbrella term for a variety of mechanisms that reduce the potential energy savings from improved energy efficiency. An example of a rebound effect would be the driver who replaces a car with a fuel-efficient model, only to take advantage of its cheaper running costs to drive further and more often' (p.1456) (see Figure 2.14)

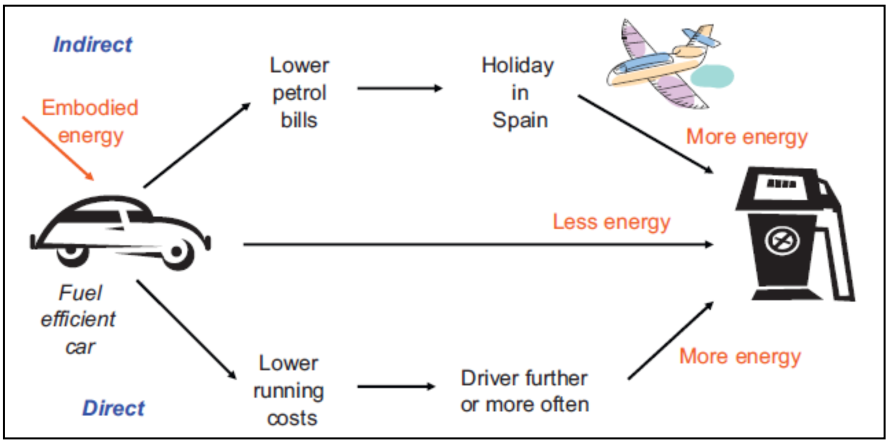

Figure 2.14 Illustration of rebound effect for consumers

Sorrell (2009) explains that rebound effects are categorised by direct and indirect effects. In the context of energy consumption, the former relates to the phenomenon where efficiency gains, and the associated reduction in consumer's energy bills, result in the individual using this spare capital to purchase and consume more energy. The latter relates to the situation illustrated in Figure 2.14, where the money saved on energy is spent on other goods and services that require energy to provide. They also explain that these effects can differ in terms of time frame (e.g. short, medium or long term) and also scale (e.g. individual, firm, sector, country).

Some authors have argued (Brookes, 2000, Saunders, 1992) that this phenomenon can lead to *back fire*, which describes the situation where energy efficiency measures lead to long-term increases in energy demand. Recent empirical studies have revealed that in most cases the rebound effect is sufficiently small to provide some reduction in energy consumption and/or GHG emissions (Barker et al., 2007, Druckman et al., 2011), however in some cases there is evidence to suggest that *back fire* does occur (Druckman et al., 2011). Taking into account these results, Druckman et al. (2011) emphasise the importance of 'moving to lower GHG intensity consumption patterns, and shifting incomes to 'green' investments [as] viable strategies for mitigating rebound' (p.3579) and thus delivering reductions in energy consumption and GHG emissions.

It is also worth noting that although authors in this field emphasise that the rebound effect can have a detrimental impact of the reduction of energy consumption, Sorrell and Dimitropoulos (2007) warn that the quantification of rebound effects is difficult due to a combination of limited data, endogenous variables, uncertain causal relationships, trans-boundary effects and other factors.

2.7 Chapter Summary

In summary, this review has identified that neither the socio-technical transitions nor the co-evolutionary literatures have paid sufficient attention to the role novel, sustainable business models play in sustainability transitions, despite the capability of such models to align environmental, social and economic objectives, as emphasised by the sustainable business model, PSS and 'pays-to-be-green' literatures. Consequently, we argue there is a pressing need to better integrate the concepts of the business model and business model innovation into theories of system change. In particular, we must examine the causal mechanisms that have so far limited the adoption of sustainable business models and reinforced the dominance of incumbent business models because. Furthermore, it is important we investigate the manner in which the proliferation of novel, sustainable business models influence socio-technical system change, in order to develop a more detailed understanding of the role they might play in sustainability transitions.

Taking these factors into account we introduce the analytical framework this research adopts in order to address our overarching research question: *What role could the development and adoption of the Energy Service Company (ESCo) business model play in the transition to a sustainable UK energy system?*

3 Analytical Framework

This chapter introduces the analytical framework this thesis employs, which integrates theoretical concepts drawn from the co-evolutionary and business model literatures, which were reviewed in the previous chapter (Section 2).

An analytical framework represents a tentative theory of the phenomena being investigated, i.e. 'a conception or model of what is out there that [we] plan to study, and of what is going on with these things and why' (Maxwell 2005 p.33). The application of an analytical framework can help to structure the empirical investigation and assist the researcher in the process of making sense of the subsequent empirical data (Smyth, 2004). Consequently, the purpose of applying the integrated analytical framework outlined in this chapter is to help structure and guide the research's empirical investigation, in order to effectively address the research questions. The application of this analytical framework consequently has an important bearing on the design of the methodology this research will employ. Therefore, this section acts as a bridge between the Literature Review (Section 2) and Methodology chapters (Section 4).

In the Literature Review (Section 2) we highlighted the lack of attention both socio-technical transition and co-evolutionary scholars have paid to the interplay of innovative, sustainable business models and the different dimensions that make-up socio-technical systems. As a result we currently have a poor understanding of not only (1) the conditions under which novel, sustainable business models can gain wide-scale uptake but also (2) how the application of such business models might influence wider socio-technical system change and in particular, sustainability transitions. We seek to improve our understanding of the above by developing an analytical framework that integrates insights from both co-evolutionary and business model literatures. Subsequently, we apply this analytical framework to aid analysis of the data generated by this project's empirical investigation into ESCo operation in the UK energy system. By applying this integrated analytical framework, we seek to elucidate our understanding of the following:

- the core characteristics of the ESCo model, which represent a form of novel, sustainable business model
- the causal mechanisms responsible for limiting the uptake of the ESCo model and the continued dominance of the EUCo model
- the extent to which the ESCo model has so far causally influenced UK energy system change and is likely to do so in the future

Our analytical framework combines two conceptually distinct but complementary frameworks, namely Osterwalder and Pigneur's (2010) 9 building blocks framework for business model characterisation (otherwise known as the 'business model canvas') (Section 2.4.1) and Foxon's (2011) coevolutionary framework for analysing a transition to a sustainable low carbon economy (Section 2.3.3.3). The business model framework is selected to assist our efforts in constructing a detailed picture of the core characteristics of the ESCo business model and thus, the ESCo population. Having developed a detailed picture of ESCo business model and thus the ESCo population, we then apply the coevolutionary framework to examine how the evolution of this population has been causally influenced by the different dimensions of the wider UK energy system but also, the causal influence the ESCo population has had on the evolution of these energy system dimensions. Drawing upon our insight into the coevolutionary relationship the ESCo population share with the various dimensions of the UK energy system, in conjunction with empirical evidence of recent and emerging system developments, we then explore how this coevolutionary relationship is likely to change in the future. This will consequently provide us with a stronger understanding of the role the ESCo model is likely to play in a low-carbon transition of the UK energy system.

In this chapter we first re-visit the two different analytical frameworks, which were introduced in the Literature Review. Here we provide a justification for their selection and highlight how we have integrated these. Additionally, we identify potential issues that might arise from employing these frameworks and explain how we intend to address these. Finally, we explain how the two frameworks have been synthesized, underlining the minor changes we have made to the original frameworks as part of the integration process.

3.1 A Framework for Business Model Characterisation

As we emphasised earlier in this section, before we explore the co-evolutionary relationship the ESCo population shares with the wider UK energy system, a necessary first step is to build a detailed picture of the characteristics exhibited by the ESCo model and thus the ESCo population. Consequently, we adopt Osterwalder & Pigneur's (2010) 9 business model building blocks framework as it provides us with a structure around which we are able to populate the components of the ESCo model and consequently provide insight into the mechanics of an ESCo's activity system. The framework teaches us that business models are made up of the following: *key partners, key activities, key resources, customer value proposition, customer relationships, channels, customer segments, cost structure* and *revenue streams* (Section 2.4.1).

Osterwalder & Pigneur's framework has been chosen over other frameworks for business model population primarily because it has been specifically designed to assist researchers' and practitioners' efforts to populate business models. This is evident in the way that they have packaged their framework within their 'business model canvas' (Appendix A - Section 12.1), which has been designed as a template upon which the various dimensions of a firm's business models can be populated. The canvas incorporates a number of sub-questions that are designed to guide enquiry in order to accurately populate the business model under examination. For example, in relation to the business' *Value Proposition*, it asks 'which customer needs are we satisfying?' and 'what bundles of products and services are we offering to each *Customer Segment*?' Additionally the canvas sub-categorises the kinds of business characteristics that relate to each building block. For instance, it categorises a business's *Key Resources* into physical, intellectual, human and financial, whilst it lists various types of *Revenue Streams*, such as asset sales, licensing, usage fees, subscription fees etc. We argue that the sub-categorisation of each building block and the provision of questions designed to help identify components relating to these represents an effective approach to populate business models. In contrast, we argue the majority of the other frameworks that have been designed to aid conceptualisation of a business model (e.g. Hedman and Kalling, 2003, Mason and Spring, 2011, Shafer et al., 2005) provide relatively little practical support to those undertaking an empirical investigation of a firm's or population's business model.

Another strength of the business model canvas is that it has emanated from a comprehensive review of the business model literature (Osterwalder et al., 2005) and thus constitutes a unifying framework that seeks to integrate the various different components scholars have associated with a firm's business model, in order to form a more coherent and comprehensive conceptualisation of the business model:

> 'To identify the most common building blocks among business models in the literature, we compared the models mentioned most often and studied their components. From this synthesis, nine building blocks emerge that cover all the business model components' (Osterwalder et al., 2005 p.17)

Consequently, accounts of business models constructed by this framework can be considered to be representative of the various perspectives on business models that exist in this theoretical discourse, helping to improve the integrity of the research's findings.

Turning to our empirical study it is important to consider whether there is novelty in populating the ESCo business model. To date various studies on energy service contracting have made reference to the business model ESCos employ, often referred to as the 'ESCo model' or 'ESCo business model' (Hansen, 2009, Sorrell, 2005, Steinberger et al., 2009, Goldman et al., 2005). Although this work has been particularly valuable in identifying many of the core characteristics the ESCo model exhibits, these studies have not constituted a holistic and in-depth examination of the building blocks that make-up an ESCo's business model. Consequently, we possess a poor understanding of both the content and mechanics of an ESCo's business model. This has in turn led to some confusion around what actually constitutes an ESCo (Bertoldi et al., 2006a, Hansen, 2011, King and Shaw, 2010, Sorrell, 2005). By populating the ESCo model with this framework we provide a clear and detailed picture of how an ESCo operates, which will help to address this confusion.

Applying this framework also enables us to populate the characteristically distinct Energy Utility Company (EUCo) model, which is similarly poorly understood considering the lack of research that has examined the business model employed by Energy Utilities, particularly in a specific UK context[18]. By populating both the ESCo and EUCo model we are afforded the opportunity to identify the key characteristic differences between these models. Understanding how they are differentiated will better enable us to understand why the EUCo model has so far thrived in the selection environment of the UK energy system, whilst the ESCo model has struggled to survive. In summary, applying this framework will enable us to populate the various components of ESCos' and Energy Utilities' business models, which will provide insight into not only how they operate as viable businesses but also how they operate differently from one another.

3.1.1 Potential Challenges of Adopting Business Model Framework

In the literature review we highlighted a number of criticisms that have been levelled at the application of the business model concept (Section 2.4.1.1). We briefly discuss these and identify the ways in which we intend to mitigate these challenges as part of the design of our integrated analytical framework.

Some scholars have questioned whether the business model concept is sufficiently conceptually distinct from other business related units of analysis, making it polysemic and ambiguous (Perkmann and Spicer, 2010). Instead we concur with the results of Zott et al.'s (2011) review of the business model literature that the business model represents a new unit of analysis, which is conceptually distinct from others and worthy of further academic examination. They explain that this is because a business model incorporates the components and linkages that enable a firm to create, deliver and capture value. It is also distinct in the

[18] The studies that have examined the EUCo business model have focused on the US energy system not the UK (see York and Kuschler, 2011, Valocchi et al., 2010, Small and Frantzis, 2010). These companies are likely to be similar but may not be identical

sense that the boundaries of the business model extend beyond the firm to incorporate its key partners and customers.

There are also concerns that the concept of the business model does not lend itself particularly well to empirical investigation (Perkmann and Spicer, 2010, Porter, 2001). However, we argue that the business model canvas presents us with a user-friendly means of constructing a detailed picture of both the characteristics and mechanics of a particular business model as the framework incorporates sub-questions and sub-categorisations relating to each building blocks (Appendix A – Section 12.1), meaning that a model can be populated relatively easily by collecting data from firms using methods such as documentary analysis and semi-structured interviews.

Finally, with respect to case studies of individual firms, some academics have expressed concern that populating a business model provides only a snapshot of how a firm or a group of firms create, deliver and capture value at a particular moment in time (Mason and Spring, 2011, Osterwalder et al., 2005). This is a valid criticism considering that firms' business models are prone to change over time due to a combination of internal and external factors, as we highlighted in Section 2.4.3. However, we argue that by charting a firm's history through careful empirical investigation, we are able to use this framework to develop a narrative of how the firm's business model has evolved up to the present day. We can also examine why a firm's business model has evolved in this manner by examining how the firm's environment has changed during this same period and consequently, the causal mechanisms that have linked the evolution of the firm's business model with its environment. This framework therefore provides us with the opportunity to develop a narrative of how and why a firm's business model has evolved in the manner it has.

3.2 A Framework for Analysing Business Model and Socio-Technical System Coevolution

In applying the 9 building blocks framework we are able to build a clear and detailed picture of the ESCo model and consequently the various attributes that are common to all ESCos and thus the key characteristics of the ESCo population. However, this framework alone is insufficient to identify the causal mechanisms that have influenced the evolution of the ESCo population in the UK, namely the factors that have led to the emergence of variants of the ESCo model (*variation*), as well as those that have determined the extent to which these variants have been adopted (*selection*) and finally, those factors that have enabled these variants to persist and be replicated by other organisations (*retention*). The framework is also unable to provide insight into how the ESCo population has, to date, influenced the evolution of the various dimensions of the UK energy system (e.g. technology, institutions, user practices etc) and consequently, how it might shape system change in the future. Therefore, we must identify an additional framework that compliments the 9 building blocks framework and is capable of examining the coevolutionary relationship the ESCo population shares with the wider energy system.

In the literature review we introduced Norgaard's (1988, 1994) framework for facilitating the examination of coevolutionary interactions within socio-technical systems. More recently Foxon (2011) has revised Norgaard's framework to better equip it to analyse sustainability transitions, by incorporating some insights from the socio-technical transitions literature (Section 2.3.3.3). It is Foxon's co-evolutionary framework that we adopt for this research and now we briefly outline the reasons why we have selected this over other frameworks.

The key difference between Foxon's and Norgaard's frameworks is that Foxon puts greater emphasis on the importance of the coevolutionary interactions between technologies, institutions and business strategies, a dynamic that has received significant attention not only in evolutionary but also socio-technical analyses of system change. Crucially for this research, whose unit of analysis is the (ESCo) business model, Foxon's framework acknowledges the importance of business activity in shaping socio-technical system change (i.e. the provision of valuable commodities or services to customers in return for revenue streams that outweigh the costs incurred). Although we welcome Foxon's addition of a business dimension to the framework, we do however question the framework's incorporation of the *business strategy* concept as opposed to that of the *business model*. As outlined in Section 2.4.1 a business strategy represents 'the plan of which business model to adopt' (Casadesus-Masanell and Ricart, 2010 p.204). A business model therefore constitutes 'a reflection of a firm's realized [business] strategy' (Casadesus-Masanell and Ricart, 2010 p.205), i.e. what the business does as opposed to what it intends to do. Consequently, we make reference to business models rather than strategies as these represent the locus of behaviours that are responsible for influencing other aspects of the system.

The business model dimension can be considered representative not only of the way private sector organisations function but also public and third sectors (Neely and Delbridge, 2007, Kaplan, 2011). This is predominantly because these organisations also apply a logic that means they are able to provide valuable services in a financially sustainable manner (i.e. where expenditure does not outweigh funding or revenues) and thus, operate very much like any viable business would. In essence, all organisations operate business models and if an organization doesn't have a financially sustainable business model then it will soon cease to exist (Kaplan, 2011). The key difference between models employed by private sector and public and third sector organisations is that public and third sector organisations' key objective is not to generate profit but instead to deliver a range of cost-effective social, cultural and environmental benefits via the provision of products and services.

A key strength of both Norgaard's and Foxon's frameworks is that they focus attention on the five heterogeneous key sub-systems that are considered to represent the most important dimensions that make up a socio-technical systems. As Foxon explains the main strength over the MLP here is that:

> 'this greater degree of analytical separation…focuses attention on the causal influences between systems, and hence may give greater insight into how decisions made by policy-makers or other actors could affect these influences, so as to promote evolution towards more sustainable, low-carbon systems' (p.2262)

In contrast the MLP stresses the inter-connectedness and mutual dependence of social and technical system components (Foxon, 2011). We argue that whilst the MLP does provide some distinction between the different dimensions that make-up the socio-technical regime, i.e. *science, culture, technology, markets/user preferences, industry and policy* (Geels and Schot, 2007), the approach does not explicitly examine the co-evolutionary relationships that exist between these dimensions, instead these relationships are more implicit. Furthermore, unlike Foxon's co-evolutionary framework, the MLP does not provide a break-down of what socio-technical components can be assigned to each of these dimensions. Therefore, we select the co-evolutionary framework over the MLP because we consider it to exhibit three key strengths over the MLP for improving our understanding of how the UK ESCo population has been shaped by the key dimensions that make-up the UK energy system and vice versa. These include a (1) greater analytical separation of the key dimensions that make-up the socio-technical system; (2) greater emphasis on the causal inter-play between these dimensions and (3) greater clarity of what components these different system dimensions are composed of.

We make one further analytical separation in our framework, which is between novel and incumbent business models. This division is important because it enables us to explore how the evolution of non-incumbent firms practicing novel business models is causally influenced by incumbent firms practicing traditional models and vice versa, such as between the ESCo and Energy Utility populations. Furthermore, by separating these dimensions we are able to examine the coevolutionary relationship *each* model shares with the wider energy system. This separation will enable us to examine whether or not the dominance of the EUCo model and the marginalisation of the ESCo model can be explained by co-evolutionary processes, such as positive feedback mechanisms.

3.2.1 Potential Challenges of Adopting the Co-evolutionary Framework

In Section 2.3.3.4 we identified a number of challenges associated with the empirical examination of coevolutionary change. In particular, we highlighted the difficulty associated with identifying the causal mechanisms that are responsible for coevolution. Murmann (2003) explains that the central focus of an investigation seeking to identify coevolution should be to locate 'the bidirectional causality linking the two parties in the relationship' (p. 23) and therefore, 'the key challenge for such arguments is to establish that causal processes indeed do connect the two partners in a co-evolutionary relationship' (p.23). Stenzel (2008) supports this argument and explains that one must seek to identify 'a detailed mechanism that explains how the inter-connection in a coevolutionary relationship is causally linked' (p.64). Murmann (2012) duly takes this approach and identifies three causal mechanisms that operated between the synthetic dye industry and academia during the mid to late 19th and early 20th centuries. These included *exchange of personnel, commercial ties and lobbying*, each of which were responsible for influencing at least one of the evolutionary processes (i.e. variation, selection and retention) that dictated how these two populations evolved.

We take a similar approach for our empirical investigation and seek to identify causal mechanisms that link the evolution of the ESCo population with other key populations that make-up the socio-technical system (e.g. institutions, technologies, business models, user practices, ecosystems). A Straussian Grounded Theory qualitative research strategy is employed to collect sufficient evidence to identify and detail these mechanisms (Section 4).

Kallis and Norgaard (2010) emphasise how important it is for scholars applying coevolutionary frameworks to be sensitive to the multiple levels at which coevolution occurs because biological and socio-technical systems exist within nested hierarchies of other systems:

> 'Evolution takes place at different levels of nested biological and social hierarchies...The conceptual challenge is how to frame the different levels of evolution in social systems and their internal and external interactions, especially with multi-levelled biophysical systems' (Kallis and Norgaard, 2010 p.696)

They explain that future empirical research examining coevolutionary phenomena must be sensitive to 'the different levels of (co) evolution, within and between hierarchies, their weights, and the nature of their interactions' (Kallis and Norgaard, 2010 p.696) and make efforts to map these out. Consequently, with respect to our coevolutionary examination of ESCos, we take care to investigate causal mechanisms operating at multiple levels. For instance this research is sensitive to the nature of regulation, which typically operates at different levels of government, ranging from local to regional to national to international.

Kallis and Norgaard (2010) also warn that space and isolation are under-theorized in coevolutionary analyses. They explain that at present this discourse fails to adequately take into account the influence of the 'friction of distance and the shelter of boundaries' (Clark and Tsai, 2002 p.426) and thus the importance of geography on the evolution of non-biological populations. Geography could potentially play an important role in the evolution of business populations too. For instance, firms operating in an area with similar natural resources (e.g. gas, biomass, wind) may ultimately develop similar business models that are designed to create value from utilising these local resources. Furthermore, firms operating in close proximity to one another may form strong social networks or clusters that may alter the selection environment in that particular area, such as the various IT firms that located in Silicon Valley during the late 20th century. However, globalization is also seen as a phenomenon that has had a potentially moderating effect on the role of space and isolation in non-biological population evolution, as it has opened firms up to knowledge and material flows across the world. Considering these factors, as part of this research we pay attention to how firms' local environment has influenced the evolution of its business model as well as the connections they may have developed nationally or internationally.

Kallis and Norgaard (2010) highlight that a weakness of Norgaard's framework, and by extension Foxon's, is their lack of ability to accommodate for the inequalities of power and agency between actors. We move to address this weakness to some extent by making an analytical distinction between firms practicing novel, non-incumbent business model (e.g. ESCos) and those practicing a traditional, incumbent business model (e.g. EUCos) in our framework. The former are predominantly new entrants who wield less political power than the incumbent firms who have normally spent years cultivating a formidable power base. We argue this analytical distinction between incumbent and non-incumbent firms helps us to examine how inequality of power between these two populations and the subsequent playing out of this power (Shove and Walker, 2007) can influence not only these populations' evolution but that of the wider socio-technical system.

This separation will enable us to explore how incumbent firms may use their political power, via such means as political lobbying, to help cultivate a favourable selection environment that is supportive of their business operations. For instance, Murmann (2012) revealed that industrialists operating in the synthetic dye industries of Britain, Germany, France, Switzerland, and the United States, made efforts via lobbying to ensure that certain academic disciplines obtained a significant share of public research money in order to support advances in organic chemistry that would help to develop a more supportive selection environment for their industry. Additionally, this process of an incumbent group of organisations utilising their political and economic strength may not only help to reinforce the incumbents' dominance but also serve to undermine organisations operating novel business models, if it demands a very different selection environment to proliferate.

3.3 Summary of Integrated Analytical Framework

To illustrate how we have integrated the business model and co-evolutionary frameworks together, we provide a visual representation of our analytical framework (Figure 3.1).

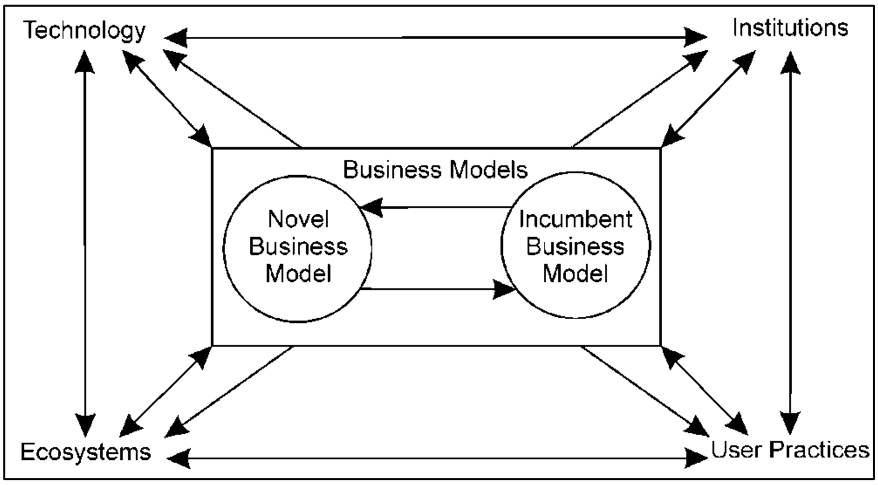

Figure 3.1 An integrated analytical framework illustrating the coevolutionary relationship between novel and incumbent business models and the various dimensions of the wider socio-technical system (adapted from Foxon, 2011, Norgaard, 1994)

This is predominantly based upon on Foxon's framework, although we have made four important changes, which we have both explained and justified throughout this chapter. We briefly summarise these changes and explain our reasons for making them:

1. The business dimension has been centralised as this represents our unit of analysis and represents the central focus of this research
2. In relation to the business dimension, *business strategy* has been replaced with *business model* because a business model constitutes the realization of a firm's business strategy. Therefore, business models represent the locus of established routines and behaviours that characterize firms operating these models, which in turn influence other aspects of the system. The remaining 4 dimensions however remain the same, i.e. *ecosystems, technology, institutions and user practices*
3. We 'open-up' the business model dimension by applying Osterwalder & Pigneur's (2010) 9 business model building blocks framework in order to help us construct a

more accurate and detailed representation of certain business models that characterize different populations of firms. Understanding the characteristics of these firms and the populations they are part of is necessary if we are to appreciate how and why they are co-evolving with their wider environment

4. The business model dimension is split into firms adopting novel and incumbent business models. This is because these business models and thus the firms that adopt them are characteristically distinct from one another. Furthermore, incumbent populations tend to wield more economic and political power than non-incumbent or niche populations of firms. This analytical separation affords us the opportunity to examine the coevolutionary relationship each population shares with the wider system and how these differ, as well as the coevolutionary relationship that exists between these two populations

Although we make specific reference to the ESCo model, this framework could be applied to examine the coevolution between other populations of organisations also practicing novel business models (which may or may not be recognised as sustainable), with the dimensions of other socio-technical systems. Particularly systems that are currently dominated by an incumbent business model (see Section 10.3).

In this chapter we have explained and justified our choice of analytical framework. Its central role is to mobilise relevant theoretical constructs in order to aid our empirical investigation and consequently, assist our efforts in addressing the research questions. We now turn to our methodology, which is designed to mobilise this analytical framework via the application of complimentary methods of data collection and analysis, in a bid to provide the necessary evidence to address our research questions.

4 Methodology

The previous chapter introduced the integrated analytical framework this thesis applies, which integrates a combination of co-evolutionary and business model theoretical concepts. The framework constitutes a written and visual explanation of the key aspects this thesis examines, i.e. 'the key factors, concepts or variables – and the presumed relationships among them' (Stake, 1995 p.14). The framework represents the analytical tools this research applies in order to identify the core characteristics of the ESCo model and subsequently examine the coevolutionary relationship the ESCo population shares with the wider UK energy system. This chapter introduces the methodology this research employs in order to mobilise this analytical framework in a real world context, via a combination of qualitative methods for data collection and analysis.

It is important to note that one of the key criticisms levelled at research that has examined socio-technical system change to date has been the lack of methodological rigour employed (Section 2.2.2.5). In light of this, we argue that by detailing and justifying the methodology we adopt in order to examine the factors shaping system change, this thesis makes an important contribution to this literature by providing a methodological basis for future empirical research of socio-technical transitions to potentially follow.

In Section 4.1 we introduce the Straussian Grounded Theory approach to theoretical development, which forms the foundations of this methodology. Here we justify the selection of this approach with respect to answering our research questions. It is also in Section 4.1 that we outline our reasons for adopting an exclusively qualitative research strategy. Subsequently, in Section 4.2 we outline and justify the scope of the research, before we explain how and why this research is split into two key phases of data collection in Section 4.3. In Section 4.4 we pay attention to the data collection methods employed in both the sector-level (Phase 1) and ESCo case-study (Phase 2) phases of the empirical investigation. Finally, in Section 4.5 we introduce the methods this research adopts for qualitative data analysis. Throughout this chapter we identify potential weaknesses of this research's methodology and the efforts we have made to address these.

4.1 Research Strategy

In this sub-section we introduce the research strategy this thesis adopts to examine the inter-play between the UK ESCo population and the key dimensions of the UK energy system. Here we not only provide a detailed description of the methods this research applies but also a rationale for their selection in relation to addressing our research questions.

4.1.1 Straussian Grounded Theory Approach

This thesis examines the co-evolutionary relationship between the ESCo model, which represents a novel, sustainable business model and the various dimensions that make-up the UK energy system. As we outlined in both Sections 2 and 3, this relationship is currently under-researched. Consequently, we understand little of the inter-play between novel, sustainable business models and the wider socio-technical system, in order to appreciate the role they might play in sustainability transitions. Therefore, this research employs a form of Grounded Theory, known as Straussian Grounded Theory, which enables us to draw on insights from the existing co-evolutionary, socio-technical transitions and business model theory, whilst reserving an extremely important role for empirical observations in the development of new theory. We briefly explore the origins of this approach before we outline how it is used as part of our research strategy.

Grounded theory was first introduced by Glaser and Strauss (1967) to describe an approach where theory is 'grounded' in data and observation, instead of being influenced by pre-conceived theories, thus constituting a counterpoint to positivism (Pidgeon and Henwood, 1997). Consequently, 'systematic data collection and analysis should lead into theory'(Ezzy, 2002 p.7). Glaser and Strauss eventually disagreed on how this approach should be developed. Glaser (1978, 1992) remained faithful to the classic conception of grounded theory as previously described, whilst Strauss, alongside Corbin (1990), adapted the approach.

Both Glaserian and Straussian grounded theory approaches recognise that the researcher does not enter the field without their own ideas and pre-conceptions, which are likely to have been derived from past experience and existing literature. In this sense 'presuppositionless data collection is impossible' (Blaikie, 2000 p.104). However, these approaches fundamentally differ with respect to how researchers should utilise existing concepts before and during the researcher process. Locke (1996) explains that Strauss and Corbin (1990) 'allow for the potential of prior theory, nontechnical literature, and personal as well as professional experiences to help researchers gain insight into the data' (p.242). Ezzy (2002) explains that this Straussian strain of Grounded Theory 'emphasise[s] the role of prexisting theory in sensitising the researcher to orienting questions that need to be examined during the research' (p.12). In contrast Glaser (1978, 1992) objects to this approach, 'advocating the position that the researcher should not bring any a priori knowledge to the research endeavour' (p.242). Despite the obvious contrast between the two approaches, it remains a common misconception that all grounded theory approaches encourage the researcher to ignore existing theory until data is collected and analysed (Suddaby, 2006). As such Ezzy (2002) describes Straussian Grounded Theory as a sophisticated model for Grounded Theory, which draws upon both inductive and deductive methods of theory generation, as illustrated in Figure 4.1 and the following quote:

> 'The task of the [Straussian] grounded theorist is to allow deductions from pre-existing theory to suggest specific research problems and foci, but the researcher must not allow this pre-existing theory to constrain what is noticed. [Therefore,] the grounded theorist uses deductively derived theory, but also examines questions and issues beyond what is suggested by deductively derived theory' (p.12)

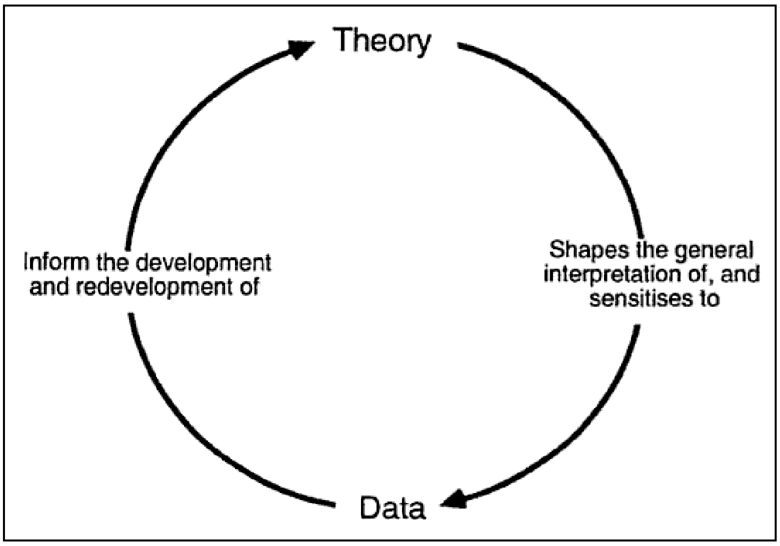

Figure 4.1 The Straussian Grounded Theory Approach (Ezzy, 2002)

As part of this research we adopt Strauss and Corbin's grounded theory approach in an effort to provide insight into the role novel, sustainable business models might play in socio-technical transitions. For instance, we employ an analytical framework built upon existing theory and designed to assist our efforts in making sense of the data collected (Smyth, 2004). In turn, the insights generated by applying this framework to the empirical data are drawn upon to inform the development and redevelopment of theory relating to the co-evolutionary relationship between novel business models and their wider socio-technical system.

A particular strength of a Straussian Grounded Theory research strategy is that it ensures the researcher first engages with the existing theory, affording them the opportunity to identify existing 'gaps' in the literature, i.e. topics that would benefit from additional research. This can help to ensure that the researcher is aware of the research that has preceded their own and thus the type of research that would constitute a novel contribution to science. However, Maxwell (2005) explains that drawing upon theory prior to empirical investigation may cause the researcher to overlook important ways of conceptualizing their study or key implications of your results because 'a theory that brightly illuminates one area will leave other areas in darkness; no theory can illuminate everything' (p.43). Consequently, we make every effort to 'listen' to the data and allow this to inform the development and redevelopment of theory (Ezzy, 2002).

The Straussian grounded theory approach encourages the constant interaction of pre-existing theoretical and experiential insight with the generation of empirical evidence through data collection and analysis: 'in Grounded Theory, the analysis begins as soon as the first bit of data is collected' (Strauss and Corbin, 1990 p.6)(Figure 4.2). This process is otherwise known as the *constant comparative technique*, which entails the constant comparison of new data with existing data, categories, concepts and theory throughout the research process (Bryman, 2012) and is considered one of the most elucidating ways to knowledge (Flick, 2006):

> 'With grounded theory in particular, what appears to be 'discovery' or 'emergence' of theory is really the result of a constant interplay between data and the researcher's developing conceptualisations, a 'flip flop' between ideas and research experience' (Pidgeon and Henwood, 1997 p.255)

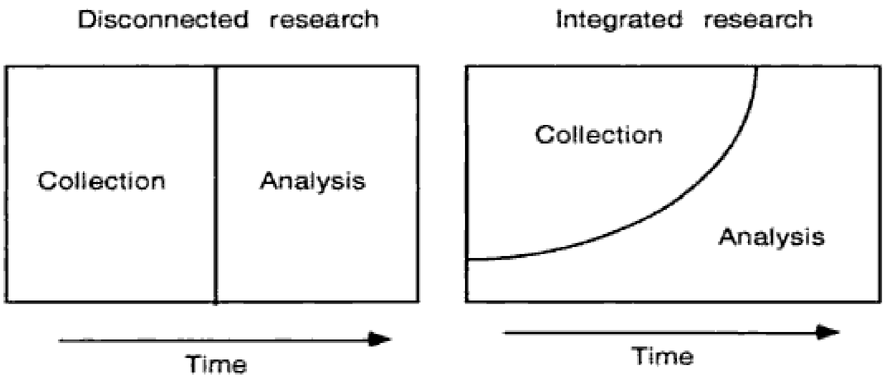

Figure 4.2 Comparison between phases of data collection and analysis for constant comparative method (right) and non-constant comparative method (left) (Ezzy, 2002 adapted from, De Vaus, 2001)

This iterative process of data collection, analysis and theoretical development continues until *theoretical saturation* is reached, which refers to the stage where additional data collection and analysis is unlikely to provide significant additional insight into emergent theory (Bryman, 2012). Strauss and Corbin (1998) explain that this point is reached when:

a) 'no new or relevant data seem to be emerging regarding a category' (p.212)
b) 'the category is well developed in terms of its properties and dimensions demonstrating variation' (p.212)
c) 'the relationships among categories are well established and validated' (p.212)

Bryman (2012) raises concerns about using a Straussian grounded theory to generate theory, explaining that there is generally a relatively small scope for generalizations to be drawn from the data, considering that grounded theory studies tend to have a relatively narrow focus. However, we argue that an in-depth analysis of social phenomena within specific contexts represents a critical stage in developing a comprehensive understanding of how these phenomena play out in various different contexts.

4.1.2 Qualitative Research Strategy

As outlined in the previous sub-section, this research employs a Straussian grounded theory approach, which means that although it draws upon insight from pre-existing theory it also seeks to uncover new insight via empirical investigation. Therefore, it is critical that methods for data collection and analysis are employed that can enable such insights to emerge from the data. Quantitative methods are deemed inappropriate for this research because they fix meaning rather than allowing meaning to emerge through the interplay between researcher and researched (Pidgeon and Henwood, 1997). This is because quantitative research typically seeks to operationalize and test existing theory, which requires hypotheses to be rigidly defined prior to empirical investigation (Pidgeon and Henwood, 1997). Considering that we currently have a poor understanding of the interplay between novel business models and socio-technical systems, it would be inappropriate to develop and test hypotheses without exploring their relationship first in order to provide the necessary insight to generate tentative theory (Weiss, 1994). Consequently, we turn to qualitative methods as a means of generating theory (Blaikie, 2010) relating to the interplay of novel, sustainable business models and socio-technical systems.

Qualitative methodologies are particularly well suited to providing detailed, holistic descriptions of events and their causes, as interpreted by those that experience them (Weiss, 1994). This implies a broadly interpretivist epistemology, whereby the subjective meanings that human actors construct and associate with social phenomena are considered the acceptable form of knowledge (Saunders et al., 2009). Consequently, we adopt a set of appropriate qualitative data collection methods (e.g. semi-structured interviews) that enable us to uncover these subjective meanings, which can provide a rich, deep and textured understanding of the phenomena under investigation and their underlying causes (Bryman, 2012, Pidgeon and Henwood, 1997). Building such a detailed picture of the ESCo business model as well as the interplay between the ESCo population and the wider UK energy system would be extremely difficult to achieve using quantitative methods alone.

Developing such an in-depth understanding of social phenomena and the contexts in which they emerge using qualitative methods can help facilitate insight to emerge, via the interplay between the researcher and the researched (Bryman, 2012, Pidgeon and Henwood, 1997):

> 'Conducting close, detailed qualitative analyses which are grounded in participants' understandings and local contextual knowledges, and which seek to make explicit what is otherwise taken for granted, is an invaluable resource for the generation of new ideas' (Pidgeon and Henwood, 1997 p.252)

The unstructured nature of qualitative research and the ability for it to be employed in natural settings (Bryman, 2012) presents an effective means for gaining insight into the factors that shape real-life, social phenomena, such as the coevolution of the ESCo population and the UK energy system.

4.1.3 Summary of Research Strategy

In this sub-section a brief summary and visual representation of the research strategy is provided (Figure 4.3).

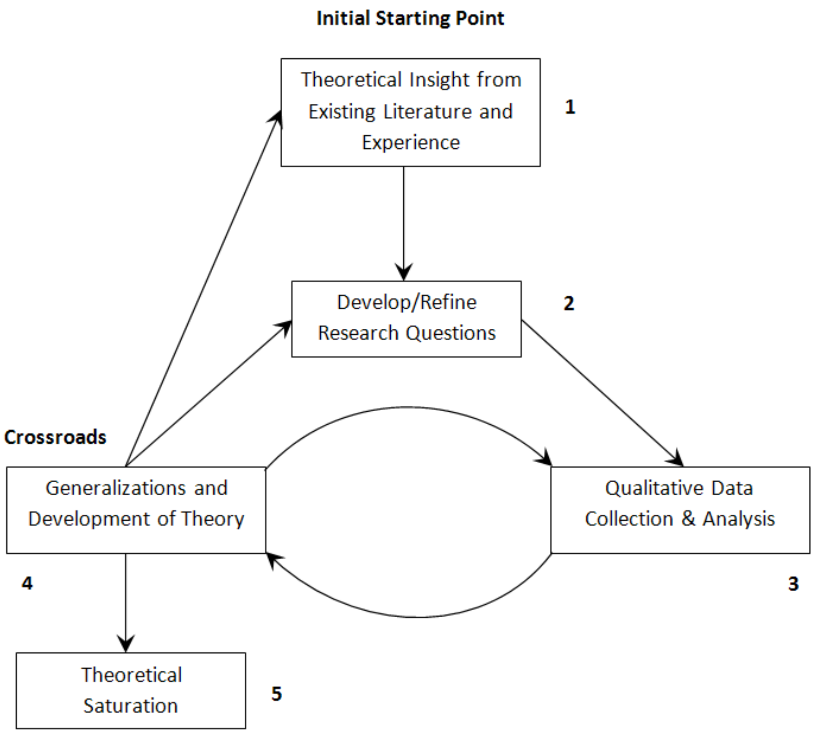

Figure 4.3 Visual representation of key stages of research strategy

Stage 1 - Phenomena worthy of additional research were identified through a detailed review of government, industry and academic literature

Stage 2 - Research questions were structured with the aim of providing valuable insight into these phenomena through generating theory grounded in empirical data

Stage 3 - Data collection was designed and undertaken with the aim of providing the necessary evidence to address these questions and generate theory (Section 4.4). Analysis was undertaken in accordance with the analytical framework introduced in

Section 3.3 and the methods in Section 4.5. Data collection and analysis were undertaken in parallel with one another in line with the *constant comparative technique* (Section 4.1.1).

Stage 4 - In parallel with data collection and analysis, generalizations were sought from the findings of the empirical investigation, considering these constitute the building blocks for the development of new theory (Blaikie, 2000)

Crossroads – After efforts were been made to develop theory from the research findings, it was necessary to make a decision about the next step to take

Return to Stage 1 – At points during the stage of theoretical development (Stage 4), it became evident that we had to return to the literature (Stage 1) in an effort to identify theory that might help to facilitate an explanation of the phenomena that had been observed as part of the empirical investigation

Return to Stage 2 – At other times, instead of seeking additional theoretical insight from the literature, it was considered necessary to refine the research questions. For example, the research questions were deemed unrealistic (e.g. too broad, too in-depth) and/or are unrepresentative of the subjects under investigation and thus required altering

Return to Stage 3 – Towards the end of the empirical investigation it became apparent that that the existing literature was unlikely to provide significant additional theoretical insight into the phenomena under investigation. Furthermore, after multiple iterations, the research questions were considered appropriate. However, after analysis and theoretical development it was decided that additional empirical evidence was required to enable further generalizations to be drawn, thus presenting a need to engage in further data collection and analysis

Progress to Stage 5 - Once theoretical saturation was reached (i.e. additional data collection and analysis was unlikely to provide additional insight into emergent theory) data collection and analysis ceased, marking a period of refining the theoretical insights generated by the investigation

4.2 Research Scope

As outlined in the Introduction, this research is concerned with understanding the role sustainable, novel business models for energy provision are likely to play in sustainability transitions. We identified the ESCo model as a form of sustainable, novel business model that could potentially play an important role in facilitating transitions to sustainable energy systems. The decision was made to identify an energy system already undergoing a transition and one where ESCos were already present as this would be more amenable to an empirical investigation of the role ESCos might play in a socio-technical transition than a system that is *not* undergoing a transition and where there is *no* established ESCo market. The UK was selected as the focus for this research because here the energy system is already undergoing a transition to an alternative system-state and already incorporates a nascent ESCo market. The UK posed a particularly interesting case because the ESCo population is operating within an energy system that is currently dominated by vertically-integrated Energy Utility companies, which employ a very different business model to ESCos. This afforded the opportunity to explore how the interplay between two characteristically distinct populations of energy companies and their interaction with the wider energy system has given rise to causal mechanisms responsible for the locking-in of the EUCo model and marginalisation of the ESCo model.

The scope of the empirical investigation was restricted to the UK, as opposed to a group of countries. Although this would have likely provided valuable insight into the role novel, sustainable business model play in sustainability transitions, the view was taken that investigating ESCo markets in multiple countries would require more time and financial resources than were available for the research. Limited resources also represented an important factor in deciding to select the UK over other countries, considering that the researcher was located in the UK, making research there much more amendable and thus less resource intensive. Additionally, the language barrier and accessibility to information also represented an important consideration.

The scope of the research was also limited to residential and commercial energy service contracting. Again this was a decision made due to the limited resources of the research project. Industrial contracting was also omitted on grounds that the baseline of current industrial energy provision is relatively heterogeneous, making it difficult to draw generalizations from the research, unlike commercial and residential contracting.

4.3 Phased Empirical Investigation

In line with the grounded theory approach outlined above the research was structured to allow for simultaneous data collection and conceptualisation. To allow for intense periods of comparison, the research was split into three different phases (Phase 1a, Phase 1b & Phase 2), after which the researcher was able to spend a period of time to make sense of the data and subsequently, to take stock of the progress that has been made in answering the research questions. The end of each phase presented a particularly good opportunity for the researcher to return to the literature to explore existing theory that could help explain observed phenomena and/or refine the research questions in light of the findings from the data collection and analysis (Stage 4 in Figure 4.3), prior to additional data collection and analysis.

Another important reason for splitting the investigation into different phases was to allow for the opportunity to provide a copy of the results from each of the phases to interviewees and subsequently receive feedback from them on the results of that phase. This method is regarded as an important means of validating data in qualitative research, often referred to as respondent verification or member validation (Lincoln and Guba, 1985, Mays and Pope, 2000). Feedback from interviewees not only helped to validate the results but also informed the subsequent phase(s) of data collection and analysis. Finally, a key reason for splitting the research into phases was to allow for a shift in focus to take place between the sector-level examination of the ESCo population and the case studies of individual ESCos. The sector-level investigation (Phase 1) was undertaken first because it enabled us to identify a handful of ESCos that were suitable for case-study analysis, considering their potential to provide additional insight into the relationship between the ESCo population and the wider UK energy system, as part of Phase 2.

Taking these factors into account the research was split into 3 phases: Phase 1a, 1b and 2. Both phases 1a and 1b constituted a sector-level investigation, whilst Phase 2 incorporated 4 ESCo case studies. In total 43 in-depth semi-structured interviews were conducted with a broad range of ESCo experts, each typically lasting between 30 minutes and an hour long .

Phase		**Date**	**Nos. of Interviews**	**Focus**
1	**1a**	22/7/2010 – 17/1/2011	11	Pilot sector-level study of UK ESCo market
	1b	8/7/2011 – 10/10/2011	20	Sector-level study of UK ESCo market
2		13/7/2011 - 31/1/2012	12	4 case-studies of archetypal UK ESCo variants

Table 4.1 Summary of Research Phases

4.3.1 Phase 1 – Sector Level Study of ESCo Market

Phase 1 constituted a sector level study of the UK ESCo market and was split into two different stages: Phase 1a and 1b. In total it consisted of 31 interviews with ESCo experts from a range of different backgrounds, the details of which are outlined in Section 4.4.1. The purpose of this sector-level approach was to develop a detailed picture of the UK ESCo market and in particular the commonalities and differences between the business models these organisations employ. Furthermore, the sector-level investigation was designed to provide insight into the structure and nature of the UK energy system. Combining a detailed understanding of (1) the characteristics and operations of the ESCo population and importantly, (2) the socio-technical energy system in which these organisations operate, we were able to begin developing theory that could help us to explain how novel, sustainable business models might causally influence the evolution of the various dimensions of the socio-technical system and vice versa.

Phase 1 constituted a cross-sectional study. Consequently, a single interview was conducted with each interviewee at a single point in time, as opposed to multiple interviews with the same interviewee at different points in time (Miles and Huberman, 1994). However, it shared some of the same characteristics a longitudinal study would. For instance, the study was conducted over 15 months, during which the ESCo population and the UK energy system were undergoing changes. Furthermore, it not only took account of the coevolution between ESCos and the UK energy system at present but also in the past, thus taking a retrospective approach (Miles and Huberman, 1994).

4.3.1.1 Phase 1a – Pilot

Both Phases 1a and 1b shared the same focus (i.e. a sector-level investigation of the UK ESCo market), however the two differed in the respect that Phase 1a constituted a pilot study, which informed the design of Phase 1b. Its primary role was to ensure that the research strategy as a whole functioned effectively (Bryman, 2012), however the results were still considered valuable and were therefore used for theory building. As such Phase 1a presented an opportunity to refine the design of data collection, ‘with respect to both the content of the data [sought] and the procedures to be followed’ (Yin, 2009 p.92). For instance, the pilot study helped to refine the interview schedule by illuminating questions that worked and those that didn’t, as well as areas for additional investigation that may not have otherwise been identified, for which new questions need to be drafted (Bryman, 2012, Yin, 2009). In this way the pilot study highlighted aspects of the research design that were both suitable and unsuitable (Yin, 2009), giving the researcher the opportunity to alter its design as necessary (Bryman, 2012):

> ‘No design is ever so complete that it cannot be improved by a prior, small-scale exploratory study. Pilot studies are almost always worth the time and effort [if] any facet of your design needs clarification’ (Light et al., 1990 p.213)

The pilot study was also integral in the development of the ESCo selection criteria (see Section 4.3.2.3), which constituted a number of important, basic characteristics an organisation had to exhibit to be deemed an ESCo. These selection criteria had an important bearing on the guided the interviewee (Phase 1b) and case study (Phase 2) sampling strategies as explained in Section 4.3.2.3. The ESCo selection criteria was important considering that the term ESCo is often misused, having been applied to organisations that often do not fulfil the ESCo criteria (Bertoldi et al., 2006a, Hansen, 2011, King and Shaw, 2010, Sorrell, 2005, Ürge-Vorsatz et al., 2007). Therefore, in order to build a detailed picture of the ESCo model, we had to be sure we were dealing with ESCos and not other forms of organisation that operate similar but characteristically different business models.

Pilot studies are also instrumental in highlighting where the researcher might benefit from returning back to the literature, in an effort to identify existing theory that might help them ‘make sense of what [they] see’ (Maxwell, 2005 p.43) (Figure 4.3). In the context of this study, Phase 1a was only loosely guided by theory relating to socio-technical transitions and thus represented a more Glaserian form of Grounded Theory approach. However, it was during and after this phase of data collection and analysis that the author identified the need to identify an analytical framework that would help to guide the remaining empirical investigation (i.e. Phases 1b and 2) and make sense of the phenomena that had been observed in order to effectively address the research questions (see Section 3 for details of framework).

4.3.1.2 Phase 1b

Phase 1b constituted an extension of the sectoral level study of the ESCo sector conducted in Phase 1a. It incorporated an additional 20 semi-structured interviews, meaning that Phase 1 incorporated 31 interviews in total. As explained in the previous sub-section, the main difference between the Phase 1a & 1b was that in Phase 1b our analytical framework was employed. Therefore, Osterwalder & Pigneur’s (2010) business model building blocks framework was adopted to identify the core characteristics of the ESCo and EUCo business models, whilst Foxon’s (2011) co-evolutionary framework, was employed to provide insight into the manner in which the ESCo population had influenced the evolution of the UK energy system and vice versa. Although the theme of the interviews was not radically different to those in Phase 1a, the adoption of the analytical framework did have a bearing on the structure and content of the interviews. For instance, the adoption of the business model framework helped to structure questions designed to populate the ESCo business model, such as ‘what are ESCos’ core *Revenue Streams*?’ or ‘who are normally an ESCo’s *Key Partners*?’. Naturally, the framework also had a bearing on our analysis as explained in Section 4.5.1.

Another key difference was that the ESCo selection criteria (Section 4.4.1.1), which was both informed by the literature review and refined during Phase 1a, was applied as part of the interviewee sampling strategy for Phase 1b.

4.3.2 Phase 2 – ESCo Case Studies

Phase 2 incorporated 4 cross-sectional case studies of different types of ESCo variant and was designed to build upon the insight gained from Phase 1. The purpose of these case studies was to examine how these 4 different ESCos have coevolved with the various dimensions of the wider UK energy system and provide insight into the causal mechanisms that have shaped this phenomenon (Yin, 2003). Furthermore, by drawing upon the experience and intuition of individuals working as part of the organisations, we were also afforded insight into how the ESCo was likely to coevolve with the UK energy system in the future. We now examine the reasons why a case study approach was adopted in more detail and how these case studies were conducted.

4.3.2.1 Why a Case Study Approach?

Yin (2009) explains that a case study approach is suitable when ‘(a) ‘how’ or ‘why’ questions are being posed, (b) the investigator has little control over events , and (c) the focus is on a contemporary phenomenon within a real-life context’ (p.2). This research fulfils all these criteria considering (a) that research questions (RQs) 3, 4 and 5 are all ‘how’ questions (Section 1.5), (b) the investigator has little/no control over events in the UK energy system and (c) the research examines the contemporary phenomenon of the interplay between novel, sustainable business models and socio-technical system by investigating the real-life context of the ESCo market and the UK energy system. Having identified the compatibility of the case study approach with this particular research project, we now outline the specific need to employ it.

The sectoral level study of the UK ESCo market (Phase 1) identified the key characteristics of the ESCo business model, however it also identified a number of key variants of this model being operated in the UK (Section 6.1.5). A case study approach was subsequently adopted to not only verify and add to the business model characteristics of the ESCo model identified in Phase 1 (RQ 1) but to also provide additional insight into the core characteristics of the business models there ESCo variants employed. In total, 4 case studies, each corresponding to one of the 4 key variants identified in Phase 1 (Table 4.2), were conducted to provide extensive, in-depth, detailed accounts of the business models these ESCos employed.

A case study approach was also employed to develop a more detailed understanding of the strengths and weaknesses of the ESCo model (RQ 2). By talking with numerous ESCo personnel and developing a detailed picture of their operations, we were able to gain insight into what they considered to be the strengths and weaknesses of the business model their organisation had adopted. Furthermore, in undertaking case studies of different variants we were able to better appreciate how strengths and weaknesses differed between these variants, depending on their characteristic differences.

In Phase 1 interviewees often illustrated their responses with examples of individual ESCo's experiences in the UK. However, these examples were often isolated in the sense that they were not situated within the wider context of the organisation's narrative. This meant that only sections of the ESCo's story were revealed making it difficult to identify and differentiate between cause and effect. Therefore, it was decided that in order to provide additional insight into the coevolutionary relationship ESCos share with the wider UK energy system, an extensive and in-depth examination of the narratives of a number of different ESCos was required (Yin, 2009). Therefore, the case studies provided retrospective insight into the nature of this coevolutionary relationship by developing a narrative of these organisations that began from the point at which they were established, up to the present day (RQs 3, 4) (De Vaus, 2001). By conducting case studies, we were also able to improve our understanding of how different ESCo variants had enjoyed different experiences of operating in the UK, considering their characteristic differences. Importantly, the case studies also provided insight into the role these ESCo variants and ESCos more generally were likely to play in a transition to a sustainable UK energy system as interviewees were invited to talk about how and why they believed this co-evolutionary relationship was likely to change in the future (RQ 5).

4.3.2.2 Considering Traditional Criticisms of Case Study Approach

We now briefly consider some criticisms the case study approach has attracted and how we intend to address these in the design of this research.

Reliability

To ensure reliability, the researcher must document the research procedures followed so that an external auditor could in theory repeat these and generate the same results (Yin, 2009). As part of this research a standard set of procedures, similar to a case study protocol (Yin, 2009), were followed to ensure the procedures were replicable but also to ensure that a certain level of consistency between case studies was maintained, in order to enable cross-case generalization to emerge. These procedures included the following:

- An ESCo selection criteria, which had to be satisfied by each case study (see Section 4.3.2.3)
- A set of field procedures that were followed for each case study (e.g. ethical protocol, procedures for gaining access to organisations, data collection methods etc)
- Standard procedures for interview (e.g. semi-structured interview guide) and documentary (e.g. search engine, access via interviewees etc) data collection
- Standard procedures for interview (e.g. transcribing, coding etc) and documentary analysis
- A standard format which each case study reports would follow (Section 6.2)

These procedures are discussed in more detail in the following subsections.

External Validity and Generalizability

One of the major criticisms levelled at the case study approach is its external validity, i.e. the extent to which insights drawn from individual case studies has relevance beyond the case study research site (Bryman, 2012, Blaikie, 2010). One way of improving the 'generalizability' of case study findings is to conduct multiple case studies, across different sites, as opposed to undertaking a single ESCo case study (Firestone and Herriott, 1984, Yin, 2009). Gomme et al. (2000) explain that the scope for generalization can also be improved if the group of case studies selected are representative of the degree of heterogeneity exhibited by the population the case studies are drawn from, in this way 'generalizing is done by making judgements on the basis of knowledge of the characteristics of the case and the target population' (Blaikie, 2010 p.194). To understand the degree of the population's heterogeneity a prior investigation of the population should be undertaken. Phase 1 constituted such a study and identified 4 key variants of the ESCo model, which each of the 4 ESCo case studies corresponded with.

Another recommendation in relation to case study selection criteria is to select 'typical' case studies, i.e. seeking to ensure that the case studies selected can be shown to be similar to other cases in terms of their characteristics (Whyte, 1984). Yin (2003) does however warn that it can be extremely difficult to establish the comparability of multiple cases due to how unique each case normally is. However, on the basis of insights gained in Phase 1, we argue that the 4 case studies selected in Phase 2 can be considered typical cases of the sub-species they represent within the ESCo population.

To improve the scope for generalisations Yin (2009) also recommends that the researcher employs multiple methods for data collection to allow for the convergence of evidence and consequently, the process of triangulation. Therefore, both interview and documentary analysis were employed (Section 4.4) to allow for triangulation and thus affording us a stronger position from which to generate cogent theory (Bryman, 2004).

4.3.2.3 ESCo Selection Criteria and Selected Case Studies

The first criterion for case study selection was that each of the case studies satisfied the ESCo selection criteria as outlined in Section 4.4.1.1 to ensure that the organisations selected constituted ESCos. Another important criterion was that each of the case studies corresponded to one of the key ESCo variants selected in Phase 1[19], i.e. *Independent Energy Service Provider, Energy Utility Energy Service Provider, Local Authority 'Arm's Length' ESCo and Community ESCo* (Table 4.2).

A decision had to be made to select one ESCo for case-study examination over other potential case-study candidates. This was normally a question of how accessible personnel were for interviews and the accessibility of primary literature for documentary analysis, which was gauged during Phase 1 when interviews were undertaken with representatives from a range of different ESCos. Another important selection criterion was that the ESCo had to have been operational for a number of years so that an extensive, rich and in-depth narrative could be developed.

Company	Type of ESCo Variant	Dates	Nos. of Interviews
Thameswey	Local Authority Arm's Length ESCo	10/1/2012	2
MOZES	Community Owned and Run ESCo	(9/8/2011) 2/2/2012 - 9/2/2012	3 (4)*
Honeywell	Independent Energy Service Provider	(23/7/2011) 3/4/2012 - 2/5/2012	3 (4)*
Energy Utility X	Energy Utility Energy Service Provider	(22/9/2011) 16/1/2012 - 1/2/1012	4 (5)*

Table 4.2 Case studies of ESCo variants conducted for Phase 2

*This denotes that one interview conducted in Phase 1 was used as evidence for the case study. The dates of these are provided in brackets. Consequently, only 12 additional interviews were conducted in Phase 2, even though the case-study analysis incorporated 15 interviews

[19] The different ESCo variants are examined in detail in Section 6.1.5

4.4 Data Collection

We now explore the qualitative data collection methods employed in both Phases 1 and 2, and explain the rationale for selecting these.

4.4.1 Phase 1 Data Collection

Data collection during Phase 1 was centred around semi-structured interviews with experts on ESCo operation, specifically in the UK.

4.4.1.1 Semi-Structured Interviews

Phase 1 consisted of 31 interviews, where interviewees were invited to talk about (1) the core characteristics of the ESCo model and its different variants, (2) the strengths and weaknesses of the ESCo model, (3) how environmental factors have shaped the characteristics of the ESCo population, such as its size, heterogeneity etc, (4) how ESCos have influenced UK energy system change and (5) how they believed emerging developments could alter the co-evolutionary relationship between the UK energy system and the ESCo population. Interviewees were encouraged to illustrate their responses with specific examples of ESCo activity, as well as examples of broader developments in the sector, in a bid to provide additional richness to the empirical data.

Interviews were selected as the preferred method of data collection because they provide 'access to the observations of others' (Weiss, 1994 p.1). They represent a particularly powerful means of learning about places we have not visited and about settings in which we have not lived, thus helping to inform us about the nature of social life (Weiss, 1994). Interviewing enables the researcher to uncover the meanings and interpretations that social actors ascribe to social phenomena (Blaikie, 2010), helping us to identify the perceived causal inferences and explanations for these (Yin, 2009). Taking these factors into account, this method was selected to help us develop a picture of the UK ESCo market and energy system but also the reasons why these have evolved in the manner they have.

Weiss (1994) explains that interviews can provide us with a window on the past, enabling us to build a detailed picture about the nature of social phenomena and the factors responsible for their emergence. They can also help to elucidate our understanding of what could happen in the future. With respect to this research interviewees were not only invited to discuss how the interplay between ESCo population had influenced the various different dimensions of the UK energy system but also to hypothesize about how this dynamic might change in the future by drawing upon their own knowledge and past experiences, as well as insight into on-going and emerging market developments. In some cases they made reference to probable, imminent developments such as the ratification of regulation, which would most likely have an important bearing on the UK energy system. In other instances, they made reference to plausible and/or possible developments, such as rising energy prices or the proliferation of sustainable user practices.

Saunders et al. (2009) highlight the value of semi-structured interviews. In comparison to structured interviews they allow the interviewee to lead the discussion to a large degree. This can often mean that they lead the discussion into areas that the researcher had not previously considered but which provide valuable insight into the phenomena being investigation. They also explain that this technique also allows the interviewee to 'think aloud' about issues they may not have previously considered. The interviewee often has to go through this process to provide insightful responses to the interviewee's own answers. This method also provides the interviewer with sufficient control to cover the necessary themes during the interview and also to probe answers that require further explanation from the interviewee, helping the interviewer to 'understand the meanings that participants ascribe to various phenomena' (Saunders et al., 2009 p.234). The semi-structured method therefore provides a balance between the benefits of structured and unstructured interviews.

Despite the strengths of the interview method for data collection, we acknowledge it does have its limitations. For instance, Weiss (1994) explains the interviewer must be aware that the interviewee may indeed omit certain pieces of crucial information relating to the interview questions for a range of different reasons (e.g. trust, confidentiality etc). It is also possible that the interviewee's interpretation of events may not present a sufficiently accurate account of past events to be able to identify the causal factors of social phenomena, possibly due to an imperfect recollection of events. It is for these reasons that a large number of interviews were conducted, which all followed a similar interview guide, in order for us to be able corroborate interviewees' accounts (Weiss, 1994).

To avoid bias responses, the interview guide included questions that were open ended, allowing the interviewee to provide a wider range of responses to the same question, i.e. where possible the questions were not 'leading'. In some instances questions were asked in relation to specific phenomena that the interviewee had made reference to, in order to provide them with the opportunity to embellish their account.

Interviewee Sampling Strategy

In line with the Straussian Grounded Theory approach, a theoretical sampling strategy was employed, considering that it constitutes a 'defining property of grounded theory' (Charmaz, 2000 p.519). Theoretical sampling is understood as:

> 'the process of data collection for generating theory whereby the analyst jointly collects, codes and analyses [their] data and decides what data to collect next and where to find them, in order to develop [their] theory as it emerges. The process of data collection is *controlled* by the emerging theory, whether substantive or formal' (Glaser and Strauss, 1967 p.45)

Therefore, data collection and analysis did not represent a pre-planned linear process of testing hypotheses (Blaikie, 2010). Instead, it constituted 'an evolving process in which what has been 'discovered' at any point will determine what happens next' (Blaikie, 2010 p.143). As illustrated by Figure 4.3 in Section 4.1.3, sampling continued until theoretical saturation was reached.

Turning to the types of individuals this research sought to interview, a core criterion for interviewee selection in Phase 1 was that they had extensive experience of ESCo management and/or working alongside ESCos. In relation to the former, this meant interviewing individuals who were either currently employed by an ESCo or had recently been so. Expanding upon the latter, this meant that the interviewee was working or had recently worked with ESCos in an operational (e.g. provision of financial, technical or legal expertise) and/or strategic capacity (e.g. design of ESCo related policy). However, interviewee sampling was complicated by the issue that the term ESCo is often a contested and often misused term (see Section 3.1). Therefore, the decision was made to identify a core set of characteristics that ESCos exhibited in order to guide our selection of ESCo, from which we could then select interviewees who had extensive experience and knowledge of these kinds of organisations.

ESCo Selection Criteria

An initial set of ESCo selection criteria were developed from the existing literature relating to energy service contracting, which provided us with valuable insight into what constituted an ESCo. Consequently, these criteria guided the sampling strategy for Phase 1a.

During Phase 1a these criteria were refined as a more detailed and accurate picture of what constituted an ESCo emerged from the data collection and analysis. These refined selection criteria were subsequently adopted to guide interviewee selection for Phase 1b and case study selection in Phase 2. By using these criteria as opposed to only selecting organisations that were referred to as 'ESCos', we avoided the issue of selecting organisations that had been incorrectly termed ESCos, or omitting organisations that had not been labelled as ESCos despite exhibiting the necessary characteristics. The ESCo criteria were as follows:

- Provides either *useful energy streams* and/or *final energy services* to customers, not units of *delivered energy* or primary energy (e.g. gas) (see Sorrell, 2007)
- Provides either Energy Supply or Performance Contracts (as outlined in 2.6) where the ESCo is committed to an on-going, long-term service arrangement that stipulates the provision of a certain quality and/or quantity of energy service(s) to its customer
- Assumes all or some of the technical and financial risk associated with the supply of energy services to its customer
- Recoups the upfront costs associated with delivering these energy services via on-going revenue streams (e.g. sale of energy to customer, receipt of financial incentives) and/or any cost savings achieved on the customer's energy bill over a long-term period

Once the relevant organisations were identified it was then a matter of identifying individuals who had extensive experience and knowledge of ESCos. Interviewees were identified via an extensive review of academic, governmental, industrial and third sector literature relating to ESCos in the UK (as defined by the selection criteria above). This review provided us with details of individuals both working directly and indirectly with ESCos. In particular, high-quality reports, papers, presentations etc on ESCos were useful for providing names of ESCo experts. Additionally, websites of individual ESCos or those associated with the energy services industry (e.g. National Energy Action, Energy Services and Technology Association, Energy Savings Trust) were also helpful for identifying interviewees. Suitable interviewees were then invited along to interview via a personalised invitational email. Snowball sampling was also employed , whereby interviewees were asked to identify other individuals who might possess valuable information relating to the research questions. In some cases prospective interviewees were identified by other interviewees, who provided the referral.

The sampling strategy was designed to ensure that a broad range of experts from different professional backgrounds were interviewed in order to provide a variety of different perspectives on ESCo-related issues. Although all interviewees were required to have an expert understanding of the ESCo business model, efforts were made to select a range of interviewees who possessed expertise in different disciplines (e.g. financial, legal, architectural etc) (Appendix E – Section 12.4).

Ethical Considerations

'Data collection is associated with a range of ethical issues' (Saunders et al., 2009 p.193) and these should be considered and addressed as part of the research design. One of the most important ethical considerations relates to interviewee consent. As Weiss (1994) explains it is important to gain the interviewee's written consent to be interviewed. In line with his recommendations, as part of the data collection all interviewees were provided with an email and separate document outlining the content and purpose of the research to provide the interviewee with the necessary information to make an informed decision regarding consent. Furthermore, they were also provided with a consent form that was either sent prior to the interview or presented during the interviewee. Interviewees were required to read, complete and sign the consent form, which stipulated the manner in which they were prepared for the information they provided to be used because 'confidentiality and anonymity may be important in gaining access to organisations and individuals' (Saunders et al., 2009 p.194). During the interview the interviewee was also requested to highlight any confidential information before or after they provided it so that it could be omitted from analysis. The details of all interviewees were also anonymised.

It is important to note that the research project as well as the related ethical documentation (e.g. information sheet, consent form) was reviewed and approved by the Ethics Committee at the University of Leeds.

Interview Technique

All interviews followed an interview guide, which included a list of themes and questions to be covered with the interviewee (Saunders et al., 2009). Although the interviews covered similar themes and questions the nature of semi-structured interviews is that these sometimes varied from interview to interview. Furthermore, the order of questions also 'varied depending on the flow of the conversation' (Saunders et al., 2009 p.320). It is also important to note that additional questions were sometimes included if the interviewee had made a particularly revealing remark relating to the research questions, which probing could provide valuable insight into (Saunders et al., 2009).

Ideally interviews were conducted on a face-to-face basis because this allowed us to more accurately gauge the reaction of the interviewee and ask questions accordingly. Furthermore, it meant that a stronger rapport was built between the two parties, which often helped the interviewee to relax and consequently, provide more revealing information. They were also predominantly conducted on a one-to-one basis to allow the interviewee to respond without interruption or interference from other interviewees. Where face-to-face interviews were not possible either due to the interviewee's schedule or because such a meeting was logistically difficult (e.g. rural, long-distance away etc) and/or too resource intensive, phone interviews were conducted. All interviews were recorded via Dictaphone to enable the interviews to be accurately transcribed.

Potential Weaknesses of Interview Method

Weiss (1994) warns that one of the potential shortcoming of employing interviews for data collection is that we as interviewers 'cannot assume that we will be told the whole truth nor the precise truth. If respondents want to keep from us events or behaviours or a sector of their lives, there is every reason to believe that they can succeed' (p.149). He explains that to address this inaccuracy or bias within the data, we should look to other records for corroboration. Consequently, we conducted a large number of interviews in Phase 1 (31 in total), which presented us with the opportunity to compare and contrast responses from interviewees, relating to the same issue or event.

Access to interviewees was also an issue in some cases considering that not all interviewees responded to their invitation and those that did were either unable to be interviewed due to confidentiality reasons, time constraints etc. Although sufficient data was collected to enable generalisations to be drawn and theory to be developed, a handful of individuals who could have provided valuable insight were sadly not interviewed.

4.4.2 Phase 2 Data Collection

Data collection was again centred around semi-structured interviews, with an additional 12 interviews being conducted across 4 different organisations. Unlike Phase 1, primary documentary evidence formed an integral aspect of data collection in Phase 2, being used to provide additional information to construct the narratives of each ESCo (Section 4.4.2.2). This allowed for triangulation to take place between interview and documentary evidence, helping to improve the reliability of results (Yin, 2009). Furthermore, it allowed for the design of predominantly retrospective case studies to be developed 'through the use of archival records and documents, or interviews with people who participated in or observed past events' (De Vaus, 2001 p.227)

4.4.2.1 Semi-Structured Interviews

Yin (2009) identifies interviews as 'one of the most important sources of case study information' (p.106) due to their ability to target relevant information, which normally provides sufficient insight to identify perceived causal inferences and explanations. The interview sampling strategy was very similar to that employed in Phase 1 (see Section 4.4.1), however in Phase 2 only senior personnel from a single ESCo were selected for interview for each case study, as opposed to a broad range of experts from a range of ESCos and non-ESCos, as employed in Phase 1. The only exception was the Thameswey Energy case study where a member of Woking Borough Council was interviewed. This was because the council own Thameswey.

The ethical considerations and interview technique (Section 4.4.1.1) were the same as in Phase 1, however although interviewees were asked similar questions to those in Phase 1, these were phrased in relation to a specific ESCo (i.e. the ESCo they were affiliated with) as opposed to ESCos more generally, in order to encourage responses that related back to that ESCo in order to help construct the case study. For instance, instead of asking 'what are the core characteristics of the ESCo business model', interviewees were asked 'what are the core characteristics of your organisation's business model?'

4.4.2.2 Primary Literature

Primary literature[20] was used to construct the case studies as it provide qualitative, detailed information of events stretching back over a number of years, which was helpful in developing the narratives of each ESCo's evolution since formation (Yin, 2009). It was particularly useful in providing precise details relating to the ESCo's operations, such as the quantification of carbon and cost savings achieved, turnover, expenditure, number of personnel etc. This kind of precise numerical data was often hard to come by during the interviews and so documentation proved extremely valuable. Furthermore, rather like the transcripts, documentation can be revisited at a later date for analysis (Yin, 2009), when new ideas or connections may have occurred to the researcher, thus putting the documentation in a 'new light'.

Documentation produced by the case study ESCos was collected alongside case studies of these organisations that had already been compiled by reputable organisations (e.g. Energy Savings Trust, NESTA, CHPA etc). In some cases, archival data was collected to provide valuable context for the case study (Yin, 2009), which could help to explain why the company was established and has since evolved, such as statistical data relating to an area's level of fuel poverty, mix of housing stock, disposable income etc.

A significant amount of primary literature relating to the 4 ESCo case studies had already been sourced as part of the extensive review of academic, governmental, industrial and third sector literature relating to energy service contracting and ESCos in the UK conducted as part of Phase 1 (Section 4.4.1.1). Additional documentation was sourced via internet searches that typically included the name of the case study ESCos and/or the names of their personnel. Other valuable documentation was provided by interviewees. In all cases, it was important to take into account that this documentation was likely to incorporate the bias of the ESCo or the organisation's reporting on the ESCo (Yin, 2009).

[20] Primary literature refers to documentation that constitutes the first occurrence of a particular body of information or research, such as company reports, employee presentation, conference proceedings, archival records (e.g. census data, maps etc)

4.5 Data Analysis

This section identifies the methods of data analysis that were employed and the reasons for their selection.

4.5.1 Coding

In accordance with Straussian Grounded Theory, coding was applied in both phases to help 'make sense' of the interview data collected and to produce 'a set of well-developed categories…that are systematically related through statements of relationship to form a theoretical framework that explains some relevant social…or other phenomenon' (Strauss and Corbin, 1998 p.22). The three core coding stages are as follows (Strauss and Corbin, 1990):

> **Open coding** – The breaking down, examining, comparing, conceptualizing and categorizing of qualitative data
>
> **Axial Coding –** A set of procedures whereby data are put back together in new ways after open coding, by making connections between categories
>
> **Selective Coding –** The procedure of selecting the core category, systematically relating it to other categories, validating those relationships, and filling in categories that need further refinement and development

Coffey and Atkinson (1996) have criticised the de- and re-construction of data via the coding process for leading to a loss of context, which is crucial for understanding how and why phenomena emerge. In reaction to this, efforts were made to retain context and narrative where possible during the coding process via the use of illustrative examples of ESCo activity. Furthermore, the ESCo case studies are also designed to capture this valuable context through the development of individual ESCo narratives.

Initial coding began during the transcription of the interviews (Sandelowski, 1995), where particularly insightful phrases or passages were highlighted. Conversely, phrases or passages that were not relevant to the research questions, as well as duplication of statements, were excluded from the transcripts to avoid wasting time that could be better spent preparing and analysing pertinent data. Once transcripts had been produced from the interview and we had familiarized ourselves with these, the main bulk of the coding was facilitated using a form of computer-assisted qualitative data analysis software (CAQDAS) known as NVivo.

It is important to note that the analytical framework outlined in Section 3.3 had an important influence on the coding categories that were used because the framework incorporated a number of pre-defined coding categories as illustrated by Figure 2.9. For instance, Osterwalder

& Pigneur's business model framework provided a number of coding categories, which facilitated the population of the ESCo business model generally, as well as the case studies ESCos (Figure 4.4 in Section 4.5.1.1). Consequently, empirical data was coded in accordance with each of these building blocks (e.g. revenue streams, key partners, customer relationships etc).

The co-evolutionary framework had less of an influence on the design of the coding categories, however categorisation was broadly split between the causal influences the different dimensions of the UK energy system had on the ESCo population (e.g. institutions, technologies, incumbent business model etc) and conversely, the causal influence the ESCo population had already had or was likely to have on the wider UK energy system. This meant that coding categories were arranged to broadly reflect the coevolutionary dynamic between ESCos and the UK energy system.

Although Phases 1 and 2 both followed the coding strategy outlined above they differed with respect to the level of analysis, considering that Phase 1 was sector-level and Phase 2 was ESCo-level. As such, the focus for Phase 1 was to improve our understanding of how and why the ESCo sector had co-evolved with the wider UK energy system. For Phase 2 the focus was on providing insight into how and why an individual ESCo had co-evolved with the different dimensions of the energy system.

4.5.1.1 NVivo 8

NVivo 8 represents a form of CAQDAS and is designed to take 'over [the] manual tasks associated with the coding process...[such as] writing marginal codes, making photocopies of transcripts or field notes, cutting out all chunks of text relating to a code [etc]' (Bryman, 2012 p.591). Therefore, it is thought to speed up the time intensive process of thematic coding. Creswell (2007) elaborates upon the benefits this software can provide, explaining that it can facilitate qualitative data analysis by helping the researcher to:

- Store and organize qualitative data
- Locate text or image segments associated with a code or theme
- Locate common passages or segments that relate to two or more code levels
- Make comparisons among code labels
- Conceptualize different levels of abstraction in qualitative data analysis
- Provide visual illustrations of codes and themes
- Write memos and store them as codes

As illustrated by Figure 4.4, after analysis had been completed we had a number of codes underneath categories that broadly corresponded to our main research questions[21]. This was extremely valuable in addressing helping us to answer our research questions and develop theory relating to the role novel, sustainable business models could potentially play in sustainability transitions. The coding process employed via NVivo is depicted in more detail in Appendix B – Section 12.2.

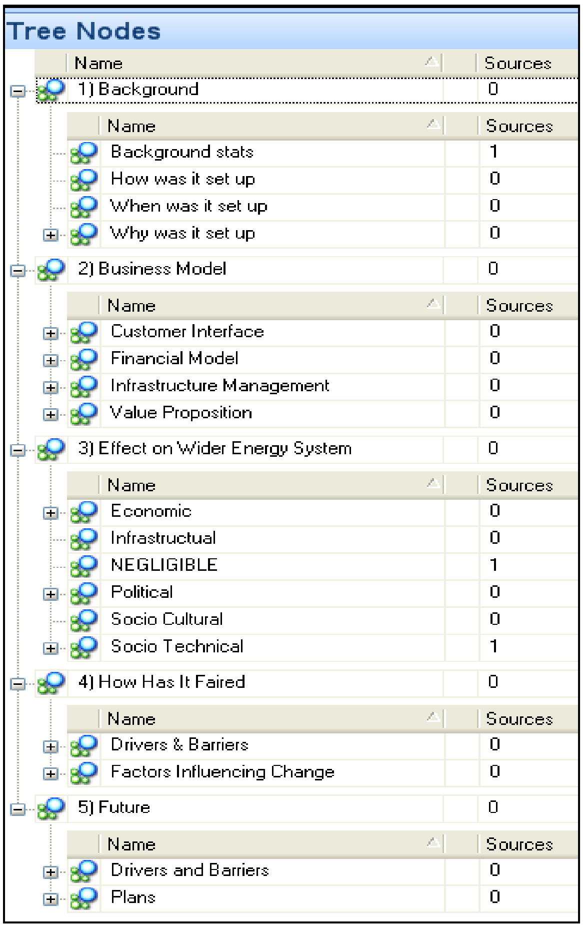

Figure 4.4 NVivo screenshot of ESCo case study coding structure

4.5.2 Document Analysis

In parallel with the case study interviews, primary literature was collected that could help provide information relating to the structure and experiences of the ESCo being investigated (Section 4.4.2.2). These documents were read carefully and any information that provided insight into the characteristics of the ESCo's business model and how it had interacted with the wider UK energy system was highlighted. Yin (2009) explains that case studies can produce

[21] Figure 4.4 represents a snapshot of the coding structure employed for a case study undertaken in Phase 2. The coding structure for Phase 1 was very similar. The screenshot illustrated how the 9 business model building blocks framework helped structure the coding categories. Here the 9 building blocks are collapsed into 4 categories, in accordance with Osterwalder's (2004) 4 business model pillars

unmanageable amounts of data and therefore recommends developing a case study database. Consequently, the primary literature was logged into an EndNote documentary data base for each case study in order to categorise the documents with respect to the type of information they provided. For example, a category for 'ESCo objectives' was normally created where documentation that provided information relating to the ESCo's mission statement was filed. Once the data had been analysed and sorted, the documentation was then used to supplement the thematically coded interview data to provide the additional information necessary to build a detailed narrative of each ESCo.

4.5.3 Case Study Analysis

4.5.3.1 Within-Case Analysis

Once the interview and documentary data had been analysed using the methods described in Sections 4.5.1 and 4.5.2 the data was then subject to within-case analysis, which involved the various forms of qualitative data being assembled into a traditional and detailed narrative of the ESCo (Miles, 1979), each of which followed a similar structure (Section 6.2). This presented a useful means of coping with the enormous volume of data and an opportunity to become intimately familiar with each case as a stand-alone entity (Eisenhardt, 1989). Additionally, taking this approach allowed the unique patterns of each case to emerge (Eisenhardt, 1989), helping to illuminate the various causal mechanisms linked the evolution of the ESCo and its environment. Each narrative for case-study ESCos are presented in Section 6.2.

4.5.3.2 Cross-Case Analysis

Once the unique patterns of each case had emerged, cross-case analysis was employed. Here the narratives of the various cases studies were compared and contrasted in order to identify the commonalities and differences between these (Charmaz, 2000). This examination served to highlight how patterns within each of the cases could be generalized across cases (Eisenhardt, 1989), an important stage in the development of theory. Eisenhardt (1989) explains that cross-case analysis of numerous case studies is an important tactic if investigators are to go beyond their initial impressions of each case study. This is because it forces the researcher to go beyond analysing each case in isolation and instead considering them as a collective. This helps the researcher to identify common and contrasting themes between each the cases. She emphasises that this approach 'enhance[s] the probability that the investigators will capture the novel findings which may exist in the data' (p.541), leading to the generation of more robust theory.

In summary, the analysis as part of Phase 2 incorporated a combination of within-case and cross-case study analysis. The former involved the development of detailed narratives of the

ESCo case studies, each of which corresponded to the key variants identified in Phase 1. The latter incorporated the comparing and contrasting of these 4 different accounts of ESCo activity with one another.

The purpose of employing both within-case and cross-case analysis was to improve our understanding of (1) how the characteristics of the business models these ESCo variants employed differed from one another; (2) the different strengths and weaknesses of these variants; (3) the different co-evolutionary relationships these variants shared with the broader UK energy system and (4) how the variants' co-evolutionary relationships with the wider energy system were likely to develop in different ways, despite being subject to the same emerging developments in the UK. Consequently, by ensuring that this research took into account the narratives of these ESCo variants and consequently factored in the heterogeneity of the UK ESCo market, we were able to provide additional and valuable insight into how the characteristic differences between these different ESCos have had an important influence on the nature of their relationship with the wider UK energy system, such as why some variants have enjoyed greater uptake than others. In turn, this helped to provide a more balanced account of the role ESCo are likely to play in a transition to a sustainable UK energy system.

4.6 Chapter Summary

This chapter has introduced the methodology this research employs and provides a detailed rationale for having selected these methods over other alternatives. We outline in detail how we have mobilised our analytical framework, which was outlined in the previous chapter, via a phased qualitative research strategy that adopts a Straussian Grounded Theory approach to theory building. In the following chapter we consider the empirical context in which this methodology will be applied, providing a detailed overview of the ESCo and Energy Utility populations' historical development alongside key historical events in the UK energy system during the 20th and 21st centuries.

5 Empirical Context: Historical Development of ESCos in the UK Energy System

This chapter explores the history of the Energy Service Company and Energy Utility Company markets in the UK and explores how both these populations have evolved alongside key developments that have shaped the UK energy system since the Second World War. In particular, the chapter focuses on how the UK energy system has changed in the face of privatisation and liberalisation since the 1970s, and how this gave rise to an energy sector in the UK, which became dominated by 6 large, vertically-integrated, Energy Utilities. Most importantly, we highlight how in the context of these developments a small ESCo market has emerged and slowly matured in the UK over the late 20th century and early 21st century, enjoying periods of sustained growth since its formation.

The purpose of this chapter is not to identify the causal mechanisms that exist between the ESCo and EUCo populations and the wider UK energy system, which have been responsible for shaping their evolution. This line of enquiry is explored in the following chapters of this thesis. Instead, this chapter develops a narrative of both these populations' development during the 20th and 21st centuries, to highlight how the timing of defining moments in these populations' history has in some cases coincided with key developments in the UK energy system. We argue that developing a detailed, historical narrative of these populations' evolution alongside key UK energy market developments constitutes an essential step in order to make sense of the data collected as part of our empirical investigation outlined in Section 4. A clearer picture of the context in which the ESCo and EUCo markets have evolved will inevitably support our efforts in identifying the causal mechanisms that have been responsible for the dominance of the EUCo model and marginalisation of the ESCo model in the UK.

We also take the opportunity to explain how the ESCo model has enjoyed greater uptake in other countries apart from the UK, namely the US, Germany and France, despite these energy systems sharing some key characteristic features with the UK. For example, these countries' energy system have all been subject to privatisation and liberalisation by their national governments (Heddenhausen, 2007). The rationale for doing so is to identify the context in which the ESCo model proliferated in these countries and to emphasise that the emergence of a healthy ESCo in the UK is a distinct possibility.

The chapter is structured as follows. In Section 5.1 we describe how the UK energy market was nationalised after the war and how it was within this environment that the first ESCos were established in the UK. In Section 5.2 we explore the reasons why the UK energy market was privatised in the 1980s and early 1990s, discussing how this changed the structure of the UK energy system and importantly how this impacted upon the ESCo and EUCo markets. In Section 5.3 we adopt a similar approach but this time focusing on the period of liberalisation during the 1990s and 2000s. In Section 5.4 we highlight how the UK energy system has been characterised in recent years by a focus on improving energy security, affordability and sustainability. Here we discuss how the ESCo market has developed in light of important market and regulatory developments and take stock of the current status of both the ESCo and EUCo markets. Finally in Section 5.5 we briefly discuss how and why the ESCo model has enjoyed greater traction in other countries compared to the UK.

5.1 1940s – 1980s: State Owned

'For most of the post-war period, the [UK] energy sector was run by the state through integrated monopolies' (Helm, 2003 p.14) (Appendix C – Section 12.3). This was a consequence of nationalisation, which Chesshire (1996) explains had been deemed necessary 'given the need to restore and expand electricity supply capacity as a precondition for economic recovery' (p.37), following the effects of the war. Consequently, in 1948 the electricity sector was divided into 3 distinct geographical areas: (1) England & Wales, (2) Scotland and (3) Northern Ireland (Pond, 2006), across which a number of publicly owned national institutions were responsible for the generation, transmission, distribution and supply of electricity and gas (Ekins, 2010). In England and Wales the Central Electricity Generating Board (CEGB) was established in 1957, taking over from the Central Electricity Authority (Helm, 2003) and was responsible for both the UK's electricity generation and transmission.

Moving down the supply chain, electricity distribution and supply was the responsibility of 12 regional bodies known as Area Boards (Pond, 2006). In contrast in Scotland and Northern Ireland the public institutions were vertically integrated and were therefore responsible for electricity generation, transmission, distribution and supply, rather like many of today's Energy Utilities in the UK. The gas sector was also nationalised during this post-war period, with the Gas Council and Area Boards being formed in 1948 (which later became known as the British Gas Corporation in 1972) to take responsibility for the distribution and sale of natural gas sourced from the North Sea (Ekins, 2010). In light of these developments, the UK energy system between the end of World War Two and the late 1970s was characterized by government led, top-down decision making and nationalised institutions responsible for energy generation, distribution and supply (Pond, 2006). During this period 'the idea that [the UK energy system] could be left to market forces was simply beyond the pale' (Helm, 2003 p.14).

It was during this period of nationalisation that the first ESCo emerged in the UK. It was known as Associated Heat Services[22] and was established in 1966 as a subsidiary of the nationally owned National Coal Board (Fawkes, 2007, Iqbal, 2009). It was established by Sir Derek Ezra, then Chairman of the National Coal Board, as a down-stream energy management business to which organisations could outsource the management of their boiler houses (Fawkes, 2007, Dalkia, 2012). The company had been established to provide supply-side energy services amid growing concerns around escalating energy prices in the late 1960s (Dalkia, 2012) in order to achieve a reduction in organisations' energy costs, predominantly via energy efficiency and labour savings (Iqbal, 2009). Iqbal (2009) explains that following the establishment of Associated Heat Services 'many other similar companies came on the scene and they all offered very similar services of providing operation and manning...[of] coal-fired boiler houses' (p.27).

During the period in which the majority of the UK energy system was nationalised, two 'oil crises' occurred. The first was the 1974 oil crisis, following the Yom Kippur war, and the second took place in 1979, following the Iranian revolution (Thomas, 1996). These events were subsequently responsible for a dramatic rise in energy prices during the later 1970s (BP, 2011): 'From the mid 1970s to the early 1980s, many thought that oil prices were on a permanent upward trajectory' (Pearson and Watson, 2012 p.8). During these crises and prior to the growth of the UK ESCo market, the UK entered a deep economic recession in the mid 1970s, which the oil crises are thought to have contributed to (Aguiar-Conraria and Wen, 2006)[23]. These developments consequently had a major impact on industrial and political decision making in the UK energy sector (Pearson and Watson, 2012). Bolton (2011) explains that the recession was partly responsible for undermining the rationale that had previously underpinned the nationalised structure of the industry, as the financial crisis was at odds with the strategy relating to promoting expansion of the energy system and to increase energy demand after the war. This contributed to a step-change in UK energy policy and consequently a period of privatisation, signalling a radical transformation of the UK energy system during the 1980s.

Before the cogs of privatisation were really set in motion, the ESCo market enjoyed a period of growth. In the context of rising energy prices, following the energy crises of the 1970s, the UK welcomed the first ESCo to offer energy performance contracts, known as the Utility

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[22] Associated Heat Services is no known as Dalkia, one of the largest ESCos in the UK

[23] The link between oil price shocks and poor macro-economic performance has been debated (e.g. Barsky and Kilian, 2004), although a large body of empirical literature supports the relationship (see Aguiar-Conraria and Wen, 2006 for references)

Management Company (1980) (Fawkes, 2007). There was also additional growth in ESCos focused on providing heat via energy supply contracts, with the establishment of the non-state owned Shell's Emstar (1982) and BP Energy (1983) (Sorrell, 2005). These companies offered to take responsibility for not only the design, building and financing of customer's boiler houses, (normally large systems situated on large industrial sites) but also the operation and maintenance of these facilities, in accordance with pre-specified service level agreements and performance guarantees (Fawkes, 2007, Sorrell, 2005). Fawkes (2007) explains that ESCos offering these services emerged mainly in reaction to the support the UK government was providing for the use of coal fired boiler houses by industrial consumers at the time, in the form of coal conversion grants.

5.2 1980 – 1990s: Privatisation

The formation of Margaret Thatcher's government in 1979 led to significant changes in the structure of the UK energy system, as an intense period of privatization commenced. Indeed, privatisation proved to become the 'centrepiece' of this government's policy programme (Thomas, 1996). Thomas (1996) explains that the core rationale behind the government's privatisation strategy was to create a 'share-owning democracy', where shares were created via the privatisation of the main public institutions, be they energy related or otherwise. This strategy would also generate money for the treasury via the sale of these shares. It was the revenue from privatisation that 'allowed public services to be maintained at a level that would have been impossible without politically damaging tax increases' (Thomas, 1996 p.41). Another integral driver behind privatisation was the government's aim to reduce the power wielded by the large unions (Thomas, 1996).

As outlined in the Appendix C (Section 12.3), privatisation of the UK energy industry began first with the oil industry (1982-1987) followed by the gas (1986), non-nuclear electricity (1990-1991), coal (1995), transmission (1995) and nuclear power (1996) markets (Bolton, 2011, Ekins, 2010). Privatisation of the non-nuclear UK electricity market began with the sale of the Regional Electricity Companies (RECs), which were sold intact (Pearson and Watson, 2012). Subsequently in 1991, the National Grid Company, the CEGB and the two Scottish companies (i.e. Scottish Power and Scottish Hydro-Electric) were privatised (Pearson and Watson, 2012). The CEGB was divided into three parts: Nuclear Electric, National Power and Powergen (Thomas, 1996, Pond, 2006). Nuclear Electric remained publicly owned until 1996 when British Energy was formed, whilst National Power and Powergen, who held the non-nuclear generation, were privately owned from their formation in 1990 (Thomas, 1996, Pond, 2006, Helm, 2003). The division of the nationally owned CEGB into a mixture of private and public sector organisations signalled the birth of the privately owned Energy Utility companies that dominate the UK energy system today. For instance, Powergen was eventually bought by E.On in 2001, and National Power became part of the German energy company RWE.

Another defining feature of the privatisation of the UK energy market was the formation of the 'Power Pool', which constituted a wholesale market for electricity which generators were obligated to participate in (Thomas, 1996). Generators sold their output according to changing prices in response to the demand of the regional electricity companies and other major users (Pond, 2006). This pool was integral to opening up the electricity market to competition and thus fulfilling the basic philosophy upon which electricity privatisation was established (Thomas, 1996). The pool represented the predecessor for later electricity trading arrangements (i.e. the New Electricity Trading Arrangements (NETA) and the British Electricity Trading and Transmission Arrangements (BETTA)), which have subsequently been criticised for favouring large-scale generators that utilise mature technologies, such as those that utilise fossil fuels (e.g. coal, gas etc), because they reward flexibility and predictability (Mitchell, 2008, Woodman and Baker, 2008). Consequently, the introduction of the Power Pool laid the foundations for an electricity market that was not supportive of companies seeking to trade electricity who operated at a small scale and utilised less mature, more intermittent generation technologies (e.g. PV, wind, CHP etc), such as many ESCos providing Energy Supply contracts. We elaborate upon this point in Section 5.3.

The gas market was also subject to privatisation during this period. The 1986 Gas Act ratified the privatisation of British Gas, although the organisation initially remained intact after this piece of legislation was passed (Thomas, 1996). Consequently, there was little immediate impact on the structure of the UK gas market post-privatisation as British Gas continued to hold a monopoly over the market (Stern, 1997). However, the focus of liberalisation was to promote competition in this newly privatised energy market, eventually giving rise to the Big 6 Energy Utility companies that dominate both electricity *and* gas markets today

5.3 1990 - 2000s: Liberalisation

Once the process of privatisation in the energy markets had gained momentum, the UK government's attention then turned to promote competition in this newly privatised energy market, a process known as liberalisation (Ekins, 2010, Pearson and Watson, 2012). To achieve this objective a number of major changes were made to the UK energy system, which primarily included (1) the introduction of market regulators; (2) the break-up of the incumbent energy companies to encourage new entrants into the market; and (3) the reform of the electricity market arrangements. We briefly outline these changes before describing how the ESCo market evolved in parallel with these developments.

In the late 1980s market regulators were introduced for both the gas (Ofgas in 1986) and electricity (Offer in 1989) markets, which were eventually merged in 2000 to form the Office of Gas and Electricity Markets (Ofgem) (Ekins, 2010, Pearson and Watson, 2012). The market regulators existed to promote and manage competition in the energy industry via regulation, which has historically lent itself to natural monopolies (Ekins, 2010). Focusing on the liberalisation of the gas market, Ekins (2010) notes that 'as retail competition in the utilities sector developed, multi-utility suppliers emerged, such that the main gas suppliers are now the same as the main electricity suppliers' (p.43). For instance, British Gas, under the ownership of Centrica, is now a retailer of both gas and electricity.

The UK government also moved to break-up the recently privatised and extraordinarily powerful incumbent energy companies (i.e. British Gas, Powergen and National Power) (Appendix C – Section 12.3) as a means of weakening their hold on the energy sector and encouraging new entrants to enter the market in a bid to encourage greater competition. For instance, in 1997 the UK government moved to break-up British Gas, which led to the establishment of two separate organisations: Centrica, which took responsibility for gas trading and retail and Transco, which owned and operated the gas pipeline network (Pearson and Watson, 2012). Powergen and National Power, the two incumbent electricity companies, who at the time possessed sufficient power to set prices in the wholesale markets, were encouraged to divest large swathes of their generation capacity, much of which was subsequently bought up by the Regional Electricity Companies (Pearson and Watson, 2012). In return the two generators were allowed to acquire some of the RECs in 1998, who represented the energy retailers of the market at the time (Pearson and Watson, 2012, Pond, 2006). This policy enabled the Energy Utilities to engage in a much greater degree of vertical integration across the whole energy industry (Helm, 2003, Pond, 2006), ultimately laying the foundations for the emergence of the vertically integrated UK Energy Utilities we see today in the UK (e.g. RWE nPower, Centrica etc).

Helm (2003) explains that the reason the Energy Utilities wanted to become large-scale, vertically integrated companies was because both generation and supply had become a risky business. For instance, if 'generation was in excess of supply and there were no-long term contracts to provide stability, prices could collapse' and 'if generation was tight, suppliers without contracts would be exposed to rapidly rising prices' (Helm, 2003 p.243). Vertical integration helped to mitigate this risk because: 'if the company is big enough, it can take price risk against equity, as oil companies do' (p.243). This trait has been inherited by today's UK Energy Utilities, helping them to dominate the market.

Finally, the other key change during this period of liberalisation was the reform of the electricity trading arrangements (i.e. the Power Pool) in order to further promote a competitive generation market (Helm, 2003) and to ensure that the electricity system was balanced, largely due to the limited opportunities for electricity storage (Ekins, 2010). Consequently, NETA were introduced in 2001, which was superseded by BETTA in 2005. These arrangements are still in operation today and dictate that generators inform the system operator (the National Grid) of their contracted output whilst the suppliers inform the operator how much they intend to buy (Mitchell, 2008). It is the National Grid’s responsibility to ensure minute-by-minute balancing of this system (Ekins, 2010). Mitchell (2008) provides a brief synopsis of this complex system:

> ‘All contracts [are] submitted to central settlement 1 hour (initially 3.5 hours) ahead of the half hour dispatch period. After this gate closure, generators, suppliers and customers can submit offers and bids to deviate from their expected levels at specified prices into the Balancing Mechanism. The system operator can then accept or reject these to ensure the system is balanced, the quality of supply is maintained and short-term transmission constraints are dealt with. Prices in the Balancing Mechanism dictate the prices that must be paid by any generators or suppliers for any differences in their contracted position after real time Imbalance Settlement. If a generator has a shortfall in its contracted generation it must pay for that shortfall at the System Buy Price and if it exceeds it at the System Sell Price’ (p.144)

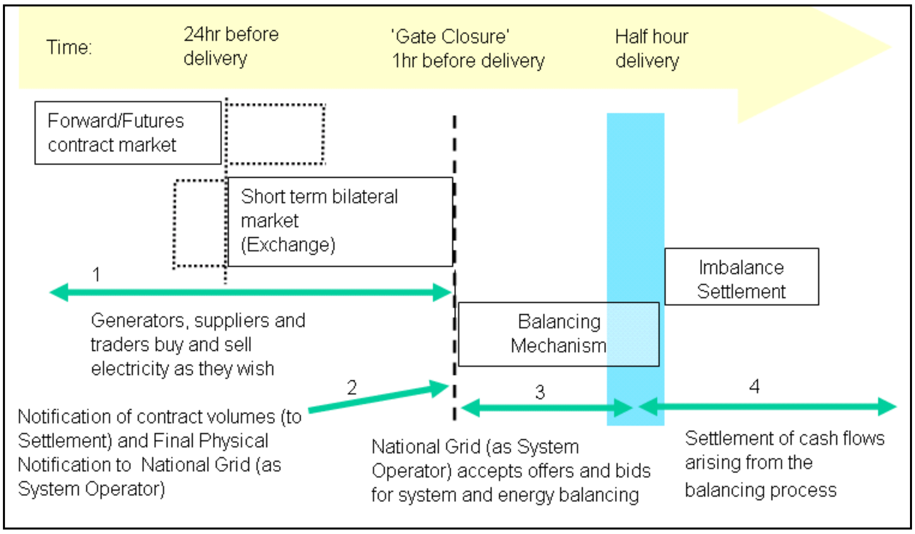

Figure 5.1 Overview of BETTA market structure (National Grid, 2006)

BETTA was designed to support large, centralised, predictable fossil-fuelled and nuclear generation, with the view to deliver sufficient electricity capacity at low cost (HMG, 2011). Consequently, its design has created difficulties for intermittent electricity sources (HMG, 2011). Mitchell (2008) emphasises how these electricity arrangements have served to maintain the status quo and buttress the dominance of the Energy Utilities because the arrangements are technology and fuel blind, which means the system favours large-scale and/or conventional technologies (e.g. combined cycle gas turbines) because these are normally the most cost-effective. Furthermore, they contain no mechanism to allow intervention in the market that could support the use of sustainable energy technologies, often utilised by companies such as ESCos. BETTA rewards predictability of supply, not intermittency, with financial penalties issued to those responsible for imbalances between electricity demand and supply, which increases costs for these intermittent generators (e.g. some ESCos), consequently discouraging them to enter the pool and inhibiting their development (Mitchell, 2008, Woodman and Baker, 2008). By not joining the pool, these small-scale, intermittent generators are likely to sell their electricity to a third party, known as an electricity consolidator ‘who is likely to offer a price that factors in the impact of imbalance changes on its own market participation’ (Woodman and Baker, 2008 p.4528). In essence, these arrangements support the operation of the large-scale, vertically-integrated Energy Utilities who utilise centralised, conventional technologies, at the expense of small-scale, low-carbon energy generators, such as ESCos.

It is worth noting that less than 5% of electricity generated is traded through the balancing mechanism (Toke and Fragaki, 2008). Instead, the bulk of electricity is traded through either between the Utilities and large generators via long-term contracts or through bilateral contracts that are internal to the large vertically integrated Energy Utilities, who own generation as well as supply units (Toke and Fragaki, 2008). Some of the Energy Utilities also own distribution (DNOs) and transmission network operators (TNOs) (e.g. SSE, Scottish Power), enabling them to take responsibility for the entire electricity supply chain. Therefore, in many cases the Energy Utilities do not normally rely on other organisations to satisfy their customers’ energy needs.

Whilst, the periods of privatisation and liberalisation culminated in a major reconfiguration of the UK energy industry, this transformation ultimately accomplished relatively little with respect to moderating the power of the large Energy Utilities:

> ‘The consequence of this new [market framework] is that the very market power and vertical integration that privatization tried to curtail has re-emerged – and largely without regulators or politicians realizing what they have allowed to happen’ (Helm, 2003 p.243)

In some respects liberalisation was seen to undermine growth in the ESCo market. For example, the significant and prolonged reduction in electricity prices was in part attributed to the introduction of the new electricity arrangements (i.e. NETA & then BETTA), which had the effect of limiting interest in energy efficiency measures and consequently the ESCo model (Sorrell, 2005, Bertoldi et al., 2007, Bertoldi et al., 2006b). Despite the negative influence this had on the UK ESCo market in some respects, liberalisation of energy markets throughout Europe is considered to have played an important role in supporting ESCo market growth. For example, it:

> 'transformed the semi-public energy sectors of some member states into sectors with competing market oriented companies, thus creating more room for value-added services and facilitating contractually arrangements' (Marino et al., 2011 p.6193)

On balance the ESCo market enjoyed a period of sustained growth during the 1990s (Sorrell, 2005). For instance new entrants such as Enron Energy Services (1999) and RWE Solutions (2002) entered the UK ESCo market,(Fawkes, 2007). Fawkes (2007) explains that this growth was predominantly in Combined Heat & Power (CHP) oriented energy supply contracts (Fawkes, 2007). In an effort to quantify this growth during this period, Sorrell (2005) explains that according to Energy Service and Technology Association (ESTA), the total value of the annual energy bills being handled by ESCos rose from £127 million/year in 1993 to £500 million/year in 2001. Growth in the ESCo market at the time was mainly due to the rise of industrial downsizing and outsourcing. He also notes that in 1992 there were changes to Treasury rules (known as the 'Ryrie rules'), which had acted as a barrier against the use of private finance within the public sector, meaning that energy service contracting had largely been limited to the private sector (Sorrell, 2005). The removal of these rules and the introduction of the Private Finance Initiative (PFI) in 1992, meant that private finance could now be leveraged to deliver energy service contracts to the public sector, helping to grow the ESCo market (Sorrell, 2005, Grout, 1997).

Pearson and Watson (2012) explain that with the election of the Labour government in 1997, the focus remained on liberalisation but it was also during this time that the government's political objectives slowly became centred around improving the security, affordability and sustainability of energy supply, which began to have a profound effect on the environment in which ESCos operated.

5.4 2000s – 2010s: Security, Affordability and Sustainability of Energy Supply

At the turn of the century the UK's energy regulatory framework began to change in response to a number pressing energy challenges, namely energy security, affordability and reducing carbon emissions (Section 1.3). Many of the challenges facing the UK energy system have provided a welcome boost to UK ESCo market growth. For instance, Sorrell (2005) explains that large increases in gas and electricity prices in relation to issues relating energy scarcity and supply disruptions during the 2000s have provided a boost to the ESCo market, which was growing at approximately 15%/year during the mid 2000s. Furthermore, the UK government's reaction to these challenges has played an important role in supporting this growth, such as the introduction of stringent environmental regulations in response to climate change and other adverse environmental effects associated with energy consumption (Sorrell, 2005). The work in this thesis will analyse how these challenges and other related developments are beginning to change the institutional context for the application of the ESCo model in the UK.

In light of the emergence of this triumvirate of energy challenges the UK 'government has sought to take the powers it perceived necessary to address these new concerns' (Ekins, 2010 p.45), signalling a new era for UK energy policy. An important aspect of this strategy was the introduction of a number of policies to incentivize low-carbon energy generation capacity, including amongst others the Renewables Obligation Certificates (ROCs) (2002); the Feed-in-Tariff (FiT) (2010) and the Renewable Heat Incentive (RHI) (2011)(Ekins, 2010).

The ROC scheme provides certificates to electricity generators in relation to the amount of eligible renewable electricity they generate, which can subsequently be sold on to suppliers or traders, allowing them to receive a premium in addition to the wholesale electricity price (DECC, 2012t). Unlike this scheme the FiT provides a long-term revenue stream for the small to medium-scale, decentralised generation of low-carbon electricity. A *generation tariff* is available for each unit of electricity generated, which is dependent on the form of generation, whilst an *export tariff* is available for the sale of excess electricity to the grid (DECC, 2012l). The RHI is similar to the FiT but instead provides generators with a long-term revenue stream for the small to medium scale generation of low-carbon heat, as opposed to electricity. The RHI payments have been available for non-domestic generators since November 2011 but the domestic RHI will not be introduced until 2013 (DECC, 2012s).

Policies have also been introduced to address these energy challenges by increasing levels of energy efficiency, which have included Warm Front (2000); the Climate Change Levy (2001); the Energy Efficiency Commitment (EEC) (2002-2008); the Carbon Energy Reduction Target

(CERT) (2008-2012); the Community Energy Savings Programme (CESP) (2009) (Ekins, 2010). EEC, CERT & CESP all represent forms of obligations on energy companies to reduce the GHG emissions associated with their energy supply. For example, as part of CERT, all energy companies with a customer base of over 250,000 customers are required to deliver measures that will provide overall lifetime carbon dioxide savings of 293 MtCO2 (DECC, 2012c). Ofgem is able to impose a financial penalty of up to 10% of the utility's annual turnover if it fails to achieve this target (DECC, 2010c). The utilities are expected to meet this target by promoting the uptake of energy efficiency or low carbon energy solutions to their customers. Finally, in 2010 the CRC Energy Efficiency Scheme (CRC) (2010) was introduced, which required all organisations consuming more than 6GWh of electricity per annum are required to buy allowances each year to cover their emissions, which started at £12/tonne of CO_2 in 2011 (Carbon Trust, 2012). Furthermore, participants' performance is ranked in a publicly accessible league table (Carbon Trust, 2012).

The recent step-change in UK energy policy from privatisation and liberalisation towards promoting a secure, affordable and low-carbon energy supply has provided fertile ground for growth in the ESCo market. Recent surveys estimate the size of the ESCo market to be worth approximately €400 million per annum (Marino et al., 2010), whilst Fawkes' (2007) own estimates value the market between £500 and £700 million per annum[24]. However, despite the introduction of a raft of legislation that supports energy efficiency and low-carbon energy supply measures, Marino et al. (2010) point out that whilst the ESCo market continues to grow, growth has in fact slowed in recent years. This stands in stark contrast when compared with the Energy Utility Market, where the combined pre-tax profit for the six major Energy Utilities in 2010 stood at approximately £8.55 billion, constituting a 35% increase on 2007 profits (Consumer Focus, 2012). This comparison serves to highlight how the EUCo market continues to grow and how the Energy Utilities continue to dominate the UK energy market. It also serves to illustrate how small the UK ESCo market is in comparison, emphasising how the ESCo model has enjoyed only niche applications to date.

Looking to the future it is quite possible that the ESCo market could begin to enjoy a period of accelerated growth, in light of the existing and emerging raft of legislation that has been designed to promote energy efficiency and low-carbon energy supply. For example, the Electricity Market Reform (EMR) is expected to be introduced in 2013, which contains within it a carbon-floorprice. Other legislation includes new Low Carbon Building Regulations; the Energy Company Obligation (ECO) and the Green Deal, all designed to promote domestic

[24] It is unclear from Fawkes' (2007) and Marino et al.'s (2011) methodology how they calculated the value of the UK ESCo market

energy efficiency. These policies and their impacts upon the UK ESCo market are explored in detail in Section 6.1.4.3 and the ESCo case-studies in Section 6.2. There is certainly significant scope for growth in the UK ESCo market, considering for example the potential size of the EPC market for the non-residential sector alone is estimated at approximately €1 billion (Marino et al., 2010). We now examine how the ESCo model has fared in energy systems outside the UK.

5.5 International Comparison of UK Energy Services Market

In outlining how the UK ESCo market has developed alongside the broader UK energy system since the war, we have highlighted how market developments have provided the ESCo model with sufficient scope to emerge and enjoy some modest uptake. However, these developments were also responsible for the proliferation and ultimately, the dominance of the Energy Utility market over the ESCo market. Whilst the ESCo model has enjoyed limited uptake in the UK, it has been much more successful in other countries:

> ‘The energy services market is mature in the United States and Canada, well established in some European countries (e.g. Austria, Germany, France, Hungary), emerging in others (e.g. Spain, Sweden, Italy) and almost entirely absent in countries outside the OECD’ (Sorrell, 2005 p.36)

In this sub-section we briefly examine the ESCo markets in the US, Germany and France, whose energy systems share some similar characteristics with the UK, for instance all having undergone privatisation and liberalisation (Heddenhausen, 2007). Here we identify the factors responsible for the development of much larger and healthier ESCo markets that in the UK.

5.5.1 United States

The US ESCo market is the largest in the world (Sorrell, 2005) and like in the UK the majority of energy consumers are served by large, privately owned Energy Utilities, with approximately 75% of the population being supplied by them (York and Kuschler, 2011). Furthermore, as in the UK, the US energy market has been liberalised, with private sector companies also subject to significant amounts of regulation, from a combination of local, state and federal agencies (York and Kuschler, 2011). In contrast to the UK ESCo market, the US market has grown at an annual growth rate of between 10-25% during the 1990s. In 2000 ESCos in the US generated $2 billion of revenue and between 1990 and 2000 delivered $15 billion in net energy cost savings (Goldman et al., 2005).

Goldman et al. (2005) attribute the dramatic growth of the US ESCo market to a number of key drivers. These include for example the introduction of the Demand Side Management and Integrated Resource Planning programmes in the 1980s, which provided standardised contracts to deliver verified Energy Performance Contracts. Another important driver was the introduction of state legislation designed to encourage public sector institutions to sign long-term energy service contracts, by allowing procurement decisions to be made on the basis of whole life costs, rather than minimising capital costs. The US ESCo market also benefitted from the emergence of new sources of finance to fund energy service contracts. Finally, the 1992 Energy Policy Act mandated federal agencies to make arrangements for cost-effective energy efficiency investments, thus encouraging many of these to turn to ESCos as a means of fulfilling this objective. The case of the US ESCo market shows us that:

> 'US ESCos have demonstrated that performance contracting, in combination with other supporting policies, can be used to address and overcome many market barriers that inhibit energy-efficiency investments among large, institutional, public sector customers' (Goldman et al., 2005 p.404)

5.5.2 Germany

According to Marino et al.'s (2010) European ESCo review, Germany is Europe's largest and most mature ESCo market, valued at between €1.7 and 2.4 billion/annum, with approximately 250 – 500 ESCos operating there. Bertoldi et al. (2007) explain that standard procedures, EPC model contracts, procurement procedures and contracting guidelines have all helped to provide confidence in the German market, something that is currently lacking in the UK. However, Marino et al. (2010) attribute the German ESCo market's success primarily to:

> 'a good mix of governmental support (including both technical and financial support), non-governmental programs and favourable conditions such as the energy taxes (ecological tax reform[25]), which were increased considerably during the energy sector liberalisation along with an increase in energy prices. The implementation of a large number of municipal projects along with public-private partnerships also had a strong demonstration effect by introducing the ESCo and EPC concepts on the market' (p.26)

5.5.3 France

Finally we turn to the case of France, where the provision of outsourced energy services dates back to the 19th century, with approximately 100 ESCos operating in France today (Marino et al., 2010). Marino et al. (2010) attribute the current growth in the market primarily to 'Le Grenelle de l'environnement', which constitutes an action plan developed by businesses, local communities, unions, associations and most importantly the French government, with the aim

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[25] 'The ecological tax reform has two objectives. The first is environmental protection, particularly the reduction of greenhouse gas emissions. The second objective is to reduce statutory pension contributions in order to reduce labour cost and increase employment (Beuermann and Santarius, 2006)

of developing and implementing policies, information campaigns and financial instruments that are capable of promoting sustainable development. For instance, the Grenelle included the provision for a carbon tax that incorporated sectors that sat outside the carbon market (Pairault, 2009) and a requirement to reduce the energy consumption within existing residential building stock by 28% by 2020, compared to 2008 levels (Marino et al., 2010). It was this favourable policy framework, alongside a number of pilot projects that demonstrated the value of retrofitting universities and schools, as well as the availability of funding and finance to deliver energy service contracts that has been responsible for growth in the French market

According to Marino et al. (2010) the UK ESCo market represents one of the most developed ESCo markets in Europe (Marino et al., 2010). However, the UK ESCo market stands a long way behind France and Germany in terms of market size and maturity, and even further behind that in the US. This international comparison serves to illustrate how in countries that share a number of similar key characteristics with the UK (e.g. liberalised, centralised, regulated etc) the ESCo model has enjoyed much wider-scale uptake.

5.6 Chapter Summary

In this chapter we illustrated how the UK energy system has transformed over the years and how major developments in both the ESCo and EUCo market have to some extent coincided with important periods of change in the wider energy system. It also helped to illustrate how the UK energy system is currently subject to a dramatic period of change, in reaction to the triumvirate of challenges outlined in Section 1.3, outlining a handful of key policies that are likely to have an important bearing on the future development of the UK ESCo market. Finally, we turned our attention to ESCo markets beyond the UK to identify how developments there have encouraged the wide-scale uptake of the ESCo model. In the following chapter we draw upon these insights to examine the factors that have been responsible for the limited uptake of the ESCo model in the UK to date and how this situation might change in the future, in light of emerging developments.

6 Sector level and case study analysis of ESCos in the UK

This chapter presents the findings of the research's qualitative empirical investigation into the implementation of the ESCo business model in the UK energy system, as outlined in the Methodology chapter (Section 4). The primary purpose of this chapter is to address both research questions 1 & 2, which relate to the 'core characteristics of the ESCo model' and the 'strengths and weaknesses of the ESCo model', as well as to present the empirical evidence that is drawn upon in the Chapters 0 & 0 to address research questions 3, 4 & 5 (see Section 1.5 for Research Questions). These questions relate to the past, present and future co-evolutionary relationship between the ESCo population and the UK energy system.

Section 6.1 presents the findings of Phase 1, which constituted a sector-level study of ESCo activity in the UK. The section begins by outlining the core characteristics of the ESCo business model (Section 6.1.1) and subsequently compare these with the incumbent Energy Utility (EUCo) model (Section 6.1.2). Following this we discuss the strengths and weaknesses of the ESCo model from the perspective of potential and existing ESCo model adopters (Section 6.1.3). We then identify the factors that have either enabled or inhibited adoption or operation of the ESCo model in the UK, i.e. its drivers and barriers (Section 6.1.4) and then identify emerging drivers and barriers (Section 6.1.4.3). We complete this sub-section by addressing the heterogeneity of the ESCo population and explore the key variants that exist within the UK ESCo population (Section 6.1.5).

Section 6.2 presents the findings of Phase 2, which incorporated 4 ESCo-level case studies of UK ESCo activity, which correspond with the key variants identified in Phase 1. A cross-case examination of these case studies follows in Section 6.2.5, designed to draw out both common and divergent themes that have emerged from the case studies.

It is important to note that throughout this chapter a referencing system is used to make reference to statements made by the interviewees as a means of increasing the transparency of the research's methodology. In Section 6.1 these are predominantly provided in conjunction with quotes, whilst in Section 6.2 interviewee references are also used to signpost where interview data has been used to develop the narrative of the case studies. For example, a reference such as *'Energy Utility Senior Manager – B 27'* might be used. The first part relates to the professional capacity of the interviewee and the second part constitutes the interviewee's reference code, which the reader can use to access additional information on the interviewee via the interviewee lists for Phase 1 in Appendix E (Section 12.4) and Phase 2 in Appendix F (Section 12.5).

6.1 Phase 1: Sector Level

6.1.1 Core Characteristics of the ESCo Business Model

In this sub-section we examine the empirical evidence gathered from the 31 interviews undertaken as part of Phase 1, in accordance with the data collection and analysis methods outlined in the Methodology chapter (Section 4). A breakdown of the interviews conducted for Phase 1 is available in Appendix E (Section 12.4).

<table>
<tr><th colspan="2">Phase</th><th>Date</th><th>Nos. of Interviews Conducted</th><th>Focus</th></tr>
<tr><td rowspan="2">1</td><td>1a</td><td>22/7/2010 – 17/1/2011</td><td>11</td><td>Pilot sector-level study of UK ESCo market</td></tr>
<tr><td>1b</td><td>8/7/2011 – 10/10/2011</td><td>20</td><td>Sector-level study of UK ESCo market</td></tr>
</table>

Table 6.1 – Phase 1, sector-level investigation of UK ESCo activity

The data generated by these interviews was analysed using the analytical framework outlined in Section 3, specifically the element relating to Osterwalder & Pigneur's (2010) business model framework. This process took place to identify the core characteristics of the ESCo business model in order to address Research Question 1. The aim here is to further improve our understanding of what constitutes an ESCo and thus build upon the insight provided by the literature (Section 2.6). A summary of the core characteristics of the ESCo model identified by this research is subsequently provided in Table 10.1 (Section 10.1).

6.1.1.1 Value Proposition

The bundle of products and services ESCos offer that create value for their customers

The most important aspect of an ESCo's value proposition is that they satisfy a number of their customer's energy needs (e.g. warmth, illumination, hygiene, motive power etc). Crucially, ESCos seek to do this at a lower financial cost compared to the Energy Utilities' offerings, constituting a core tenet of their value proposition. Predominantly this is achieved by reducing the amount of primary energy input required to satisfy the customer's energy needs by installing more energy efficient primary and/or secondary conversion equipment, alongside the implementation of modern building controls and/or facilitating changes to the customer's consumption behaviour. An ESCo may also reduce its customer's energy bills by utilising an alternative, less expensive form of primary energy input (e.g. solar, biomass etc) than traditional fossil fuels (e.g. gas, coal, oil etc)(see Section 6.1.1.9 for further detail):

'The customer's energy bills are £1 million a year and our engineers go in there and save you 20%, [which is equivalent to] £200,000 a year…So now the energy bill of the

> *customer has gone down from £1 million to £800,000, so they have that £200,000 difference' (Senior ESCo Manager - B 15)*

A central part of an ESCo's value proposition is that it assumes the vast majority of the financial risk associated with delivering the energy demand management and/or sustainable energy supply measures, which are required to not only satisfy their energy needs but to do so at a lower final cost to the customer compared to their current energy costs with an Energy Utility. Consequently, the customer often makes no upfront capital investment as the ESCo covers the costs of the measures themselves or via a third party (e.g. bank):

> *'No we stump up all the capital for the build. We've got three or four sources of funding to do that' (Senior ESCo Manager - A 3)*

Additionally ESCos assume much of the technical responsibility associated with implementing and managing the measures required to satisfy their customers' energy needs. For instance, ESCos take responsibility for operating and maintaining the energy measures it employs (i.e. technical responsibility), helping to free-up time and effort on their customer's behalf, which had traditionally been spent on such tasks. For commercial organisations, by outsourcing this responsibility, they can avoid the need to hire personnel to manage their energy equipment. ESCos normally look to achieve energy related cost and time savings for their customers by taking a holistic approach to the design and implementation of its energy service contracts:

> *'What an ESCo does is look at it in a holistic way, right across the organisation [because] 80% of the [efficiency] opportunities are going to be in 20% of the buildings' (Senior ESCo Manager - B 15)*

Additionally, ESCos normally implement bespoke energy supply and/or demand management measures as part of its contracting. Consequently, ESCos' energy solutions are typically 'tailor made' to the needs of their customers, representing an important source of customer value compared to the standardized contracts Energy Utilities traditionally offer:

> *'So what you do is you look to the customer and understand what exactly they really want and then you build programme around that' (Senior ESCo Manager - B 28)*

By reducing the energy consumption of their customer and/or increasing the proportion of low-carbon energy they consume, ESCos can provide a range of broader societal benefits. For instance, by reducing residential consumers' energy bills ESCos can help alleviate fuel poverty, which can not only radically improve these residents' lives but also improve broader societal welfare by helping to address this key indicator of deprivation. ESCos can also help to mitigate against the effects of climate change by delivering demand management and/or sustainable energy supply measures, which normally result in a reduction in GHG emissions associated with their customers' energy consumption. Local Authority and community owned and led ESCos can also help to improve the local economy by localizing the capital flows associated with energy supply and recycle any profit generated back into the local area to support the local economy and associated welfare gains (Sections 6.1.5.1 and 6.1.5.4):

> *'If you can keep your pounds local you will actually get a far greater benefit to local economy…there is a multiplier effect to keeping your money local...The things with ESCos is that in theory you can re-localise money flows' (Think Tank Partner - B 13)*

These examples serve to highlight how ESCos can provide wider societal benefits, which their customers are also likely to indirectly benefit from because they are members of society:

> *'The benefits were really around something that was off [the] balance sheet [i.e.] jobs, CO2 reductions, renewable energy improvements and health benefits, also money for the local economy' (Senior ESCo Manager - A 1)*

ESCos can also help commercial customers to fulfil various regulatory obligations, such as the Carbon Reduction Commitment (CRC) (see Section 5.4 & 6.1.4.1) by reducing their GHG emissions via the implementation of demand energy management and/or sustainable energy supply measures. Additionally, the social and environmental benefits associated with ESCos' energy service contracting, as outlined earlier in this sub-section, can help ESCos' commercial customer meet a number of their own Corporate Social Responsibility (CSR) commitments.

Broadly, ESCos' customers can normally enjoy all of these direct and indirect benefits over a long-term period because ESCos typically engage in energy service contracts that last for a number of years (normally between 5 – 25 years). However, ESCos' long-term contracts can constrain the operational flexibility of their customers by locking them into this contractual arrangement over a long-term period, regardless of how their needs might change in the future (Marino et al., 2011). Furthermore, the contracts may also stipulate that the customer changes their behaviour to maximize energy savings, thus further constraining their freedom. Finally, some customers may also perceive the service arrangements to constitute a form of long-term debt to the ESCo because they are committing themselves to provide the ESCo with 'x' percentage of the revenue from the energy service project (e.g. energy savings) for 'y' years.

6.1.1.2 Customer Segments

The different groups of people or organizations ESCos aim to reach and serve

In the context of this research, which is limited to residential and commercial customers (i.e. not industrial, agricultural etc), the majority of energy service contracts to date have been signed with public sector organisations for a number of reasons. Firstly, public sector organisations typically occupy large sites (e.g. hospitals, universities etc) meaning that they normally have a large energy demand, which translates into either significant energy sales as part of an ESC or significant energy savings as part of an EPC. ESCos can also capture better economies of scale by contracting with organisations operating on large, single sites compared to smaller sites, thus helping to reduce their transaction costs and make the energy service project more financially viable. This is because they are able to implement energy measures at a single site for a single customer, rather than multiple sites for multiple customers, enabling them to centralise their operations and reduce costs such as transportation.

Public sector organisations are also attractive to ESCos because they are financially backed by government: *'the public sector never goes bust'* (*CHP Expert - B21*). This provides the ESCo with confidence that they will exist for the period of the long-term contract and thus be able to honour their payments. Public sector organisations are also attractive to ESCos because they have access to more affordable finance compared to the private sector, via schemes such as the Public Loan Works Board, which can be utilised to help fund the upfront costs of the energy service projects.

Finally, public sector organisations were generally considered to occupy inefficient buildings, thus presenting a wealth of opportunities to reduce their energy consumption and carbon footprint. However, due to recent public sector cutbacks, many of these organisations did not have the available capital and/or the human resources to make the necessary investments to improve their building stock, despite these public sector cutbacks placing additional pressure on these organisations to reduce their overheads, such as energy bills:

> *'[The ESCo market has] predominantly [targeted] the public sector because public sector have got buildings that leak like a sieve and they haven't got any money' (Senior Bank Manager - B 17)*

Energy service contracts with private sector organisations are at present less common in the UK than with the public sector, partly because the private sector often lease their own premises as opposed to own them. Therefore, they typically require the consent of their landlord to sign an energy service contract because these often entail significant changes to the building stock. However, commercial customers were deemed attractive in other respects because they can be charged the higher, commercial rate for energy.

To date there has been relatively little energy service contracting with domestic consumers, largely because it has proven difficult to capture sufficiently high economies of scale in doing so because owner occupiers traditionally contract individually for energy as opposed to communally:

> *'The cost of administration and billing per head is more when you only have 172 customers rather than 20,000 or 200,000...because you aren't going to be able to achieve some of the [economies] of scale' (Senior ESCo Manager - A 6)*

One way around this has been to contract with organisations that are able to bundle numerous consumers together, such as Housing Associations and Social Housing Providers. Here the ESCo can either sell energy services to these organisations, which in turn then sell them onto their tenants or alternatively the ESCo can contract with the tenants individually, under conditions set out as part of a concession agreement between the ESCo and the organisation representing these tenants.

6.1.1.3 Customer Relationships

The relationships ESCos establish *with their customers*

ESCos share long-term contracts with their customers, typically between 5 and 25 years, meaning they also share a long-term relationship. An important aspect of their relationship is that it incorporates a significant amount of dialogue and collaboration between the ESCo and its customers, particularly prior to the contract to not only ensure that the solutions programme is feasible and will satisfy the customer's energy needs but also generate a profit for the ESCo. Furthermore, the two parties must remain in close contact to ensure that the various, detailed stipulations of the contract are being met by both parties. For instance, the ESCo may have to monitor that it has achieved a pre-agreed room temperature for its client or delivered a certain percentage of energy savings and be able to provide the necessary evidence to verify these claims. In return the customer may have to prove it has honoured their pre-agreed behavioural changes:

> *'A really crucial element of energy performance contracting is a trusting relationship between the ESCo and the client, a more transparent and open relationship, more so than with other forms of contracting' (ESCo Employee - B 31)*

This is particularly true as part of a shared savings EPC contract, i.e. where the ESCo and its customer share the energy savings achieved, because the customer assumes some of the performance risk because they are partly responsible for delivering the savings (Section 2.6.3).

The ESCo-customer relationship associated with community owned and led ESCos, such as MOZES and Ashton Hayes Community Energy Company, is rather different to other customer relationships with external, commercial ESCos because it is the community who are responsible for making the necessary arrangements to deliver energy services to the other community members. Therefore, with this arrangement, the customers are typically responsible for fulfilling their own and other customers' energy needs.

6.1.1.4 Customer Channels

How ESCos communicate with and reach their customers

Consumers' awareness of ESCo contracting was improved mainly through ESCo-led marketing, via the internet, leafleting, marketing events etc. In some cases public and third sector organisations have helped to raise awareness of the ESCo model, such as the London Development Agency via the RE:FIT scheme (Section 6.2.3.7), which was responsible for recruiting customers to tender for EPCs: *'it made what we were trying to promote before [RE:FIT] 'mainstream' instead of a lovely, niche business idea or concept' (Senior ESCo Manager - B 30).*

In terms of payment, customers typically pay monthly or quarterly payments to the ESCo in return for *useful energy streams* via ESCs or *final energy services* and some form of guaranteed energy saving via EPCs. Where ESCs have been signed for the provision of heat and/or electricity to residential customers, the charge for these services might be levied by their Housing Association or Social Housing Provider as part of their rent.

6.1.1.5 Key Activities

The most important things ESCos do to make their business model work

ESCos key activities revolve around the financing, design, installation, operation and maintenance of the energy measures the implement, as part of their energy service contracts. ESCos do not engage in a standard set of activities because these vary with the *scope* (i.e. number of useful energy streams or final energy services the ESCo is responsible for) and *depth* of their energy service contract (the number of activities required to provide these streams and/or services) (Sorrel 2007). However, we provide an example of the type of activities an ESCo would engage in for typical form of both ESC and EPC.

Energy Supply Contracting – e.g. Supply of the *useful energy stream* 'hot water' via installation of a CHP district heat scheme

The ESCo would first identify a customer base with a sufficiently large heat and electricity consumption profile via its sales and marketing team. Subsequently, it would design its CHP system and district energy network to take into account the consumption profile of its customers and the geography of the site. It would then consider how it might fund the installation of this infrastructure, through a combination of its own capital and external sources of funding (e.g. finance, investment etc). Once the funds were in place and the various forms of consent had been secured (e.g. planning), the ESCo would commence installation of this energy system, normally with the help of sub-contractors. Post-installation, it would be responsible for contracting with customers and connecting these to the network. During the period of the contracts the ESCo would also be responsible for the operation and maintenance of the system, and the metering and billing its customers' heat and electricity consumption.

Energy Performance Contracting – e.g. Provision of the *final energy service* 'lighting' and associated guaranteed energy savings via a lighting retrofit of its customer's property

The first stage would be for the ESCo to identify a potentially suitable customer via sales and marketing, which it would then undertake a preliminary audit of their premises to ascertain whether their lighting system is sufficiently inefficient so that the upfront capital cost of an energy efficiency upgrade could be recouped via the energy savings it generates, within a reasonable time period (e.g. 10 years). If the audit stage satisfies the ESCo's criteria for a financially viable project then they would work in conjunction with the customer to develop a suite of demand management solutions (e.g. energy efficiency light bulbs, lighting sensors etc) that are capable of delivering the potential savings identified in the audit, whilst continuing to satisfy the energy needs of the customer (i.e. illumination). During this stage the ESCo explores the various ways it could fund the project (e.g. self-financing, external investment, customer investment etc), which is usually undertaken in conjunction with sub-contractors. The ESCo is then responsible for operation and maintenance of this new lighting system, as well as the measurement and verification of the energy savings it generates.

6.1.1.6 Key Resources

The most important assets required to make the business model work

ESCos require sufficient capital to cover the upfront costs of their energy service projects. Normally the ESCo is unable to cover this cost alone due to the high costs associated the implementing energy service projects (e.g. equipment, installation, design etc) and will typically require the customer and/or a third party to contribute, such as a financial institution. Typically, long-term, low-cost finance was most desirable for ESCos:

> *'If you can't get access to capital, patient capital, [at] a low rate of return over a long period of time...you're not going anywhere' (Think Tank Partner - B 13)*

As previously explained, considerable amounts of capital are normally required for the purchasing of technology, which constitutes another key resource. The technology ESCos utilise depends on the *scope* of the contract but typically includes one or more of the following:

- Primary conversion equipment (e.g. CHP, PV, biomass boiler etc)
- Distribution technologies (e.g. private wire, district heat network etc)
- Building controls (e.g. thermostat, lighting sensors etc)
- Secondary conversion equipment (e.g. lights, radiators etc)

As part of an Energy Supply Contract, ESCos will require the fuel (or primary energy) to input into these systems (e.g. gas, biomass, solar radiation etc), as well as the space/land to install and operate them. ESCos also require highly skilled personnel with a wide range of expertise to deliver energy service contracts, whether these are in-house or sub-contracted. The most important skills include:

- **Legal** - to navigate the complex regulatory framework in order to constitute the ESCo initially. These are also required to draft energy service contracts to ensure they comply with legislation (e.g. consumer rights) and offer the ESCo the necessary protection if the customer fails to pay
- **Technical** - to undertake audits to identify feasible and cost-effective energy solutions, bundle these into a workable solutions package and finally, implement these. Also, these are required to provide on-going services (e.g. operations and maintenance, measurement and verification etc) as part of the contract
- **Financial** – to advise on the design of energy service contracts to ensure they will provide the ESCo with a profit, over a long-term period. Also, these are required to

identify and secure the various forms of financial support available from government (e.g. capital grant schemes, FiTs etc)

- **Marketing** – to identify consumers who fit the ESCo's Customer Segments and subsequently recruit these as customers

6.1.1.7 Key Partners

The network of suppliers and partners that make the ESCo model work

ESCos typically require a strong network of partners to develop, fund, implement and manage their energy service contracts:

> *'Partners are important in this sector. We've got partners in a number of sectors, whether they are supporting us by communicating the opportunity to an end-user, providing a deeper understanding on the technology side or providing a complementary service alongside what we are offering' (Senior ESCo Manager - B 30)*

Key partnerships ranged throughout the private, public and third sectors and the most commonly cited ESCo partnerships are presented and explained in Table 6.2 and in Figure 6.1. It is worth noting an ESCo's key partnerships did however vary depending on the type of ESCo in question (see Sections 6.1.5 & 6.2).

Partner	Value of Partnership to ESCo	Nos. of Interviewees who Identified Partner
Financial Institutions (e.g. Banks, Pension Funds, Venture Capitalists)	The majority of ESCos are heavily reliant on securing external investment or finance to cover the upfront costs of their project and therefore normally develop a partnership with a financial institution to provide this funding. These institutions also play an important role in designing the energy service contracts, to ensure they are financially and legally robust *'Companies such as ourselves don't actually finance [the projects] ourselves; we all have a banking partner' (Senior ESCo Manager - B 15)*	13
Sub-contractors	ESCos commonly sub-contract the installation of their energy service contracts projects, normally because these require highly specialised skills, which ESCos often do not possess in-house. They are also often used for the operation and management of these measures, as well as metering, billing and measurement & verification of savings *'There is so much subcontracting down and down and down [the supply chain]. There is the biomass, gas and electrical suppliers, the maintenance on the turbines, boilers and PV, the billing and metering company, the Electrical engineers, the high-voltage specialists etc. There is a plethora of subcontracting' (Senior ESCo Manager - A 6)*	12

Financial, Legal and Technical Consultancies	As outlined in Section 6.1.1.6, financial, legal and technical resources are essential to the delivery of energy service contracting. If the ESCo does not possess these skills in-house, it is likely to turn to technical consultancies, law firms, accountancies etc to provide these resources *'You need technical people, you need financial and you need legal' (Senior Energy Consultant - A 11)*	11
Local Authorities	Local authorities wield significant political power at the local level and ESCos often require their support to unlock opportunities to develop energy service projects (e.g. district heating scheme), such as gaining planning permission. The LA can also play an important strategic role by introducing the ESCo to local stakeholders that could help facilitate the project or to potential customers *'If you are talking about local projects then you should almost certainly be talking to your local authority...If you have got them on board it is a much easier ride on planning [because] you are delivering on the LA's objectives as well as your own [helping to] reduce the uncertainty associated with the project's success' (Energy Policy Advisor - B 26)*	10
Property Developers	ESCos often engage with property developers developing new residential and/or commercial sites to come to an agreement for the ESCo to develop an energy centre on-site and subsequently to supply energy to the site's occupants *'[The ESCo is] buying into an opportunity. The developer is almost saying that here is a space for you to put your hardware in, here is a customer base and here is the opportunity for a 25 year contract or whatever it is [because] most developers will want to disappear once the building has been completed' (Senior ESCo Manager - A 6)*	8
Energy Utilities	Energy Utilities play a number of smaller, less important roles but were frequently cited as an important partner. For instance, via the energy company obligations (e.g. CERT, CESP etc) they have financially supported some ESCos' operations (e.g. Aberdeen Heat & Power, MOZES). They also often provide the fuel (e.g. gas) to ESCos, to generate energy services from. They also own a number of the District Network Operators (DNOs) that ESCos often have to work closely with when connecting decentralised electricity generation to the grid *'There are all sorts of obligations imposed on the [energy] Utilities that we have tapped in, not just the CHP, we tap into it all the time. We have had a lot of money out of them over the years' (LA ESCo Manager - B 22)*	6

Table 6.2 Typical key ESCo partners

ESCos also have relationships with a range of other energy and non-energy actors that enable them to effectively deliver their energy service contracts. These are illustrated in Figure 6.1, along with the key partners as outlined in Table 6.2.

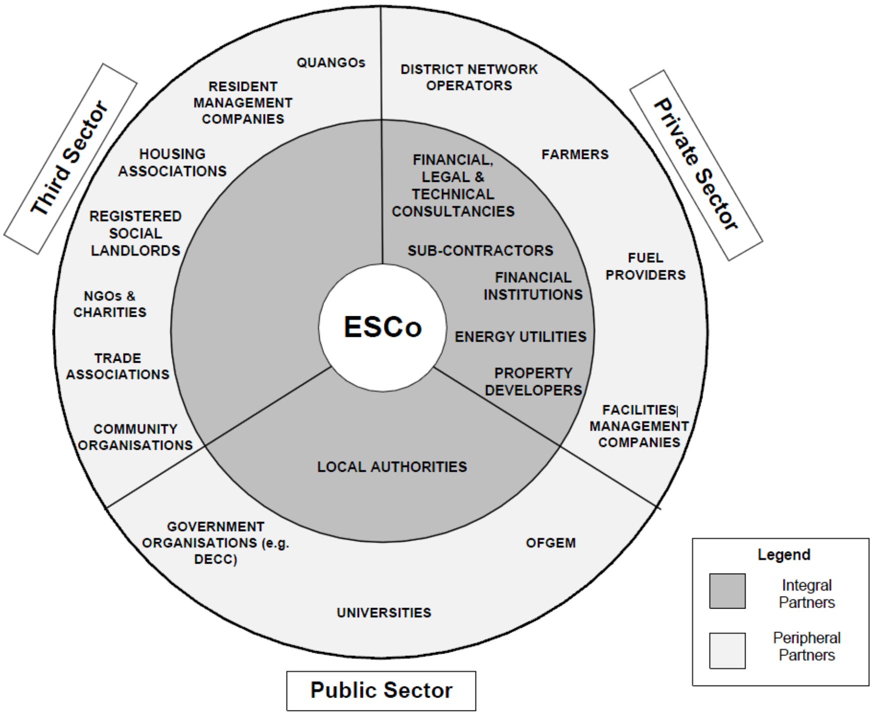

Figure 6.1 Integral and Peripheral ESCo Partnerships

6.1.1.8 Cost Structure

Major costs ESCos incur to operate their business model

An ESCo's most significant costs are reflected by the key activities it undertakes to fulfil its value proposition (see Section 6.1.1.5) and the key resources it must access in order to undertake these activities (see Section 6.1.1.6). For instance, a key activity of the ESCo model is the operation and maintenance of the technology it installs to enable it to provide energy services to its customers. This typically requires key resources such as the employment of engineers with a broad range of skills to ensure that this equipment is both safe and functional. Alternatively, the ESCo may out-source this responsibility to a sub-contractor or perform this activity in-house. Either tactic results in a cost on the ESCo. Therefore, an ESCo's cost structure is reflected by the costs associated with the key activities and resources that are essential to deliver energy service contracts to its customers.

Some of the key costs that are not highlighted in these previous sections include the payment ESCos often make to property developers or landlords to become preferred energy supplier to the consumers that reside on their development. This normally takes the form of an upfront capital contribution to the developer or landlord, as part of a concession agreement, which allows the ESCo to supply energy services to these customers over a long-term period (e.g. 25 years):

'The ESCo says 'I will make capital payment to you Mr landlord or Mr developer [because] I want to buy a concession to provide the heat…to your tenants and I am going to do that for profit'' (Senior ESCo Provider - B 18)

Other important costs include finance repayments to the financial institutions that have loaned ESCos the necessary funds to cover the upfront capital costs of their project or dividends to investors in their project or business. Finally, when providing EPCs, if the ESCo fails to meet its cost saving guarantee, it will have to pay compensation to its customers, equal to the value of the energy savings it failed to provide:

'[The ESCo] says 'I'm going to save you a 25% kWh reduction [and if they don't] they make good the shortfall however they choose to do it' (Senior Bank Manager - B 17).

6.1.1.9 Revenue Streams

The money ESCos generate from their customers

An ESCo's core revenue streams depend upon whether it is providing ESCs or EPCs to its customer. With EPCs, the main revenue stream for an ESCo is a regular payment from the customer to the ESCo to maintain a certain quantity and quality of one or more final energy services, such as lighting, ventilation, heating etc. The customer covers this cost with the savings the ESCo achieves on its energy bill (Figure 6.2). The customer's payment is structured by the ESCo so that it not only covers the upfront (e.g. cost of equipment) and on-going costs (e.g. labour) it incurred whilst delivering the measures capable of generating these savings but also provides the ESCo with a profit (Figure 6.2). The amount the customer pays the ESCo will depend on whether the two parties have signed a guaranteed savings or shared savings agreement (Section 2.6.3). Normally, the contracts are structured so that the ESCo takes the majority but not all of the cost savings it achieves on its customer's Energy Utility bill to ensure the customer immediately enjoys a small percentage cost saving (e.g. 5%) for the duration of the contract (Figure 6.2).

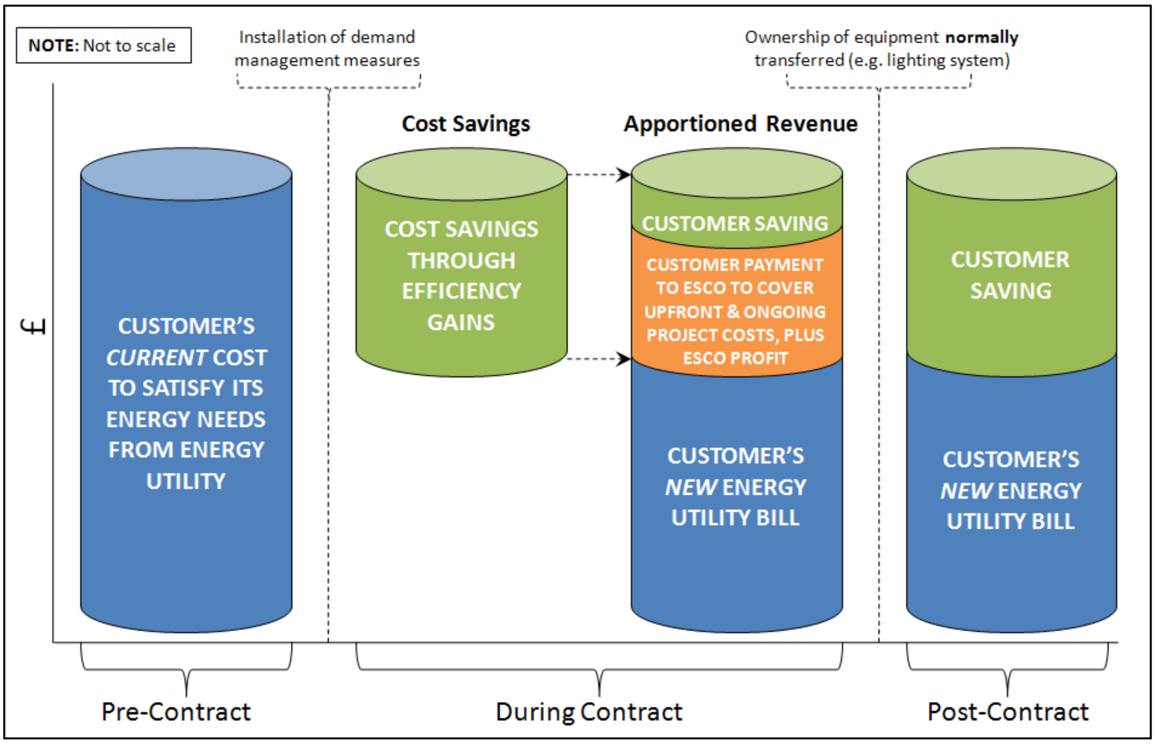

Figure 6.2 An ESCo's revenue and cost model for a basic Energy Performance Contract (adapted from Sorrell, 2005)

The core revenue stream as part of an Energy Supply Contract is the sale of useful energy streams, such as hot water and/or electricity, to its customers. In this sense the ESCo's revenue stream is rather similar to an Energy Utility's, particularly with respect to electricity supply. However, one key difference is that ESCos normally implement decentralised energy generation systems rather than centralised generation, meaning that they are often eligible to receive the financial incentives available for decentralised generation of low-carbon electricity (i.e. Feed-in-Tariff) and/or heat (i.e. Renewable Heat Incentive) (Section 5.4). Capital grants (e.g. Low Carbon Communities competition) also represent an important source of revenue for ESCos, however these represent 'one-off' payments rather than on-going, reliable revenue streams.

ESCos providing ESCs are also able to identify savings on the customer's energy bill, in a similar way to EPCs, by installing more efficient primary conversion equipment that requires less primary energy input to provide the same quality and quantity of useful energy streams. For instance, the ESCo may choose to install a CHP system that can yield a 28% primary energy saving compared to the traditional centralised forms of energy supply because it reduces electricity transmission and distribution losses by generating electricity *'close to the point of use'* (B 26) and captures heat traditionally lost via cooling towers for consumption (Carbon Trust, 2010)(Figure 6.3).

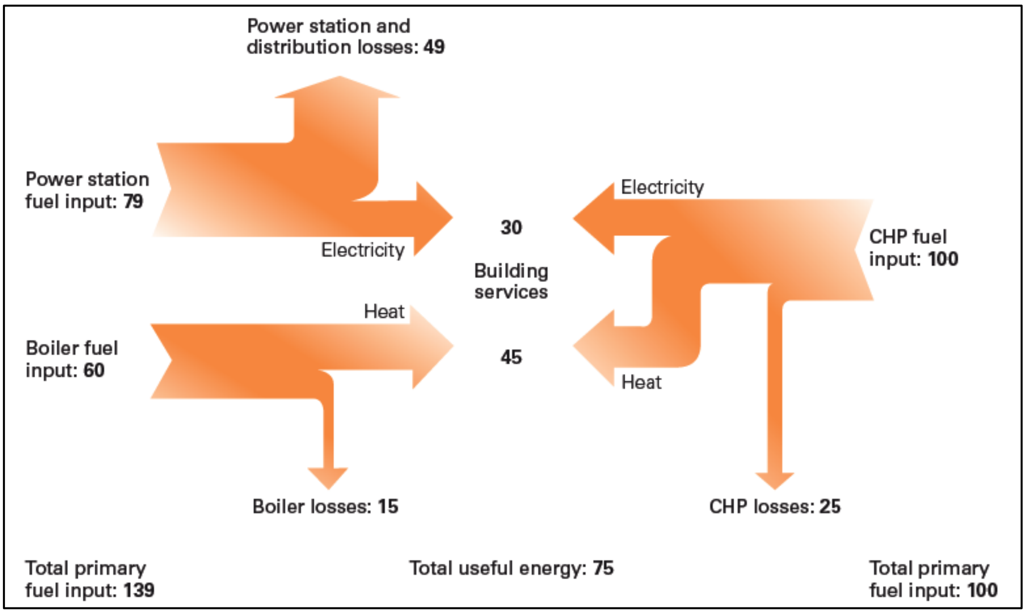

Figure 6.3 Energy efficiency of CHP compared to conventional sources of heat and power generation (shown in units of power) (Carbon Trust, 2010)

Alternatively the ESCo may choose to reduce its customer's current energy bills by replacing its customer's current primary conversion system with one that utilises a different primary energy input compared to the customer's existing choice of fuel. For example, the ESCo may replace its customer's gas-fired boiler with a biomass boiler or a solar thermal system. This decision is often made when the ESCo calculates that it can still provide the same quantity and quality of energy service more cheaply by utilising an alternative source of fuel, which has lower associated capital and operating costs over the lifetime of the contract, when compared with the costs associated the customer's existing fuel. However, this process is generally less common than developing more efficient conversion processes for traditional fuels because alternative fuels (e.g. biomass, solar, wind) often entail higher lifetime costs than traditional fuels, which have benefitted from increasing returns, such as *learning effects* (see Section 2.3.3.1).

Similar to EPCs (see Figure 6.2) the ESCo can treat these savings on the customer's current energy bill as a revenue stream because the capital has now been 'freed up'. The ESCo can capture a proportion of this cost saving via the charge it places on its customers for the sale of its useful energy streams. As illustrated in Figure 6.4, the ESCo seeks to combine the monetary value of the financial incentives and energy efficiency gains on the primary conversion equipment to subsidise the customer's energy bill so that they are able to pay less than they currently do to satisfy their energy needs with an Energy Utility:

'We put [our price] against...what you would be paying with a typical energy solution. We will show you a 5 to 10% operational cost saving [over] 10 or 15 years' (Senior EUCo Manager - B 19)

In summary, as part of an ESC, ESCos are normally able to reduce the customer's current energy bill by harnessing a combination of financial incentives and cost savings, associated with improving the efficiency of the customer's primary conversion stage or switching to a less costly primary fuel input. Alongside its 'mark-up' on the sale of kWh of useful energy (e.g. heat and electricity), ESCos also draw upon these two revenue streams as part of its own income.

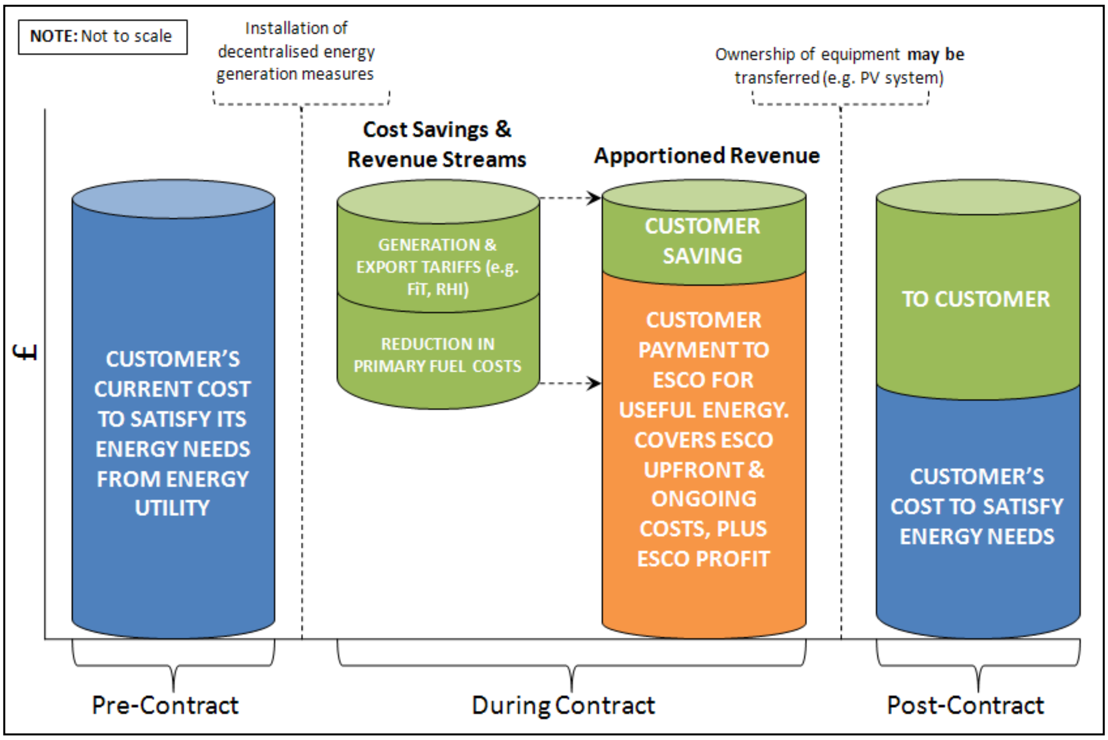

Figure 6.4 An ESCo's revenue and cost model for a basic Energy Supply Contract

6.1.2 Comparison of ESCo and EUCo Models

Our empirical investigation identified that there are a number of important characteristic differences between the incumbent Energy Utility (EUCo) business model and the ESCo model. Broadly, the ESCo business model revolves around the provision of *useful energy stream* or *final energy services* as part of bespoke, value-added, long-term contracts, which require a close and open relationship with the customer. In contrast, the EUCo model focuses on low-cost provision of gas and electricity via centralised generation and distribution, supplied to customers via standardized short-term contracts with limited customer engagement[26]:

[26] Energy Utilities have traditionally generated their electricity from high-carbon, finite fossil fuels (e.g. coal and gas), however they could generate electricity via non-finite, renewable sources of energy (e.g. wind or solar), thus making their energy supply more sustainable

'Their business model has been said to be, purchase as low as you can and cost as low as you can, and have a call centre. That is what an energy supplier is. They send out bills, that's pretty much what they do' (Energy Efficiency Expert - A 7)

We argue that in order to understand why ESCos have fared differently to the Energy Utilities within the same selection environment (i.e. the UK energy system) we must build a detailed picture of the characteristic differences between these two business models. To accomplish this we apply our analytical framework (i.e. Osterwalder & Pigneur's (2010) framework) to our empirical evidence in order to identify the core characteristics of these two business models. The core characteristics of the EUCo model were populated primarily by drawing on insights from the interviews during Phase 1 of the empirical investigations, which included interviewees from 3 of the 6 major Energy Utilities, as well as personal experience of Energy Utilities. The core characteristics of these two models are introduced in Table 6.3 and are presented side-by-side to help highlight their characteristic differences. Such a detailed analysis and comparison of the ESCo and EUCo business models has not been undertaken before, according to our literature review.

Business Model Building Blocks	**Energy Service Company (ESCo) Model**	**Energy Utility Company (EUCo) Model**
Customer Value Proposition	- Fulfil energy needs at a similar or lower cost to EUCo model - ESCo assumes most financial and technical risk of fulfilling customer's energy needs - Bespoke and holistic energy solutions that closely fit the customer's needs - Energy needs met with fewer adverse environmental effects compared to EUCo model, meaning customer can enjoy more sustainable lifestyle, fulfil regulatory and CSR obligations etc - Societal benefits (e.g. alleviation of fuel poverty, climate change mitigation, localization of capital flows)	- Fulfil energy needs at low cost - Reliable energy supply - Short-term contracts mean flexibility for customer - Little interference with customer as they do not go 'beyond the meter' e.g. few behavioural stipulations
Target Customer	- Mainly commercial (focus on public sector), with some residential and industrial	- Residential, commercial, industrial and agricultural
Customer Channels	*Similar to Energy Utilities with the addition of:* - Energy supplied via localized and often private distribution networks - Support via on-going customer interaction & project management	- On-line, TV, telephone, postal & door-to-door marketing, purchasing, metering, billing & customer feedback - Energy supplied via a national transmission & distribution network - Support via customer service call centre, metering & billing etc
Customer Relationship	- Bespoke & holistic - Long-term service contracts - Close, cooperative, candid and trusting	- Impersonal & standardised - Short-term supply contracts - Customer responsible for managing

	relationship to ensure customer's and ESCo's needs are met - Customer may invest in ESCo - Customer may manage ESCo (e.g. Community ESCo)	most conversion processes (e.g. gas to heat via boiler)
Key Activities	- Typically finance, design, build, operate and maintain small to medium scale demand management & low carbon supply energy projects **ESCs** - Generation, distribution, supply, metering and billing **EPCs** - Preliminary and investment grade auditing, measurement and verification of energy savings	- Typically Utilities engage in generation, distribution and supply (some transmission) - **Generation** - Finance, design, build, operate and maintain large-scale, centralised energy generation & distribution infrastructure - **Distribution** – Through utility owned District Network Operators (DNOs) they link transmission and generation with supply - **Supply** – Electricity trading and metering & billing of energy supply - Rarely go 'beyond the meter'. Some installation & maintenance of small-scale conversion and control technologies (e.g. central heating)
Key Resources	- Financial resources and technical, financial and legal expertise to develop small to medium scale demand management and low-carbon supply energy projects. Also customer facing services i.e. operation and maintenance, billing etc **ESCs** - Technologies: Decentralised, primary conversion technologies (i.e. generation) & distribution technologies, as well as fuel **EPCs** - Technologies: Secondary conversion equipment and building controls	- Financial and technical resources to develop large-scale, centralised generation and distribution infrastructure - Customer facing services i.e. nationwide metering, billing and customer service network - Fossil fuels (e.g. gas, coal) - Centralised generation & distribution technologies
Key Partnerships	- Financial Institutions & Investors - Technical, Legal & Financial Consultancies - Property Developers - Sub-Contractors - Local Authorities	- Financial Institutions & Investors - Electrical Power Generation Companies - Transmission & Distribution Network Operators - Gas & Electricity Network Regulators
Revenue Streams	- Capital grants - Customer investment - Bank finance **ESCs** - Payment for *useful energy* streams (e.g. hot water). Customer covers this in part via energy savings ESCo achieves through efficiency gains or utilisation of cheaper primary energy input - Low-carbon financial incentives for micro-generation (e.g. FiT, RHI)	- Sale of metered units of delivered energy (e.g. gas, imported electricity) - Low-carbon financial incentives (e.g. Renewables Obligation Certificates) - Trading of surplus electricity on the market

	EPCs - Payment for predefined quality & quantity of *final energy services* (e.g. light). Customer covers this via energy savings the ESCo achieves through efficiency gains	
Cost Structure	*Similar to Energy Utilities with the addition of:* **ESCs** - Acquiring the rights from gatekeeper organisations for energy service provision (e.g. property developer) **EPCs** - Measurement & Verification of savings. Compensation for poor performance	- Generation Technology and/or wholesale purchase of energy - Staff - Fuel - Premises & land acquisition - Marketing and communication - Infrastructure for Metering & Billing - Operations & Maintenance - Finance or investment repayments - Technical, financial and legal consultancy

Table 6.3 Detailed account and comparison of EUCo & ESCo business models

The table above highlights how the ESCo and EUCo models characteristically differ from one another. The major difference between the two is that Energy Utilities do not provide *final energy services* (e.g. lighting), whilst ESCos do. On the other hand, Energy Utilities supply primary energy to their customers (e.g. gas), whilst ESCos do not. One similarity between the two is that they both provide electricity as a *useful energy stream*, however they differ in terms of how they provide this to their customers. Essentially, ESCos typically engage in decentralised generation, often in the form of district energy or micro-generation, whilst Energy Utilities typically engage in centralised generation. The starkest difference exists between Energy Utilities and ESCos offering EPCs. The former's revenue is coupled with their customer's energy consumption, whilst the latter's is decoupled from their consumption because they draw their revenue from the savings they achieve on their customer's energy bill.

Another key difference is that ESCos typically have a closer relationship with their customers than the Utilities as they offer bespoke and holistic energy solutions, as part of long-term contracts. In contrast, the Utilities have a more distant, standardized relationship with their customers. Importantly, ESCos normally seek to fulfil their customers' energy needs at a lower cost than Energy Utilities, predominantly by reducing their customers' primary energy consumption via energy efficiency improvements and changes to their consumptions behaviour. Through their implementation of energy demand management and sustainable energy supply measures, ESCos also focus on reducing the carbon emissions associated with their customers' energy consumption, forming an important part of their value proposition. In contrast, the Energy Utilities are not intrinsically incentivised to improve their customers' energy consumption or reduce the carbon intensity of their energy supply.

The features of the ESCo model should, in principle, form an attractive package for a range of customers, particularly when compared to the EUCo model. However, as we discuss in Section 6.1.4.2, a number of key barriers have limited its uptake. Furthermore, whilst the ESCo model exhibits a number of key strengths that are mainly reflected by its value proposition, it also displays a number of weaknesses that have also helped to limit its uptake.

6.1.3 Strengths and Weaknesses of the ESCo model

In Section 6.1.1.1 we examined the Value Proposition of the ESCo model, which encapsulates the strengths of the business model from the perspective of the ESCo's customers (summarised in Table 6.3). In doing so we also highlighted some potential weaknesses from the customer's perspective. In this sub-section we now examine the strengths and weaknesses of the ESCo model as identified by our interviewees, which constituted a heterogeneous group of ESCo and energy experts. They considered how the ESCo model might be deemed attractive or unattractive from the perspective of adopters or potential adopters of the business model.

ESCos normally provide bespoke energy demand management and/or sustainable supply solutions, which is considered a key strength of the ESCo model considering how much value they create for the ESCos' customers (Section 6.1.1.1). However, it also represents an important weakness because the development of such 'tailor made' energy solution packages means that each project is normally quite distinct from others, making the replication of energy service contracts from one project to the next difficult for ESCos. Consequently, new contracts are often drafted or existing ones heavily amended with each new project, placing a significant amount of pressure on the ESCo's financial and technical resources:

> *'The big problem with the Distributed Energy (DE) ESCo model is that is very bespoke and as a result it is very costly, lawyers make a fortune. It doesn't tend to be highly replicable and that is a problem' (Senior ESCo Manager - B 18)*

Furthermore, bespoke contracting requires the ESCo to spend significant amounts of time with their customer during the design stage to ensure that the solutions satisfy their customers' needs and will not adversely affect their day-to-day operations. For instance, as part of an EPC the ESCo audits their customer's current and projected levels of consumption, which requires the ESCo to collate information from the customer to draft a workable EPC agreement.

Despite these drawbacks, the bespoke nature of energy service contracts, coupled with the small-scale energy projects ESCos normally engage with (e.g. small to medium scale CHP scheme; retrofit of an office block) means the ESCo model is relatively accessible to a broad variety of potential ESCo model adopters, ranging across the private, public and third sectors. Furthermore, the flexibility of the ESCo model also means it can be implemented to serve a broad range of Customer Segments (e.g. residential, private sector, public sector). Consequently, the ESCo model can be adopted by a broad range of organisations to satisfy a variety of *Customer Segments*.

Although, the relatively small scale of most energy service projects has made the ESCo model accessible to a broad range of organisations, it has also meant that ESCos generally struggle to effectively harness the economies of scale. This in conjunction with the resource intensive nature of bespoke contracting has meant that ESCos' transaction costs are usually high (Sorrell, 2007), which serves to constrain the ESCo's profit margin. Consequently, many ESCos have become very dependent on government capital grants (e.g. CERT funding) and regulatory financial incentives (e.g. Feed in Tariff) in order to make their business commercially viable, which exposes ESCos to risk as these schemes can be subject to major restructuring with little prior notice, as demonstrated by the recent FiT cuts.

ESCos rely on a broad range of *Key Resources* (e.g. capital, expertise, experience) (Section 6.1.1.6) and *Key Partners* (Section 6.1.1.7) to deliver energy service contracts, which serves to exclude those organisations from adopting the model who are unable to gain access to these. However, some organisations have overcome this weakness by forming joint-venture ESCos that enable multiple organisations to pool their resources and consequently provide a more compelling value proposition than if they were to operate independently:

> *'It might be that a local authority contracts with the big six operator who has their own energy services development arm…or it could be that they are contracting with the big six guy because they don't have the cash to be able to do it' (Energy Policy Advisor - B 26)*

The long-term nature of energy service contracts means ESCos are able to enjoy reliable, long-term revenue streams. The downside however is that this restricts their operational flexibility and so they are not easily able to adjust their business model as they have to honour long-term energy service contracts (Marino et al., 2011).

> *'It is very hard if you have a 20 year contract to run the boiler services for instance...to modify or change it to become a completely new type of contract…[That] becomes a barrier to implementing other [business] models' (Senior Investment Manager - A 5)*

Finally, an important potential weakness of the ESCo model is that the GHG reductions ESCos achieve via energy service contracting could potential be significantly moderated by the 'rebound effect' (Section 2.6.4). Although the impact of the rebound effect on the final GHG savings ESCo achieve for their customers has not been quantified either by this project or previous research projects, it is unlikely that the rebound effect will negate these GHG savings entirely. However, we acknowledge that this is possible and this is identified as a potential avenue for future research in Section 10.3.

6.1.4 Key Drivers and Barriers to ESCo Model Adoption and Operation in the UK

Having outlined the key strengths and weaknesses of the ESCo model from the perspective of both potential ESCo customers (Section 6.1.1.1) and ESCo model adopters (Section 6.1.3) we now examine the factors that have either enabled or inhibited the adoption and operation of the ESCo model in the UK, i.e. its drivers and barriers. These factors were identified using the data collection and analysis methods outlined in the Methodology chapter (Section 4). Considering the large number of drivers and barriers identified during the empirical investigation we present them in the tables below (Table 6.4 & Table 6.6). Only factors that had been corroborated by two or more interviewees are presented due to the sheer volume of factors identified.

The tables provide (1) a brief description of each factor and its influence on the ESCo population; (2) a selected quote to provide evidence that is representative of the driver or barrier; (3) the number of interviewees who identified the driver or barrier and (4) a ranking for each driver and barrier, which is also illustrated by colour coding. The drivers and barriers are categorized by themes (e.g. institutional and regulatory; technological and infrastructural) to enable the reader to identify which groups of factors have had the greatest influence on the uptake of the ESCo model in the UK. These themes broadly correspond with the different system dimensions outlined in the research’s Analytical Framework (Section 3). We elaborate upon and discuss a number of these factors in Section 7 to help provide insight into the co-evolutionary relationship between ESCo population and UK energy system.

6.1.4.1 Key Drivers

Description of Driver and its Influence	**Selected Qualitative Evidence**	**Frequency of Responses from Interviewees**	
		Nos. who Identified Driver	**Overall Rank**
Institutional and Regulatory			
Low-Carbon Energy Generation Financial Incentives (i.e. Feed-in-Tariff & Renewable Heat Incentive) provide revenue stream for ESCos	*‘[They are] brilliant for ESCos…It is guaranteed income, RPI linked for 25 years. Where do you get that sort of guaranteed money? It is safe as houses [and] government backed’ (A 6)*	15	1
Carbon Reduction Commitment Energy Efficiency Scheme (CRC) puts	*‘[With the CRC] you are now getting the likes of Diaggio and BP going ‘Oh God, I've got to write a cheque for £2 million, where's that come from?’…Think of their energy spend, it is*	11	2

energy efficiency on corporate agendas	*massive' (B 17)*		
Capital Grant Schemes have made upfront capital available for delivering energy service projects	*'We were fortunate because we got DECC Low Carbon Communities challenge money. We were awarded £400,000 from that which enabled demonstration [of our] community projects…to try some of these ideas out' (B 12)*	7	=6
Energy company obligations (i.e. CERT & CESP) have made upfront capital available and encouraged Energy Utilities to diversify their business activities	*'There are all sorts of obligations imposed on the [Energy Utilities] that we have tapped in, and not just for the CHP. We tap into it all the time and we have had a lot of money out of them over the years' (B 22)*	7	=6
Localism & Local Government Acts have provided greater opportunities for LAs and communities to establish ESCos	*'[The Localism Bill] is clearly closely related to planning because most of the things to do with generation involve planning permission. If that is brought back to the community level, such as a parish council for example, it would really take the temperature of the community. If the community wants to go ahead with it, why should some higher level stop them doing it? That is an important stage in the process to allow local self-determination' (B 12)*	6	=10
Planning Regulations have raised energy efficiency standards for buildings	*'[If] planning people say I want CHP on that site otherwise I will not give you planning permission, then you have to provide a gas fired CHP. If they believe in that and insist on that because they believe it gives a low carbon solution…you cannot get your site off the ground [without it]' (B 20)*	5	=12
Decline of Capital Grant Schemes has meant consumers less likely to afford upfront capital cost of energy solutions and so turn to ESCo to do so	*'[The] FITs are a bit of a bonkers idea…because the barrier [to energy projects] is the upfront capital cost, so why are we giving them a long-term revenue stream?...The institutional and policy arrangements might lead you to an ESCo [because] if you gave a grant, what is the role for ESCo? [But] if you've got a FiT, you might get a role for an ESCo. The RHI will be the same issue' (A 7)*	3	=17
Building Regulations have raised energy efficiency standards for buildings	*'Developers have this requirement on them to meet a…carbon reduction or…renewable [target]. They don't know how to deal with this…They would say 'look, I don't want to deal with this hassle. I want you guys take it away from me'…So what they do is employ us to design, build, fund and operate an ESCo company [and] take that responsibility for meeting their planning conditions' (A 8)*	3	=17
Deregulation has removed some regulatory barriers to ESCos (e.g. sale of electricity by Local Authorities)	*'There were until this year restrictions on the ability [of] Local Authorities to supply electricity. Those have been removed which opens up a greater ability certainly for Local Authorities to become involved in energy related schemes' (B 14)*	3	=17
Economic			
Recession has increased consumer desire to reduce energy bills but constrained their ability to make the necessary investments to do so	*'I don't see many people having enough free capital to be able to deliver these projects in the short to medium term, maybe say over the next 5 years. Therefore, I think ESCos are going to have an opportunity to take advantage of that' (B 30)*	9	=3
Rising levels of fuel poverty has stimulated action to	*'Quite a few of the larger community district scale projects that we see going forward, particularly led by the local*	9	=3

alleviate it	*authorities, there seems to be a particularly strong element of fuel poverty in there' (B 22)*		
Low-Carbon energy market regarded as good investment opportunity	*'Investing in green energy projects actually provides a certain level of certainty because we have projections way up to 2050, beyond which we are not going to be able to walk away from our objectives, [so] investing in these types of projects can actually be a really good thing' (B 26)*	8	5
Rising energy prices have raised interest in solutions to reduce energy costs	*'Well the obvious driver [for the ESCo model] is energy prices, because it is tangible and people know pound notes' (B 20)*	7	=6
Increasing availability of finance for ESCo projects	*'One of the initial barriers was the financial community catching up and recognising it as a viable business model but that is one that has been overcome. I think there are people looking to invest in ESCos' (B 31)*	7	=6
Market			
Existence of Local Energy 'Champions' willing to establish and lead ESCos	*'Within each local authority, you have got to find the champion. This whole thing about champions is so important and champions aren't appointed, they don't apply for a job as a champion. Instead they emerge…Generally speaking somebody will just get bitten by this and they will think 'My god, this is the right thing to do', and they will just become mad about it' (B 21)*	6	=10
Prioritisation of sustainability in corporate decision making (e.g. CSR)	*'Most organisations have CSR policies as well and they regard sustainability as something which can help them do business better, which I think Marks and Spencer have proved with their Plan A' (B 28)*	5	=12
Introduction of the RE:FIT framework has streamlined energy service contract procurement	*'The birth of RE:FIT...made what we were trying to promote before RE:FIT mainstream instead of a lovely, niche business idea or concept' (B 30)*	4	=15
UK Energy Insecurity has stimulated action to improve security	*'Then there is this security of supply and whole resilience thing…Some Local Authorities are seriously concerned about that and that is one of the [drivers]' (B 21)*	4	=15
Growing experience of delivering energy service contracts	*'I think we are learning rapidly from doing [this]…We are dealing with inadequacies in the way things are [and] everyone is trying to find their way through this structure, this crazy and difficult financial world, alongside the carbon imperatives…You get innovation in a sector where out of necessity from a certain set of drivers, you get this ballooning and refining [of business models]' (A 6)*	3	=17
Growing base of skills in UK associated with energy service contract provision	*'The calibre of staff we are getting to apply for jobs now, we didn't get 10 years ago. People...understand that this is the new industry, the new industrial revolution' (A 1)*	2	=22
Infrastructural & Technological			
Technological innovations that have improved the cost-effectiveness of energy service contracts	*'The thing about LED lighting is that instead of saving 10% or 30%, you can save 80% and then the idea of a performance guarantee finance project becomes very easy, because the returns are so huge you can say to the client I guarantee I will save you 40% of your lighting costs' (A 5)*	5	=12

Existing energy distribution networks (e.g. District Heat Networks, Private Wires, National Grid)	*'In the case of the plant we buy the existing plant room but we tie it to the existing system. So we are dropping in a new prefabricated plant on-site and then running its connection up to the header in the main plant room' (B 18)*	2	=22
Energy service projects perceived as a solution to the need for regular building upgrades	*'There was more risk in doing nothing, than doing something because had the council not replaced the heating system when it did, those buildings would not have survived another...There would have been a major failure on that site' (A 4)*	2	=22
User Practices			
Growing consumer awareness and experience of ESCo model has helped increase energy service contract demand	*'Finding customers that are ready to do [EPCs] as well is probably the second [major barrier]…but customers are now waking up to this…It is now starting to open up so we can do that. A couple of years ago it wasn't necessarily there' (B 28)*	3	=17
Customer dissatisfaction with Energy Utilities has encouraged them to identify alternative means of satisfying their energy needs	*'Three of the big six energy companies here in the UK have been saying that we really need to be referred to the competition committee because trust has broken down, our sort of brand is not respected any more by customers' (B 29)*	2	=22
Growing consumer awareness of sustainability & climate change issues	*'There is certainly far more awareness, knowledge and interest in district heating...The Renewable Energy Association's 'Heat is Half the Problem' campaign last year was a fantastic boon because people realised that heat is pretty much half the country's carbon emissions' (B 19)*	2	=22

Table 6.4 Key drivers to ESCo adoption and operation in the UK

Colour Code	Nos. of Interviewees
	10 +
	6 – 10
	4 - 6
	2 - 3

Table 6.5 Legend for ESCo Drivers Table

6.1.4.2 Key Barriers

Brief Description of Barrier and its Influence	Selected Qualitative Evidence	Frequency of Responses from Interviewees	
		Nos. who Identified Barrier	Overall Rank
Market			
Poor understanding and misconceptions of the ESCo model has limited demand for energy service contracts	*'Getting the market to understand what is on offer…is a key constraint…I don't think that the market genuinely understood what we were trying to do when we first explained to them' (B 20)*	11	1
Lack of standardized energy service contracts makes sales process lengthier and more resource intensive	*'The time that gets spent negotiating these contracts is ridiculous [because] the terms of the individual supply agreements, the leases, all require substantial amount of rework generally and you go through this process with each*	7	=3

	project of explaining the conflicts and limitations…Regulation would hopefully speed up the process [by] standardising the arrangements' (B 24)		
Unregulated heat market has limited consumer protection (e.g. monopoly suppliers)	*'There is no regulation [for energy supply contracting, so customers] can't go to Ofgem to complain, can't swap suppliers, haven't got statutory rights of compensation if [their] supply is interrupted. [They] may have all of this stuff enshrined in the contract but you as the customer have no control over what that contract says' (B 24)*	5	=7
Limited skills in the UK to provide energy service contracts	*'Finding people who understand [energy service contracts] and can structure them correctly is not easy. They are rare and not easy to find' (B 28)*	5	=7
Strength of the Energy Utilities in the energy sector	*'[The Big 6] all have one or 2 million customers, their overhead costs of supply, billing etc are as low as you can get them. So there is a cost penalty to virtually anybody coming in their in comparison' (A 7)*	3	=13
Lack of experience in UK of establishing ESCos and delivering energy service contracts	*'On the future of community groups [and] housing association ESCos, the real difficulty is that because not many people have ever done this before, they don't quite know where to start' (B 14)*	3	=13
Lack of individuals willing to lead energy projects and ESCos (i.e. 'Energy Champions')	*'I've been involved in discussions with potential clients about schemes they have where you can just tell there isn't anybody behind it to his saying right I am going to make this happen and drive it forward' (B 14)*	3	=13
Cannot easily compare ESCo contracts with Utility offerings to understand if they represent good value for money or not	*'So when [our customers] are comparing [our offer] we have been very careful to say you look you are getting a service, so if you are going to compare it you can't just go to USwitch and pick the top one...That is not looking at your servicing' (A 6)*	2	=19
Economic			
Lack of appropriate finance to support energy service contracts	*'No matter how good the project was, you need the right kind of money and the right kind of money just isn't available' (B 13)*	10	2
Recession has reduced the number of property developments, reducing ESCo opportunities to provide ESCs to new-build	*'We actually did some work for Yorkshire Forward in relation to [delivering an ESCo] for Holbeck Urban Village…It got very close too [and] would have worked. If the recession had not struck that contract would have been signed and something would have been delivered' (B 14)*	2	=19
Institutional and Regulatory			
Procurement rules makes procuring energy service contracts lengthy and resource intensive for both ESCo and customer	*'If you want to do [an EPC] with more than a certain amount of money you will have to go through OJEU to procure an ESCo in this costs money and time…It takes two years and it will cost £250,000 to procure from scratch… It is easier to say I'm doing nothing' (B 25)*	7	=3
Decline of Capital Grant schemes makes upfront capital difficult to secure for less wealthy ESCos	*'There is plenty of thinking [around new energy business models] but what there isn't is the support to make it happen and key to that support is access to capital to try things' (B 13)*	6	=5

Lack of Local Authority support to engage with ESCo projects	*'I suppose what is more problematic is that councils are very conservative [and] very risk adverse. Not necessarily that keen on innovation. So it has been perhaps problematic at times [because] as far as I can see…they were born with the word no attached to their lips' (B 22)*	6	=5
Unstable and unpredictable regulatory framework makes ESCo development difficult	*'The jury is out at the moment. You know about the FiT and how it wasn't conducted in the best manner…Policy has been communicated and implemented in such a mishandled and volatile way. It means confidence is very low in any external monetary incentive…Policy is a moving goalpost' (B 30)*	5	=7
Complexity and incoherent regulatory framework makes ESCo development difficult	*'Everyone is trying to find their way through this structure, this crazy and difficult financial world, alongside the carbon imperatives…[It's] very complex' (A 6)*	5	=7
3rd party supplier access to private wire significantly reduces an ESCo's certainty of the size of its future customer base for ESCs	*'We have a fairly captive audience and that kind of works...at the end of the day they can't really shop around and we can't afford to lose them. There is a form of dependency there. Whereas EDF could lose 2000 customers today because they can get 2001 different ones tomorrow. We can't do that…[the EU's] competition and choice agenda is at conflict with where a lot of energy and ESCo stuff is going' (A 6)*	3	=13
Landlord Tenant Act questions the legitimacy of landlords transferring their responsibility to provide their tenants with energy to a third party (e.g. ESCo) and whether this energy can be passed on above cost price	*'What you've got is a couple of hundred years of landlord and tenant law [that] is fundamentally at odds with government policy pushing an ESCo model to decarbonise new build [because it stipulates that] the landlord can't profit off the provision of communal services, such as heat. They got to pass it on at cost' (B 18)*	3	=13
Energy Supplier Obligations (i.e. CERT & CESP) provide little incentive for Energy Utilities to radically alter their business model	*'Their business model has been said to be, purchase as low as you can and cost as low as you can, and have a call centre. [The energy company obligations] haven't changed their business model fundamentally' (A 7)*	2	=19
Internal Treasury Rules prohibit Local Authorities to invest cost savings (e.g. on energy bill) into other activities	*'A treasury rule [exists] where [government] can't make savings and use them for something else, and of course that's what you're doing with the performance contract, you're making savings to then pay for that debt [i.e. cost of the upfront energy measures]' (B 15)*	2	=19
State Aid Rules caps how much government funding an ESCo is eligible receive	*'You can only have state aid up to the de minimus threshold, which is 200,000 euros…If you go above it you are breaking [the law]' (B 12)*	2	=19
Lack of city-level GHG emissions reduction targets limits Local Authority incentive to engage in low-carbon energy projects	*'There is no requirement for a city the size of Leeds to produce an energy plan, none at all. You don't have to do any of this, it is not a statutory requirement' (A 9)*	2	=19
Decentralised generation facilities can often struggle to get planning permission	*'We have had to educate the local planners in the [area] on renewable energy, sustainability and all the rest of it…[They] just didn't really know anything about it, so the planning was quite a barrier…our trial turbine took over a year to go through planning permission' (B 13)*	2	=19

Lack of planning requirements to incorporate decentralised generation in new developments (e.g. Danish Heat Law)	*'In Denmark…the power stations have to be in CHP mode and so heat is recovered by law. Whereas in this country we don't do this and so power stations locate way out in the middle of East Anglia or Lincolnshire or Yorkshire and places like that…away from where the heat can be usefully used. They can get away with that [here] whereas in Denmark…they have to locate the power station close to the point of use' (B 21)*	2	=19
Infrastructural & Technological			
High cost of low-carbon energy technologies (e.g. external wall insulation) and energy infrastructure (e.g. private wire) can make energy service projects financial unviable	*'The cost consequences of going to a passive house type product are still prohibitively expensive' (B 24)*	5	=7
Risk associated with immature low-carbon energy technologies limits investment	*'The renewable technologies have a higher risk profile.. It is easier to do gas fired CHP [because it is better] understood, therefore banks are more likely to lend you the money' (B 21)*	2	=19
High standards of building efficiency for new build may mean that there are often insufficient inefficiencies for EPCs to be cost-effective (quote 1) and insufficiently large energy demand from customers for ESCs to be cost-effective (quote 2)	*'This building is two years old, it's very efficient and we can save a bit in this building, maybe 5% say, but you are never going to go beyond 5% unless you either knock the building down and start again' (A 5)* *'Ironically by improving the building fabric…the CHP model becomes unfeasible. It's just not going to work' (A 8)*	2	=19
User Practices			
Customer preference of certain technologies even though they may not provide the most cost-effective solutions, such as generation (e.g. PV) over efficiency (e.g. insulation)	*'Where [efficiency technologies] differ is that renewable technology is 'sexy', it is visible, it is exciting and high-tech, it is marketable. Whereas your bog standard lighting, insulation, CHP, plant efficiency and fabric efficiency is less exciting for the non-energy expert. The reality of this is that the non-energy experts are making the decisions' (B 30)*	4	12
Lack of consumer awareness of the ESCo model has limited demand	*'Purely a lack of awareness Matthew. So performance contracting over here is new, people haven't heard of it before and people don't know what it is' (B 15)*	3	=13

Table 6.6 Key barriers to ESCo adoption and operation in the UK

Colour Code	Nos. of Interviewees
	10 +
	6 – 10
	4 - 6
	2 - 3

Table 6.7 Legend for ESCo Barriers Table

6.1.4.3 *Emerging Drivers and Barriers*

We now explore some of the emerging developments in the UK energy system that interviewees believed are likely to have an important influence on the evolution of the ESCo population in the future. The term 'emerging developments' refers here to developments in the UK energy system that interviewees could foresee happening but importantly, had not yet happened. Consequently, many of the emerging developments cited by interviewees were related to regulation because the development and consultation process for legislation precedes its implementation by many months if not years, meaning they many interviewees had a good understanding of how the regulatory landscape was likely change and how this might affect the ESCo population.

Focusing first on the broader developments associated with the UK energy system, the continuing and potentially worsening effects of climate change are likely to help support a sympathetic selection environment for the ESCo model, by exerting pressure on government to develop and maintain a regulatory framework that is supportive of carbon reductions. Energy insecurity is expected to worsen as the UK's finite fossil fuel reserves are steadily depleted and existing generation facilities are retired (DECC and OFGEM, 2011). This in conjunction with increased global demand for energy are likely to have an impact on energy prices, which are expected to continue to rise (DECC, 2011a). High energy prices coupled with projected poor economic growth for the UK in 2012 and 2013 (IMF, 2012) means consumer demand for a reduction in energy bills is likely to remain high, consequently making energy service contracting more attractive: '*So as energy prices increase, [ESCos] will become more and more common*' *(Senior ESCo Manager - B 20)*. In particular, public sector organisations are likely to take measures to reduce their energy costs in reaction to recent public sector cutbacks, a product of the economic downturn:

> *'I don't see many people having enough free capital to be able to deliver these projects in the short to medium term, maybe say over the next 5 years...I think ESCos are going to have an opportunity to take advantage of that' (Senior ESCo Manager - B 30)*

The emerging development interviewees most frequently cited was the imminent introduction of the Green Deal (GD), which constitutes a financial mechanism that eliminates the need for householders to pay upfront for sustainable energy supply and/or energy demand management measures as these are covered by the savings they will generate on the customer's energy bill in the future (DECC, 2012o). Savings here refer to a reduction in the units of gas and/or electricity the customer requires from the Energy Utilities to satisfy their energy needs. This can be achieved via the installation of micro-generation technology (e.g. PV panels, air source heat pumps) that enables the customer to satisfy some degree of their energy needs independently via renewable sources of energy (e.g. solar, hydro, wind etc) and/or the installation of demand side management measures (e.g. building controls, insulation, secondary conversion equipment) that enable the customer to enjoy the same quality and quantity of final energy service, with a lower primary energy input (Green Deal Initiative, 2012b).

The Green Deal will be provided by a combination of accredited 'Assessors' who assess the efficiency of the resident's home, 'Installers' who install the identified efficiency measures and 'Providers' who will set out the financial terms of the GD agreement and be responsible for fulfilling these. Providers are also responsible for organising the financing of the project and coordinating the Assessors and Installers. In some cases the GD Provider might fulfil all three roles (i.e. Assessor, Installer and Provider) and incorporate some or all of the elements of an ESCo. The Green Deal Provider will operate much like an ESCo, as it will be responsible for identifying, designing, installing, financing and servicing of a suite of energy solutions in the resident's home, the cost of which it recuperates via the cost savings they generate on the resident's energy bill. Figure 6.5 illustrates the various stages of the Green Deal process.

Figure 6.5 An illustration of the Green Deal process (BRE, 2012)

As outlined in Section 6.1.1.2, energy service contracts have to date predominantly been signed with commercial customers. Importantly, the GD is designed with the residential market in mind and many interviewees believed it should help to open this market up to ESCos by putting the necessary systems in place to allow for the cost of the measures to be repaid via the customer's energy bill. It will also attach these costs to the property, not the householder, so even if the house is sold, the new householder will continue to pay off the costs of the measures to the Green Deal Provider. It was explained that once this system was put in place, various different kinds of organisation were likely to become Green Deal Provider in order to take advantage of the opportunity the GD presents, leading to greater variety in the ESCo market:

> *'Around the Green Deal…I can imagine that you see new organisations springing up to satisfy those types of requirements and you will also see one or two other organisations changing their business models to take advantage of those opportunities' (Senior ESCo Manager - A 10)*

It was also considered by a number of interviewees that many financial institutions, in light of the Green Deal, are likely to be more forthcoming with finance to fund residential EPCs than at present. For instance, the Green Deal Finance Company has recently been set up to provide an affordable source of finance to Green Deal Providers, to enable them to deliver a wide range of energy efficient measures (GDFC, 2012). Furthermore it was considered that the Green Deal would help to raise the profile of energy service contracting and help to *'mainstream the ESCo model' (LA ESCo Director - B 22)*.

Despite the potential boost the GD may provide to the ESCo market concerns were raised that it may not have the desired impact the government is hoping for, in part because attaching the debt from the cost of the energy measures to the property could make it difficult for the householder to sell their home, making it undesirable:

> *'You are taking it on as a debt and you are forcing anybody who comes in and buys the property to take on that debt, that long-term obligation as well…I don't think it will be attractive to a mainstream property owner' (Senior ESCo Manager - A 6)*

Furthermore, the GD is an optional scheme and some interviewees were concerned that if either households or providers did not consider the GD to be sufficiently attractive they would not engage with it. It was expected that the extent to which customers will take up the GD is likely to depend on the implicit interest rate being charged by the Green Deal Provider and thus the scale of the customer's cost savings:

> *'So you are creating a structure where capital is being invested and the interest can be repaid. That doesn't mean that...people are going to rush out and do it' (Think Tank Director - B 29)*

Under the GD, a proportion of the savings on the customer's energy bill are repaid to the Green Deal Provider via the customer's Energy Utility bill. Consequently, in most cases, units of electricity and gas will continue to be provided to the customer by an Energy Utility. In this sense, the GD reserves a role for the Utilities and the EUCo business model as savings are repaid via the contracts the Utilities share with their customers. Therefore, unless the Utilities engage in the GD as a Green Deal Provider, they are unlikely to overhaul their business model in accordance with this policy.

The GD is set to work alongside the latest energy utility obligation, the Energy Company Obligation (ECO), which will provide the necessary funds to implement efficiency measures that do not meet the Green Deal's 'Golden Rule', i.e. where 'the expected financial savings resulting from installing measures must be equal to or greater than the cost of repayment over the term of the Green Deal Plan' (DECC, 2011i p.8). Despite the financial support the ECO is likely to provide ESCos supplying affordable low-carbon energy, in a similar fashion to its predecessors (CERT & CESP) (see Section 6.1.4.1), some interviewees explained that it would continue the tradition of energy company obligations that can be met *'without any sort of detailed intervention on a house by house basis'* by the utilities and without fundamentally changing their business model *(Energy Efficiency Expert - A 7) (*see Section 6.1.4.2). In essence, the introduction of ECO is unlikely to place any real pressure on Energy Utilities to alter their business model and adopt aspects of the ESCo model.

The imminent establishment of the Green Investment Bank (GIB) was identified as a potentially important driver as it could help ESCos to access appropriate finance to cover the upfront capital costs of their projects, given that the funding priorities of this body are set to include support for the Green Deal, non-domestic energy efficiency and energy from waste generation (BIS, 2011b). The GIB's role is to help organisations engaging in 'green' activities, such as ESCos, circumvent many of the existing barriers they face in accessing finance. These include 'the risk profile of green investment, the risk appetite among investors, the capacity of borrowers to absorb additional finance and the availability of project finance skills' (BIS, 2011a p.5). Some interviewees explained that the GIB may be structured to help to unlock finance for community ESCos in particular (see EAC, 2011), by ensuring that they are no longer *'at the mercy of the usual high street bank financing [and] constrained by those limitations' (Law Firm Partner - B 14*). To summarize:

> *'Potentially the Green Investment Bank [could] choose to lend to community groups or ESCos [which] might kick-start some community led stuff' (Think Tank Director - B 29)*

Another important emerging development is the Electricity Market Reform (EMR), which is designed to stimulate investment in nuclear and renewable energy, as well as carbon capture storage (CCS) (IEA, 2012a). The policy incorporates 4 main components: (1) 'Contracts for Difference' that will provide low-carbon electricity generators with a guaranteed price for their electricity over a long-term period; (2) an Emissions Performance Standard for power plants; (3) a capacity mechanism to ensure sufficient system flexibility is available to maintain reliable supplies and (4) a carbon floorprice, which will 'provide a transparent and predictable minimum carbon price for the medium and long term' (IEA, 2012a p.10), designed to supplement the one already in place with the EU Emissions Trade Scheme (EUETS)(Figure 6.6). It was thought that the latter component in particular could help to address *'one of the weaknesses at the moment [in the UK, which] is the cost of carbon' (Law Firm Partner - B 24)*. Narrowing the present gap between the cost of fossil fuel derived electricity and low-carbon electricity in the market, by making carbon-intensive electricity more expensive via a carbon floorprice, would benefit organisations (e.g. ESCos) engaging in low-carbon electricity generation because they would avoid being significantly penalised by this tax.

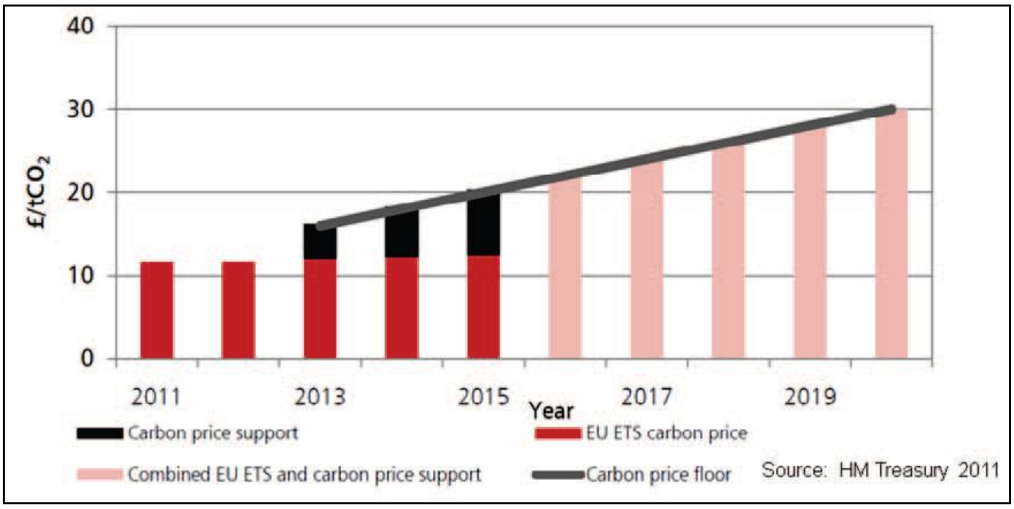

Figure 6.6 Illustration of how carbon price floor is likely to work under the EMR (in real 2009 prices and calendar years) (DECC, 2012e)

Concerns were however raised that some forms of generation that were commonly used by ESCos, such as CHP, may be subject to this 'carbon tax':

> *'Within the EMR…CHP is going to be charged carbon floor-price for the EUETS for all the energy purchases, not just electricity…but if it was a heat only plant it wouldn't because the carbon floor price doesn't apply to domestic gas. It is putting a wedge between CHP and gas only' (Think Tank Director - B 29)*

Another important emerging regulatory development identified was the emerging building regulations, where new residential developments by 2016 and new commercial developments by 2019 must be 'zero carbon'. Although the exact definition of this is still being developed, it is likely to allow developers to meet this standard via a number of 'allowable solutions', including both energy efficiency (e.g. highly energy efficiency building fabric) and low-carbon generation measures (e.g. district heat network). Inclusion of the latter would create a significant opportunity for ESCos to provide ESCs to consumers on new-build complexes:

> *'[By 2016] all new build developments need to be zero carbon. We believe that the definition of zero carbon will be a 70% on site carbon reduction [compared to 2006 Building Regulations], with the remainder being required to pay for some sort of allowable solution to meet the rest. If that is the definition it is good news for us, because we can get to the 70% carbon reduction through gas fired CHP, which is proven, reliable and efficient technology' (Senior EUCo Manager - A 8)*

Finally, the proposed European Energy Efficiency Directive was also identified as a potential driver because it would obligate EU member states to set their own energy savings targets (EC, 2011). Furthermore, the proposed Directive makes provision for member states to support energy service market growth by making a list of UK ESCos available, thus raising the profile of the market, as well as energy service contract templates available, thus helping to reduce the amount of time and money ESCos currently spend on developing service contracts from new.

In summary, it is expected that the majority of the foreseeable, emerging developments in the UK energy system will broadly be supportive of ESCo operation and will most likely improve its prospects of proliferating over the coming years.

6.1.5 Key ESCo Variants Operating in the UK

In response to Research Question 1 (Section 1.5), an important finding of the empirical investigation was that the UK ESCo population operated not just one single business model but instead exhibited a strong degree of heterogeneity, with a number of different variants of the ESCo model in operation, which were similar but still characteristically distinct. The four most common variants identified in the UK ESCo population, were the:

- Local Authority 'Arm's Length' ESCo
- Energy Service Provider
- Energy Utility Energy Service Provider[27]
- Community Owned and Led ESCo

The purpose of this section is to examine these 4 ESCo variants in greater detail and identify their different core characteristics, as well as the reasons why each specific variant has emerged. In doing so we seek to build upon the valuable work already undertaken by King and Shaw (2010) in relation to some of these variants. In the ESCo variants diagrams that follow the *spheres* represent the organisations (i.e. the ESCo and its partners) and the *diamonds* represent the customers. Please refer back to Section 6.1.1.7 and the various case studies in Section 6.2 for examples of ESCo's partners.

6.1.5.1 Local Authority 'Arm's Length' ESCo

A Local Authority 'Arm's Length' ESCo is an ESCo that is established by a Local Authority (LA), which may be wholly owned by the council or partly owned if it is a joint-venture arrangement with a private sector partner. The latter may be preferred as a means of apportioning risk and pooling organisational resources (see Section 6.1.3) (Figure 6.7). The ESCo is principally established by the LA to help it deliver on its political objectives (e.g. reduce fuel poverty,

[27] This constitutes a sub-variant of the Energy Service Provider ESCo

mitigate climate change, improve local economy etc), constituting a private sector vehicle for the *'implementation of the local authority policy' (Law Firm Partner - B 14)*:

> *'Rather than a simple contractual relationship [with an Energy Services Provider], it gives us more leverage in terms of achieving other objectives and outcomes…We can deliver on objectives X, Y and Z …such as around local employment, training and skills' (LA Sustainability Director - A 9)*

LA 'Arm's Length' ESCos can help to support the local economy because they employ a 'not-for-profit' financial model whereby *'all of the revenue is recycled back into the system to either upgrade a project or help it deliver others' (Energy Policy Advisor - B 26)*. For instance with Aberdeen Heat and Power Company, the Arm's Length ESCo to Aberdeen City Council:

> *'Any [financial] surpluses stay within Aberdeen. With EDF, any profits made in London will then go to Paris, but here they stay in Aberdeen' (LA ESCo Director - B 21)*

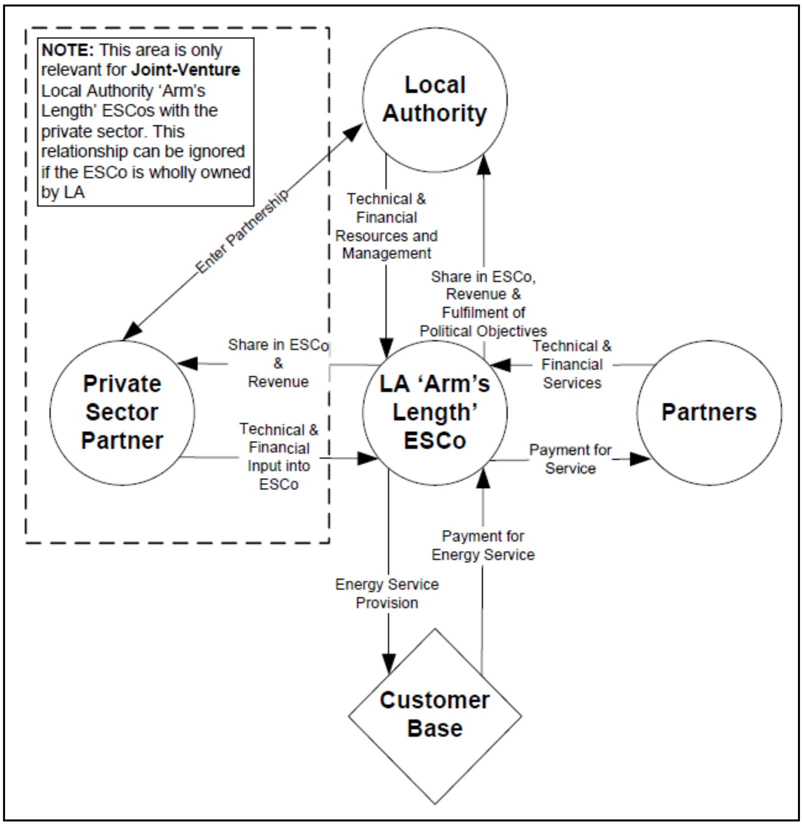

Figure 6.7 Local Authority 'Arms' Length' ESCo

The LA 'Arm's Length' ESCo model insulates the LA from much of the associated financial risk associated with delivering energy service contracts because it represents an *'off balance sheet'* solution *(Senior ESCo Manager - A 1)*, where apart from the possibility of some initial start-up investment, the LA is unlikely to continue investing in the ESCo because it should be financially self-sustaining. Furthermore, it also insulated from much of the financial and legal risk associated with operating the ESCo because the ESCo is a separate legal entity to the council:

> *'[The ESCo is] a separate legal entity, so if its business failed, then it would be that which failed, not the [Local Authority's]' (LA Sustainability Director - A 9)*

Despite this insulation from risk, the LA will still be exposed to some degree of risk, be it financial in relation to the repayment of loans it has made to the ESCos[28] and/or technical in that it relies upon its ESCo to satisfy its energy needs, which it is partly/wholly responsible for operating:

> *'You take a lot of risk…If it all goes wrong, there is no private sector provider to turn round and say 'you have messed this up, we will get rid of you and replace you with somebody new' (Law Firm Partner - B 14)*

Consequently, many LAs can opt against establishing an 'arm's length' ESCo because *'councils are very conservative…very risk adverse [and] not necessarily that keen on innovation'* (*LA ESCo Director - B 22*). The concept of establishing their own ESCo can therefore often sit outside of their *'comfort zone' (CHP Expert - B 21).* LAs may also be unable or unwilling to provide the necessary financial and technical resources to establish and operate an ESCo. For instance, a great deal of time and effort is required to establish an 'arm's length' ESCo, which the council maybe unwilling to provide. It may also be unwilling to engage in energy service contracting because it sits outside their remit and they are not incentivised to engage in such activities by regulation, such as city-level GHG emissions reduction targets (see Section 6.1.4.2):

> *'[They may think] we know nothing about operation and maintenance of district heating schemes and we don't want to go there. It is just an unwillingness to engage in that activity' (Law Firm Partner - B 14)*

Alternatively Local Authorities may choose to contract with an Energy Service Provider instead, where they deliver the energy service project on behalf of the LA.

6.1.5.2 Energy Service Provider

An Energy Service Provider is a private sector ESCo that delivers energy service contracts to either residential and commercial customers, assuming some or all of the financial risk and technical responsibility associated with the project in return for a profit (Figure 6.8).

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[28] Councils are able to raise finance cheaper than commercial organisations via schemes such as the Public Loan Works Board, which it can pass on to its ESCo at a competitive commercial rate. See Thameswey Energy case study (Section 6.2.1)

Importantly an Energy Services Provider does not exist to fulfil its own energy needs but the energy needs of others. It therefore represents:

> *'A private sector party to come along and design and build, and...if possible, to finance, and then operate and maintain the scheme' (Law Firm Partner - B 14)*

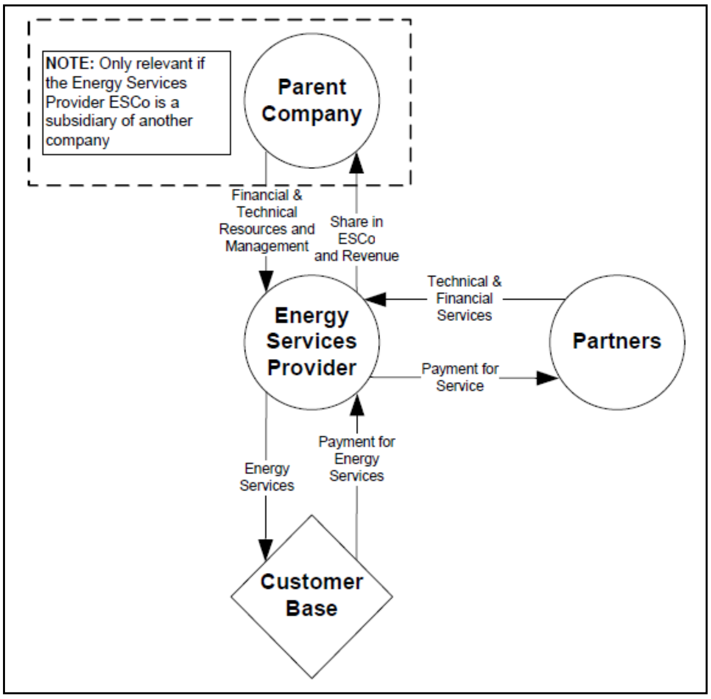

Figure 6.8 Energy Services Provider ESCo

Energy Service Providers typically offer either Energy Supply or Performance contracts, however some providers offer both, such as Font Energy, Self Energy and E.ON Energy Services. Organisations like Local Authorities or Property Developers typically engage with Energy Service Providers if they lack the financial and technical resources to deliver an energy service project capable of satisfying their energy needs and/or the impetus to deliver such projects due to the associated risks outlined in the previous sub-section:

> *'Where decisions have been made by local authorities or developers that they don't want to establish their own ESCo…then it's about going to the marketplace...With the emergence of ESCo providers, [it was] more comfortable for developers to think about engaging with them rather than setting up their own' (Senior Energy Consultant - A 11)*

It was highlighted that some organisations may choose not to contract with Energy Service Providers because transferring this responsibility would mean they are *'no longer necessarily the master of your own destiny any more'* (*Law Firm Partner - B 14*):

'They are professionally established and they will understand the risks better but the disadvantage with that is that they take all the profit unless you can have some sharing arrangement' (Senior Energy Consultant - A 11)

Transferring this responsibility to the Energy Service Provider, means they take a significant share of the revenue the project generates. In contrast, if the customer had delivered this project independently they would enjoy the entirety of this revenue stream themselves (Bale et al., 2012) [29].

In some cases the Energy Service Provider may establish a Special Purpose Vehicle (SPV) or subsidiary, which is normally solely responsible for the delivery and management of an energy system (e.g. CHP system and network) as part of the energy service contract, within a specific geographic location. These are typically set up to manage the needs of a specific property development or a town/city. Expanding upon the latter Birmingham City Council elected not to establish their own 'Arm's Length' ESCo (Section 6.1.5.1) and instead contracted with Cofely GDF Suez to deliver a district heat system on their behalf. Cofely, then known as Utilicom, established Birmingham District Energy Company (BDEC) Ltd, which is an SPV responsible for the 'design, build, finance, own and operate sustainable district energy schemes across Birmingham' (DEKB, 2012). The benefits to Birmingham City Council are that it 'will be subject to less risk and will continue to benefit from many of the project outputs (e.g., reduction in fuel poverty and CO_2 emissions)' (Bale et al., 2012 p.249). In this case Birmingham City Council constitutes both a 'partner' and a 'customer' in Figure 6.8.

SPVs may also be established to enable joint ownership and management of an energy service project or group of projects, which can help in some instances to provide *'a balance between public and private interests' (CHP Expert - B 21)* and also to pool these organisations' differentiated but complementary resources (Section 6.1.3). For instance, ownership of Thameswey Energy in Woking (Section 6.2.1) was initially split between Woking Borough Council and Xergi, a CHP specialist. Additionally, rather like the Local Authority 'Arm's Length' ESCos, Energy Service Providers may also establish SPVs to insulate themselves from some of the financial and risk associated with providing energy service contracts (Section 6.1.5.1).

6.1.5.3 Energy Utility Energy Service Provider

As outlined in Section 6.1.2, Energy Utilities have traditionally employed a characteristically distinct business model to ESCos. However, in recent years the Energy Utilities have begun to establish their own energy services divisions to provide energy service contracts (Figure 6.8).

[29] The thesis author is accredited as co-author of this paper

For example, E.On established a division called Sustainable Energy Solutions that provides Energy Performance Contracts. The research found that five of the six major Energy Utilities had recently provided energy service contracts (Appendix G – Section 12.6). It is important to note that the Energy Utility ESCo variant represents a sub-set of the Energy Service Provider variant, acting in a very similar manner. However, we make a separation between the two because Energy Utility Energy Service Providers represent subsidiaries of the incumbent Energy Utilities.

Senior Energy Utility staff explained that the key factor driving their move towards the ESCo model was that they and other senior personnel were acutely aware that the market was changing and that it was imperative that their organisation began to adjust their business model so that it could remain successful in this radically new environment:

> *'[We recognise] that the energy market is changing, that you can't continue down the big coal-fired power stations any more [or] centralised gas plants any more. We need to look at the way energy is changing in the UK. There is what we call an energy trilemma' (Senior EUCo Manager - A 8)*

> *'The bottom line of it is that this is a new world, and this is where the world is going to' (Senior EUCo Manager - B 28)*

In part the Utilities move towards the ESCo model was also seen to be a response to changing patterns in their customers' demand, with customers recently consuming less energy primarily due to high energy prices. This had led to the Energy Utilities seeking to deliver a service that resonated with customers' changing needs: *'[our customer came to us and said] we need more than just a commodity, we have got to save energy' (Senior EUCo Manager - B 28)*:

> *'After five years of the customer saying 'we want this, we want this, we want this', [the Energy Utilities] are starting to change their super tanker path' (Senior Investment Manager - A 5)*

Importantly, one Energy Utility manager indicated that their move towards energy services was in part driven by the understanding that energy service contracting could prove more profitable than their current offerings:

> *'We have to move away from [selling] commodities [because] the value and margins in commodities are so slim…If we save the customer more money, they will give us more in return as well. So the customer gets value, they use less energy, we get more value and more margin.' (Senior EUCo Manager - B 28)*

It is worth noting however that there is little regulatory incentive for the Energy Utilities to move into this space at present and it is predominantly driven by a desire to remain profitable in the future by retaining and growing their market share in the context of a radically changing energy system. Consequently there is little stopping the Energy Utilities overhauling their business strategy so that they reversed their move towards the ESCo model:

> *'Everybody says energy suppliers should become ESCos, but well if you understand the regulatory environment, they are not motivated to do that whatsoever' (Senior Investment Manager - A 5)*

6.1.5.4 Community Owned and Run ESCo

A Community Owned and Run ESCo is an ESCo that is established by a community in order to help it not only fulfil its energy needs via the delivery of energy service projects but also to realise a set of community objectives (e.g. self-sustainable, alleviate fuel poverty, growth in local economy etc). Normally the ESCo is wholly owned by the community and it is the community members who are responsible for the running of the ESCo (Figure 6.9).

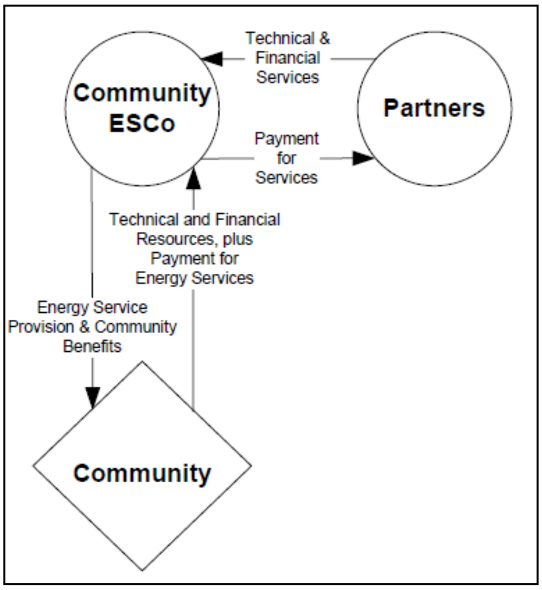

Figure 6.9 Community Owned and Run ESCo

Community ESCos can enable communities to assume a much greater degree of control over the manner in which their energy needs are satisfied and thus ensure that these are fulfilled in a manner that are aligned with community's interests:

> *'At the moment, energy is just something that is done to people but actually giving them control over the local generation, distribution and supply of electricity empowers that community' (CHP Expert - B 21)*

In a very similar fashion to the Local Authority ESCo, Community ESCos are normally non-for-profit and so any profit generated by the organisation is recycled into other energy service projects, providing a boost to the local economy:

> *'Profits from the energy system are retained, shared, distributed and used locally [so] you can probably see a measurable increase in the local economy as a result of that. Because if your profits are going to New York and Paris [they're not] being spent locally' (Think Tank Partner - B 13)*

Community ESCos typically rely heavily on key partners to help them deliver their energy service contracts because they normally have very limited resources at their disposal considering they are only able to draw upon resources amendable to the community, which are unlikely to be sufficient to successfully operate an ESCo (Section 6.1.1.5) (Figure 6.9). Consequently, Community ESCos are somewhat limited in terms of the scope of energy service projects they can engage in due to these resource constraints (Section 6.2.2.7):

> *'Disadvantages…I guess reliance on volunteer time. I mean in our community that's not too bad a disadvantage…because there are quite a lot of people in the village…there are a lot of professionals in the village and several of them are recently retired [so] therefore there are quite a lot of people who are prepared to put in the time, but that wouldn't necessarily be the case elsewhere' (Community ESCo Director - B 12)*

Despite being limited by the availability of resources the *'enthusiasm of people and the strength of the community'* was seen to be an extremely valuable resource because it meant that *'when you need to get numbers for people to do something, then you can get that done'* (*Community ESCo Director - B 23*). Community ESCos can also often avoid against local opposition because the community is unlikely to oppose the energy project they have been responsible for developing that is responsible for developing.

In summary the ESCo population exhibits a significant degree of heterogeneity, incorporating a wide variety of different ESCos types. This has implications for the future evolution of the ESCo population and how it causally influences the evolution of the various dimensions of the wider UK energy system, which is explored in greater detail in the following chapters. In the following section we explore the narratives of 4 ESCos, each of which correspond to one the key variants types outlined in this section.

6.2 Phase 2: 4 Archetypal ESCo Case Studies

In this sub-section we examine the findings from Phase 2 of our empirical investigation. The purpose of this phase was to examine the 4 key ESCo variants identified in Phase 1 (Section 6.1.5) in much greater detail by undertaking 4 ESCo case studies, each of which corresponded to one of these key ESCo variants. Care was also taken to select a mixture of ESCos providing both Energy Supply (ESCs) and Performance Contracts (EPCs). Furthermore, it is important to note that each ESCo selected for case study had to fulfil the 'ESCo selection criteria' outlined in Section 4.4.1.1.

Each of the ESCo case studies were constructed using a combination of data from interviews with the ESCos' personnel and documentation, predominantly produced by the ESCo but in some cases documentation was used that had been written by a third party about the ESCo under investigation (Section 4.4.2). The documentation used to develop the case studies as presented in the Bibliography, whilst a brief overview of the 12 interviews conducted for the case studies in this Phase is provided in Table 6.8. Details of which are provided in Appendix F (Section 12.5), which also contains the interviewee cross-reference codes.

Company	Type of ESCo Variant	Dates	Nos. of Interviews
Thameswey	Local Authority Arm's Length ESCo	10/1/2012	2
MOZES	Community Owned and Run ESCo	9/8/2011 - 9/2/2012	3 (4)*
Honeywell	Independent Energy Service Provider	23/7/2011 - 2/5/2012	3 (4)*
Energy Utility X	Energy Utility Energy Service Provider	22/9/2011 - 1/2/1012	4 (5)*

Table 6.8 Overview of interviews conducted for the 4 ESCo case studies

*This denotes that one interview conducted in Phase 1 was used as evidence for the case study (see Section 4.3.2.3)

The qualitative data generated via Phase 2 was examined using our analytical framework (i.e. Osterwalder & Pigneur's framework for business model characterisation) to outline the core characteristics of each of the ESCo's business model (Section 3.1). These characteristics, relating to the 9 business model building blocks, were subsumed under headings that broadly corresponded with the 4 business model pillars outlined in Osterwalder's (2004) earlier framework for ease of presentation, i.e. *product/value proposition, customer interface, infrastructure management and financial aspects.* For example, *customer channels, relationships and segments* were grouped under the heading *customer interface*. Additionally, the case studies were broadly constructed using the co-evolutionary aspect of our analytical framework. In this sense the case studies illustrate how the evolution of these 4 ESCos has been influenced by the environment in which they have operated but also, how their operation has influenced the evolution of the wider UK energy system.

Drawing upon this empirical evidence the case studies seek to tell the story of these different ESCo variants, highlighting in particular how and why they were established in the UK, their core characteristics, the drivers and barriers they have experienced, as well as their future prospects. Importantly, the narratives also highlight how these companies have influenced their wider environment. In Section 6.2.5 we undertake a brief cross-case analysis of these ESCo case-studies to identify themes that are either common or specific to each of the different ESCos' narratives.

6.2.1 Thameswey Energy Ltd

6.2.1.1 Overview

Thameswey Energy Ltd	
Commencement of UK ESCo Operations	1999
Location	Woking, Surrey
ESCo Variant Type	Local Authority 'Arm's Length' ESCo
Ownership	Wholly Owned by Woking Borough Council
Turnover	2010 - £2,691,521 (Thameswey Energy, 2011)
Number of Staff	23 employees
Type of Contracting	Energy Supply Contracting for heat, electricity and cooling
Generation Capacity	2.6MW of electricity, 3.2MW of heat and 1.7MW of cooling (Thorp, 2007)

Table 6.9 Key Facts and Figures for Thameswey Energy

6.2.1.2 Brief History

In 1999, Woking Borough Council (WBC) established Thameswey Group (TG), a subsidiary of the council designed to help the council deliver on its four main priorities of: decent and affordable housing, environmental conservation, health and well-being and finally, economic development (Thameswey, 2012e). A year later in 2000, Thameswey Group established Thameswey Energy Limited (TEL), a public-private joint venture ESCo in order to provide energy supply contracts to residential and commercial customers. Ownership was initially split between Woking Borough Council's Thameswey Group and Xergi, a Danish CHP design and build company (Thameswey Energy, 2012e). Xergi owned 81% of TEL, in line with the rules at the time against councils not being able to own more than 19% of private companies, with WBC owning the remainder (T 2) (Smith, 2007a).

In 2001 TEL began to install its first energy centre and private wire distribution network to supply both heat, electricity and cooling to customers in Woking town centre via energy supply contracts (Thorp, 2011). This was followed by another large-scale district energy system at Woking Park, as well as a large number of PV installations throughout the area. In 2007, TEL established its own subsidiary in Milton Keynes, outside of Woking, called Thameswey Central Milton Keynes Ltd whose aim was *'to construct and operate a Combined Heat and Power station to deliver district heating and a private wire network to newly developed areas of Milton Keynes'* (Thameswey, 2012c). Since the introduction of prudential borrowing, WBC has slowly increased its share of TEL and by the end of 2011, TEL became wholly owned by the council (T 1) (Figure 6.10). For the purpose of this case study we focus primarily on Thameswey Energy's activities in Woking, making only a few references to its work in Milton Keynes.

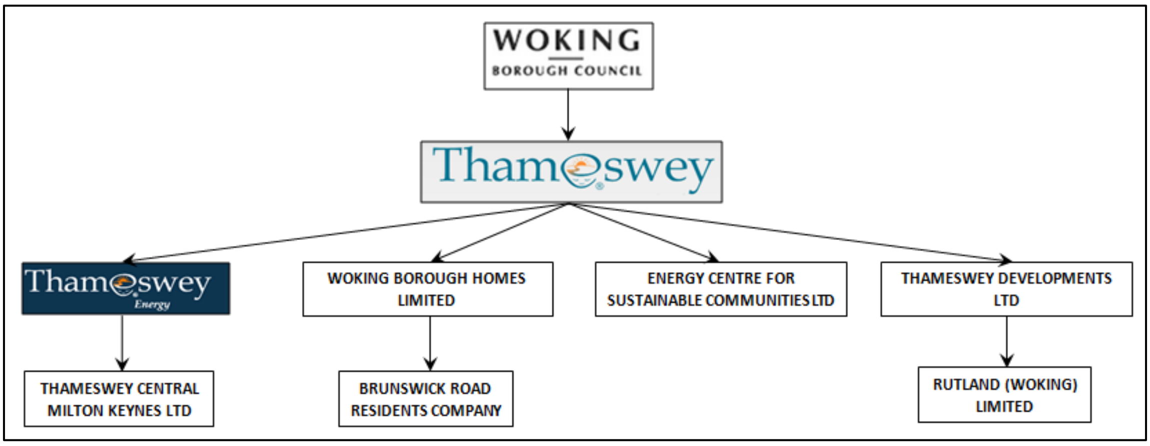

Figure 6.10 Organizational structure of Woking Borough Council's Thameswey Group (Thameswey, 2012b)

6.2.1.3 Objectives and Value Proposition

TEL was established primarily to help Woking Borough Council 'make long term energy and environmental project investments in support of the Council's climate change strategy' (Thameswey, 2012a) and other political objectives. Broadly, its primary objective is *'to provide public benefit through private sector mechanisms'* (T 2). TEL has served to deliver sustainable energy projects and services on WBC's behalf that have the potential to improve the well-being of Woking's residents predominantly by reducing their energy bills and carbon footprint, as well as stimulating the local economy. For instance, by reducing its customers' energy bills, TEL has helped to alleviate fuel poverty in the Woking area, which represents a key objective for the council (Greenpeace, 2006, Thorp, 2011).

The establishment of TEL, as an 'arm's length' ESCo to Woking Borough Council, has allowed the council to develop energy projects it might not have previously been able to because *'companies have business plans that are 25-30 years long they are able to take losses in years going forward, which the council couldn't carry on its books'* (T 2). Therefore, the council is able to develop energy projects with a longer term perspective because TEL's *'business plans transcend the democratic cycle'* (T 2), which typically only lasts for 12 months when the local elections take place:

> *'Because of the [political] churn...you wouldn't have a lot of councillors supporting something that would benefit their successors. So [establishing TEL] allows [for] developments that are to the ultimate benefit of the community that wouldn't otherwise take place' (T 2)*

TEL also insulates WBC from much of the financial and technical risk associated with energy service projects because it constitutes a separate legal entity (Kelly and Pollitt, 2009, Bale et al., 2012), thus enabling it to develop projects it might not have traditionally considered.

Conversely, the distance between TEL and WBC means that the ESCo is able to manage its budgets autonomously making it less vulnerable to the financial implications of political developments within the council and the public sector more widely (Thorp, 2011). Additionally, this distance has also meant that TEL has been able to operate outside Woking, such as in Milton Keynes.

A major benefit of establishing TEL was that the council could access private sector finance, experience and expertise via this private sector ESCo, enabling it to *‘implement large scale [energy] projects’* (Thorp, 2011 p.96), which would have been difficult to deliver had the council operated alone (T 1 & 2) (Thorp, 2011). For instance, TEL was jointly owned by Xergi, which was responsible for developing and installing its CHP systems and private distribution networks (Thameswey Energy, 2012e). Additionally via TEL, the council has also been able to capture the expertise and experiences of private sector employees because TEL is a private-sector entity, which pays private-sector rates.

An important part of TEL’s customer value proposition is that it is responsible for the design, implementation, financing and maintenance of the generation, distribution and supply of energy from its facilities (Thameswey Energy, 2007b, WBC, 2003), meaning that the majority of the risk and hassle customers associate with fulfilling their energy needs is transferred to TEL. For example, TEL are responsible for installation and maintenance of the heat interface unit, pump and exchanges in the customer’s property, as well as the various valves, controls and thermostats (Thameswey Energy, 2007b). This equipment replaces their boiler and associated controls, meaning they do not have to worry about the cost and effort associated with installing, operating and maintaining their own boiler.

An integral part of TEL’s value proposition is that it recycles the profits it generates from its energy supply contracting to fund existing and future sustainable energy projects in the borough (T 2):

> *‘[The] profits that Thamesway generate are not put into the general running of the council [but] are ring fenced and used for sustainability work within the borough… There are probably been £600,000-700,000 that has come back in so far to help support projects’ (T 2)*

This money is channelled into Woking’s cross-party Climate Change Working Group as opposed to WBC’s general operations fund. This helps to ensure that the funds are used exclusively for projects that are relevant to the council’s climate change strategy (T 2). TEL also generates additional funds for the council’s non-sustainability related operations through interest payment of interest on loans from the council. The council borrows money from the Public Loan Works Board (PWLB) at a cheaper rate than commercial loans and subsequently lends this money to TEL at a close to commercial rate to avoid State Aid rules but at a rate which is more affordable to TEL than if it had borrowed from a bank (T 2). These repayments to the council total approximately £1 million per annum, which is treated as general revenue and used to fund the council's activities going forward (T 2), helping to improve the quality of its public services to Woking's residents.

Some customers are likely to value the fact their energy needs are being fulfilled in a more environmentally sustainable way, considering their heat, cooling and electricity has been generated via a combination of renewable (e.g. PV) and highly efficient (e.g. CHP) generation technologies (Thameswey Energy, 2012c). Consequently, during 2010 TEL saved its Woking customers over 1400 tonnes of CO_2 by supplying them with low carbon energy generated from its energy stations (Thameswey, 2012d). However, the reduction TEL guarantees on its customers' energy bills was considered more valuable by their customers:

> *'Our customers are not interested in societal benefits; they haven't been to the dowdy school of corporate sustainability. They are just interested in making a profit [or saving money]' (T 2)*

TEL charges their customers *'5% below the market rate for electricity, which they would get from the top 5 dual fuel suppliers'* (T 2). A similar arrangement is in place for commercial customers where TEL guarantees to beat the price they could get on the market (T 2). The council is also able to satisfy its energy needs at a lower price than it would cost from the leading Energy Utilities (T 2), making more funds available to invest into its public services.

6.2.1.4 Key Activities, Resources and Partnerships

TEL's key activities include the design, financing, building, operation, management and maintenance of sustainable, supply side energy service projects for the generation, distribution and supply of heat, electricity and cooling (Thameswey Energy, 2012c, WBC, 2007b). Through these activities TEL has to date delivered two main CHP schemes in Woking: one in the City Centre and the other at Woking Park, a large out-of-town leisure complex. Together they have a combined generation capacity of 2.6MW of electricity, 3.2MW of heat and 1.7MW of cooling (Thorp, 2007). In addition to these schemes a number of PV installations have been completed, one of the largest is the Albion Square PV canopy outside Woking railway station, which contains 272 solar panels, with a peak capacity of 81kW (WBC, 2007a) (Figure 6.12). Combined, TEL's generation capacity meant that in 2010 it generated more than

10 Gigawatt hours (GWh) of low carbon electricity and 9 GWh of heat, enough to provide electricity and heat to over 2,000 households (Thameswey, 2012d).


Figure 6.11 Woking town centre CHP plant (WBC, 2007c)

Figure 6.12 Albion Square PV canopy, next to Woking railway station (Smith, 2007b)

Thameswey Energy also uses some of its revenue to support non-energy service contract energy efficiency measures. For instance, Action Surrey has been established and is managed by the Energy Centre for Sustainable Communities Ltd, which is a subsidiary of the Thameswey Group (Action Surrey, 2012). Its role is to offer advice to residents, schools and businesses on how to reduce energy and water consumption (Action Surrey, 2012). Furthermore, the Thameswey Group has been the vehicle for delivering the Council's home energy improvement schemes (e.g. free loft insulation) under the Government's Home Energy Conservation Act 1995 and more recently Warm Front and Energy Utility company obligations (e.g. CERT) (Thorp, 2011).

TEL has relied upon a number of key resources to deliver its energy projects, most notably a combination of technical expertise, administrative capacity and political will (T 1). Technical expertise related to the skills and experience, i.e. the 'know how', to deliver the energy service projects. Administrative capacity referred to the more tangible capacities of the organization required to deliver the project, such as sufficient staff and capital to organize and deliver the project. Finally, the most important resource identified was the political will to develop and deliver sustainable energy service projects, it was important that this vision was shared throughout senior management and also had cross-party support (T 1) (Thorp, 2011):

> *'There needs to be the will in place…You can buy the technical and administrative capacity but you cannot buy the will to do it…[i.e.] the dream, the aspiration to do something. If there is a will, there is a way' (T 1)*

The availability of decentralised generation technologies, most notably the CHP and PV systems, has also been integral to enabling TEL to extend its value proposition (Thorp, 2011). For instance, CHP technology has enabled TEL to offer lower energy prices to its customers than the bigger Energy Utilities because CHP captures the usable heat produced from electricity generation to provide to customers, which would otherwise normally be treated as a by-product in centralised generation (CHPA, 2012a), making it approximately 28% more energy efficient (Carbon Trust, 2010). Furthermore, if CHP is applied on a local-scale, lower transmission and distribution losses for electricity can be enjoyed compared to centralised generation, as the CHP plant is in close proximity to the consumers. This phenomenon is commonly referred to as the economies of proximity (Carbon Trust, 2010) (Figure 6.3 in Section 6.1.1.9).

TEL has also relies on the support of its partners to fulfil its value proposition. Although technically both its owner and largest customer, Woking Borough Council also represents TEL's most important partner, considering that WBC is a legally separate entity to TEL and the two operate fundamentally differently to one another. The council has supported TEL's operations from the very beginning, providing the start-up funds for the ESCo, which were drawn from energy savings achieved on the council's properties (Thorp, 2011). This partnership has continued throughout TEL's history, with the council having an important presence on the board of Thameswey Group, with Ray Morgan, the council's Chief Executive acting as an Executive Director of Thameswey Group. It is also likely that the close partnership it shares with the council has presented key development opportunities for TEL in the local area, considering that the council is a key gatekeeper due to its political power.

As previously mentioned in the case study, the Danish CHP firm Xergi has also been a key partner to TEL. Even though Xergi are no longer shareholders of TEL, the two continue to share a contractual relationship, where Xergi are responsible for the 'building and operation of the energy centres' (Thameswey Energy, 2012e). TEL have also been reliant on sub-contractors to deliver its PV projects such as RES Group, PV Systems and Gleeson Construction during the construction of Albion Square PV canopy (Figure 6.12) (RES, 2012). Other important partners have included the Energy Savings Trust who provided a £25,000 grant to the council to explore the possibility of establishing a public-private joint-venture ESCo. Post-feasibility study Clyde & Co., a law firm, were commissioned to provide the council with advice on the corporate arrangements for TEL, including the financing and development of its renewable and sustainable energy projects (WBC, 2007b, Clyde & Co, 2012).

6.2.1.5 Customer Interface

TEL now has over 170 business and domestic customers receiving electricity and/or heat via energy supply contracts in Woking (Thameswey, 2012d). Unlike in Milton Keynes where TEL has connected 1500 apartments to its private wire heat system[30], TEL only has approximately 40 residential customers in Woking (T 2). TEL's largest customer in Woking is the council, although it does have other public and private sector customers that mainly consist of:

> *'the Civic Offices, HG Wells Conference Centre, the Big Apple, Car Parks, YMCA, Enterprise Place, the Lightbox and the Woking Leisure Centre and Pools in the Park.' (Thameswey, 2012d)*

The contractual relationship it shares with its residential customers is very similar to that which its customers would share with an Energy Utility in terms of metering and billing (Thameswey Energy, 2012d), as well as the customer's ability to change their energy supplier and thus terminate their energy supply agreement with TEL provided they give 30 days' notice, as outlined under Ofgem rules (T 2). However, use of system charges are still applicable because their new supplier would need to use TEL's distribution network (Thameswey Energy, 2007a). Commercial customers' energy supply contracts are much longer term, lasting for at least 10 years (Thameswey Energy, 2012a), whilst TEL has signed a 'pass through'[31] contract with the council, which works on a rolling basis (T 2). TEL supplies electricity to its customers predominantly via its own private wire network, with heat and cooling supplied via a private network of pipes, which it is responsible for operating and maintaining (Thameswey Energy, 2012c). Customers are able to sign-up with TEL and pay for their energy services online, over the phone or by post (Thameswey Energy, 2012b).

6.2.1.6 Revenue Streams and Expenditure

As highlighted in Section 6.2.1.4 the initial start-up funds for establishing TEL came from the council and that WBC has continued to finance TEL's activities by raising money from the PWLB (Section 6.2.1.3). WBC is also the largest single shareholder in TEL, alongside other major shareholders such as a UK investment bank (Thorp, 2011). It was explained that *'the working capital for a lot of the activities of the group comes from shareholder loans or shareholding*

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[30] This does not necessarily equate to 1500 household customers because of the 3rd party access rules introduced by Ofgem following the Citiworks case

[31] TEL charge WBC for the amount of gas the former needs to purchase in order to supply the latter with heat, cooling, electricity, in addition to a service charge (for investment and maintenance) and a small profit margin (T 2)

equity from the council' (T 2). TEL aims to provide a return of at least 8% to shareholders on their investments in the Woking area for the period to 2030 (Thorp, 2011).

TEL's decision to install its own energy centres and private energy distribution network has meant that its upfront costs have been very high. For instance, the energy centre, private wire and heat system in Milton Keynes, which followed a very similar design to Woking, cost TEL approximately £25 million to design and install (T 2). On-going costs include the operation and maintenance of this infrastructure, labour, rental of premises, metering and billing etc (T 2). On the other hand TEL's largest revenue stream is the sale of heat, cooling and electricity to its local residential and commercial consumers, charging their customers according to how much electricity, heat and cooling they consume (Thameswey Energy, 2007b), as well as for the operation and maintenance of the systems required to generate, distribute and supply these *useful energy streams* to their customers (Thameswey Energy, 2012d). TEL also receives Feed-in-Tariffs (FiTs) from the electricity generated by its PV systems. For instance, PV panels on 35 council buildings are expected to raise £44,000 a year in FiT payments over the next 25 years (Thameswey, 2012f).

It was also explained that Thameswey Group had set up their own consultancy called the Energy Centre for Sustainable Communities (Figure 6.10), which has enabled the Thameswey Group to generate additional revenue by sharing their intellectual property relating to the development of their energy service projects. They have advised a range of other councils on the developments of ESCos and district energy systems (e.g. Southampton, Aberdeen, Leeds, Bristol etc) (T 1 & 2) helping to illustrate how TEL has served as a template for other councils to enter the UK ESCo market. Consequently, this exchange of knowledge has helped and continues to help the ESCo model to proliferate outside of Woking:

> *'Probably the change or the influence [on the wider energy system] is to demonstrate that Local Authorities could do district heating better than they had before. So that has probably been an influence, which has caused people to think, 'could we do that?'' (T 1)*

6.2.1.7 Drivers and Barriers

As outlined in Section 6.2.1.4, political will at the local level was a key factor that enabled TEL to emerge, alongside the necessary administrative capacity (e.g. staff, finance etc) and technical capacity (e.g. expertise, experience etc):

> *'It is a little bit like the alignment of the planets but we had 3 key components aligned... Those 3 happened to come together in the mid-90s and were built upon' (T 1)*

It was explained that political developments at a national and international level laid the groundwork for this local support (T 1 & 2). For instance, in 1992 the Rio Earth Summit took place and from this emerged the Local Agenda 21, which sought to link sustainability action across international, national and local levels. Subsequently, a climate change agenda began to emerge in the UK (Sections 1.3.1 & 5.4), designed to support activities that helped to mitigate climate change, such as that proposed by TEL. This agenda *'kept the council committed to Thameswey's activity'* (T 2), which was very important in the emergence and growth of TEL. Furthermore, the council had a track-record of tackling sustainability and energy related issues from the early 1990s, creating a precedence for TEL's activities (Thorp, 2011), helping them to circumvent potential barriers.

TEL has however encountered a number of regulatory barriers, most notably the structure of the electricity market and the electricity trading arrangements (BETTA), which were considered to be bias towards the Energy Utility companies by the interviewees: *'The rules are written for them'* (T 1). They explained that it was prohibitively expensive for them to enter the electricity market to trade their electricity: *'it would cost us £500,000 minimum to join that pool...far too much as a small suppliers'* (T 2); *'The transaction and membership costs are inhibitive'* (T 1). Consequently, TEL is unable to benefit from the advantages of joining this pool such as being able to access a significantly larger customer base than could realistically be connected to its own private network, as well as avoiding the cost and hassle associated with establishing their own private electricity distribution network and operating this network.

This meant TEL has had to apply for electricity generator, distributor and supplier licence exemptions under the Electricity (Exemption from the Requirement for a Generation Licence) (No.2) Order 2004 to be legally allowed to supply energy. Selling electricity directly to its customers and not via the pool has benefitted TEL in a number of ways such as avoiding the costs incurred from transmission and distribution losses, Transmission & Distribution Use of System charges[32], VAT etc, which account for a large proportion of customers' electricity bills (WBC, 2003). Avoiding these costs, in conjunction with the high levels of energy efficiency from CHP means TEL has been able to undercut the Energy Utilities' price for electricity (WBC, 2003). However, *'the exempt licensing regime limits exempt supply capacity to domestic customers and limits exports over public wires'* (Thorp, 2011 p.96). The Electricity Order 2004 stipulates that licence exempt generators can generate up to 100MW; distribute up to 2.5MW but only up to 1MW for each private wire; and supply up to a maximum of 5 MW of power, of which a maximum of 2.5 MW may be to domestic customers (at present the aggregate limit is

[32] Charges for connecting to and using the electricity transmission and distribution networks

500KW) (DTI, 2004). Consequently, these restrictions have limited the scale of WBC's activities and the economies of scale they can harness, thus negatively impacting upon their profit margin (T 1) (Smith, 2007a).

Even though TEL does not sell its electricity via the National Grid, it is still is required by law to connect their private wire network to the grid for load balancing (T 2). They were also incentivised to connect in order benefit from FiT payments for their PV generation (Thameswey, 2012f). Although TEL has connected to the grid, *'the bureaucracy around gaining access to that network and the rules around it and the time delay and the cost associated with gaining access to that network'* (T 1) was considered a major barrier. Furthermore, it was felt that the grid connection arrangements were *'written to suit the established order'* (T 1), namely the Energy Utilities because the only means of gaining cost-effective entry to the grid was to work in partnership with them. However, despite the significant cost of connecting to the grid, TEL did not have to invest significant amounts of money on a new private distribution network because a private wire and several district heating schemes already existed in Woking (EST, 2005, CHPA, 2012b) .

It is worth noting that despite the continuation of these regulatory barriers a number of regulatory changes have meant that the TEL's environment is now more supportive of Local Authority activity in the energy market than it once was: *'All of the legislative framework means it is now easier to setup what we setup in 1999 [i.e. Thameswey Group]'* (T 1). For instance, Local Authorities used to be prohibited 'from selling electricity which is produced otherwise than in association with heat [e.g. CHP]' (DECC, 2010b p.4) until a clause in the 1976 Local Government Act was repealed in 2010. Importantly, TEL and WBC played an important role in getting this rule changed by engaging with national government (DECC, 2010e). For instance, Chris Huhne, then Secretary of State for Energy and Climate Change, explained in 2010 that;

> *'For too long Whitehall's dogmatic reliance on 'big' energy has stood in the way of the vast potential role of local authorities in the UK's green energy revolution. Forward thinking local authorities such as Woking in Surrey (the owners of Thameswey ESCo) have been quietly getting on with it, but against the odds, their efforts [have been] frustrated by the law. I've taken the early step of overturning the ban on local authorities selling renewable electricity to the grid' (DECC, 2010e)*

The 'localism' agenda has gained momentum in other ways, such as with the introduction of the Local Government Acts 2000 and 2003, and more recently the Localism Bill, which has provided WBC the 'power of well-being'[33], broader borrowing powers and the ability to establish non-public sector organisations such as Community Interest Companies (CiCs) (T 1 & 2). However, despite this support for grass-roots developments, TEL raised concerns about the removal of the Local Authority National Indicators and how this might affect the council's willingness to tackle fuel poverty, particularly N186, which was for carbon emissions and N187, which was for fuel poverty (T 1 & 2).

6.2.1.8 Expectations for Future Development

The global recession has already had a negative impact on TEL's activities. For instance, in Milton Keynes a number of developments that were set for construction and to be supplied by TEL were side-lined due to the poor economic climate (T 1). Consequently, TEL has restricted investments in future energy projects until the economic climate improves. As this recession is set to continue in the UK (IMF, 2012), TEL is likely to continue operating in a challenging environment for the foreseeable future.

Turning to regulation, the emerging regulatory framework is likely to continue being supportive of low-carbon energy and grass roots activity (Section 6.1.4.3). For instance, Renewable Heat Incentive (RHI) could provide an additional revenue stream for TEL, as it is a major supplier of heat. However, it was explained that the growing complexity of the framework has made it increasingly difficult to navigate (T 1). Furthermore, due to developments such as the FiT cut, the interviewees explained that they lacked confidence in how the regulatory framework would develop in the future, making it difficult to plan ahead:

> *'You don't know how much confidence you can put in what the government is saying because they might change their mind in 3 months, as they did with the [FiT] tariffs. We do need a certain time period to develop and implement investment and if the government keeps chopping & changing, there isn't a stable platform to go forward and start planning' (T 2)*

More specifically, although TEL acknowledged the Green Deal could provide them with opportunities going forward, they had concerns around the extent of support it was likely to offer. For instance, they did not feel the Green Deal would be sufficiently attractive enough to consumers to encourage them to sign up for it, meaning that the policy would do little to improve TEL's fortunes: *'there's nothing inspiring about it or attractive'* (T 1). It was also felt that the policy had been written with the major Energy Utilities in mind and not LA led ESCos.

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[33] These allow local authorities in England and Wales to implement any policy that they consider will promote the economic, social and environmental well-being of their area, unless explicitly prohibited by national legislation (CLG, 2009)

This is because the repayments for the efficiency measures had to be paid via the customer's bill with the Energy Utility bill:

> *'So the option of putting it on the council tax bill [like PACE in the US] was rejected and that would have given local government a far greater involvement in the GD' (T 1)*

Finally, following the Citiworks case in Germany[34], the introduction of legislation requiring private wire electricity suppliers to allow 3rd party access to their networks (OFGEM, 2011) has meant that TEL now has less certainty around the number of customers it will serve either on its existing networks or any future networks because customers are now able to switch to other suppliers who have accessed that network (T 2). ESCos often need this level of certainty to know whether they will be able to recoup their high upfront costs or not and consequently, be successful in securing the necessary finance to deliver the scheme.

6.2.1.9 Summary

In summary, TEL has demonstrated how Local Authorities are able to satisfy not only their energy needs but the needs of their local residents and organisations via energy service contracting, in such a way that enables them to fulfil a broad set of political objectives. However, TEL has had to battle against a number of key barriers, many of which were attributed to a regulation that were considered to favour the incumbent Energy Utilities. However, international, national and local political support for sustainable energy projects has been a key driver to TEL's success and despite a challenging economic environment, the emerging regulatory framework is likely to ensure TEL continues to operate successfully.

[34] Citiworks, a German utility company, sued Leipzig Airport for breach of competition laws as it held a monopoly over energy supply on an on-site private wire scheme (CHPA, 2011)

6.2.2 MOZES

6.2.2.1 *Overview*

MOZES	
Commencement of UK ESCo Operations	2009
Location	The Meadows, Nottingham, East Midlands
ESCo Variant Type	Community Run ESCo
Ownership	Company Limited by Guarantee
Turnover	Less than £10,000 to date
Number of Staff	Board of 13 directors, all volunteers and no full-time staff
Type of Contracting	Energy Supply Contracting for electricity
Generation Capacity	Approx. 95kW of PV

Table 6.10 Key Facts and Figures for MOZES

6.2.2.2 *Brief History*

The story of Meadows Ozone Energy Services Limited (MOZES) began with an unsuccessful bid in 2005 for Living Landmarks National Lottery funding with the view to help the Meadows become Nottingham's first, inner city low carbon neighbourhood (M 1) (NEP, 2011) (Figure 6.13). Although the group were unsuccessful the work they had undertaken prompted the local council to work towards implementing some of the ideas the group had developed. However, these ideas ultimately these failed to materialise (M1).

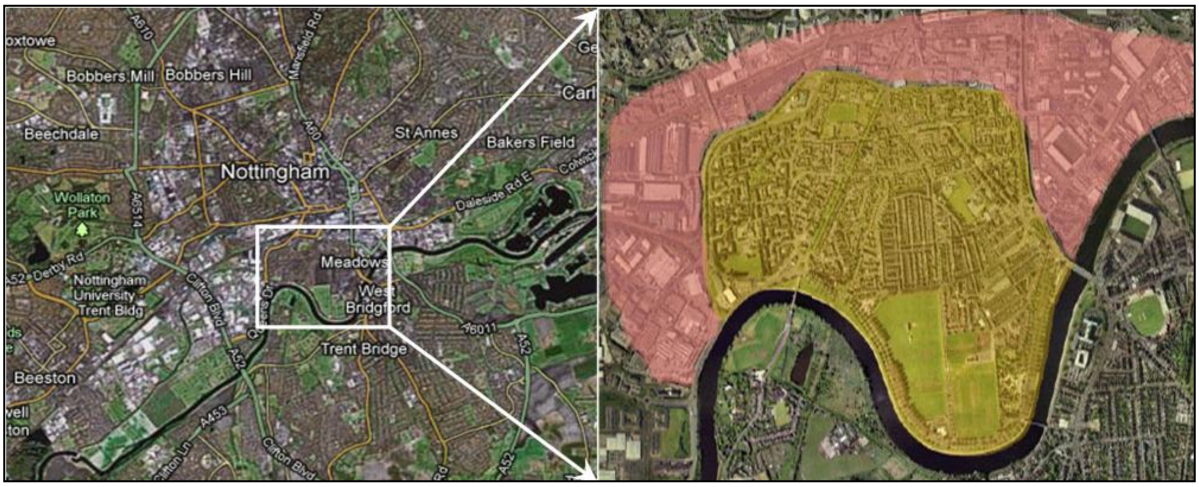

Figure 6.13 A map of the Greater Meadows area. The yellow denotes MOZES's catchment area and the red the wider Meadows area (MOZES, 2012g)

The Lottery bid *'left an awareness in the community of green issues and [an] aspiration in the community to move towards a zero carbon footprint'* (M4). The group responsible consequently began to explore how the Meadows could reduce its carbon footprint and turned to the idea of establishing an ESCo, largely in light of the Meadow Partnership Trust's (MPT) work with the Credit Union on developing a rolling loans fund (NEP, 2011). Consequently, a steering group was established to explore the options for establishing an

ESCo-like entity, which included representatives from MPT, Nottingham Energy Partnership (NEP), National Energy Action (NEA), Nottingham City Council and local Residents Associations, as well as the local MP (Alan Simpson) and the local Councillor at the time (MPT, 2012).

In 2007 NEA provided the Meadows community with sufficient funds to conduct a feasibility study into the options for establishing an ESCo, which was undertaken by Brodies, a law firm (M 1) (Energyshare, 2012). Brodies identified a range of options for the Meadows community to establish a community led ESCo. After considering these options, MOZES was constituted in 2009 as a company limited by guarantee, effectively owned and run by the Meadows community. Since its formation MOZES has undertaken a number of energy related projects, such as energy efficiency retrofits and the provision of energy efficiency advice for residents of the Meadows. However, their largest project so far was the installation of 67 photo-voltaic (PV) systems in 2009 throughout the Meadows area, the vast majority of which were installed as part of an energy supply contracts, at no upfront cost to the consumer.

6.2.2.3 Objectives & Value Proposition

The Meadows is a relatively deprived neighbourhood of England[35]. For instance, according to the most up-to-date statistics for the area, in 2007 4.4% of the area's residents were claiming Job Seekers benefits, compared to an average of 2.3% for the whole of England (Monstadt, 2007). Furthermore, in 2007/8 the average net household weekly income was approximately £400, compared to £490 for the East Midlands area (ONS, 2008):

> *'We have quite a deprived community. Some people own their own houses but some people don't and there are some people in the community who have money but not many' (M 3)*

Consequently, a key objective of MOZES was to help alleviate deprivation in the Meadows neighbourhood by promoting community and economic development in the local area (Brodies, 2008, Gutteridge, NEP, 2011). It has primarily sought to achieve this by localizing the capital flow associated with payment for energy services by establishing a community ESCo (i.e. MOZES) to satisfy the community's energy needs as opposed to a multinational Energy Utility. The logic here is that by keeping this capital in the community it can support local economic growth via the 'local multiplier effect', where each pound spent locally stimulates considerably more local economic growth than if it were spent elsewhere (New Economics Foundation, 2005). This effect is enhanced because MOZES's revenue is not appropriated by shareholders but instead is recycled into future local energy projects (Section 6.2.2.6).

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[35] We have chosen the Middle Layer Super Output Area 'Nottingham 033' to provide deprivation statistics as this area encompasses most of the Meadows neighbourhood

MOZES has focused on alleviating fuel poverty in particular, a core indicator of deprivation, where 21.2% of households in the Meadows were in fuel poverty, compared to the national average in England of 18.4% (DECC, 2011e)[36];

> *'A lot of people are on benefits…most of them are living hand to mouth and it is kind of 'heat or eat'. It is one of those communities' (M 3)*

The Meadows's antiquated building stock, where approximately 1/3 of its 3800 homes were built around 1900 and the majority of the rest during the 1970s, has also contributed to this high level of fuel poverty (Gutteridge). This is because due to their old age many of the homes in the Meadows do not have wall cavities, and are therefore not suitable for cavity wall insulation, a particularly cost-effective energy efficiency measure (MOZES, 2012b). Consequently, MOZES was set up to provide a means of alleviating fuel poverty by reducing the energy bills of Meadows residents primarily via the provision of energy supply contracts:

> *'I don't think any of them are interested in saving the planet...If I talk to them about saving money, they are with me' (M 4)*

MOZES was also established to reduce the carbon footprint of the Meadows' community (M 2), with the aim of making the Meadows the first low-carbon, inner city community (M 1). A closely aligned objective was also to help the Meadows community to become more self-sufficient. Finally, MOZES has also been designed to help develop the Meadows into a space for sustainable energy technology experimentation and innovation: *'We wanted to help push things forward and we wanted to be a guinea pig'* (M 1)

6.2.2.4 Key Activities, Resources & Partnerships

To help achieve its main objectives, MOZES engaged in an energy service project where it installed PV systems on 63 houses, 3 schools and 1 community building, each system comprising of 8 PV panels (M 3), which were delivered in 2 phases (Figure 6.14). The first phase incorporated 58 PV systems and the second 9 PV systems (M 3).

[36] DECC statistics are for Lower Layer Super Output Areas (LSOAs), so we have taken an average for the 6 LSOAs that make up the Middle Layer Super Output Area 'Nottingham 033'

Figure 6.14 Meadows housing after PV installation (MOZES, 2012e)

After the PV installations residents enjoyed approximately a 20% reduction on their energy bills, which amounted to approximately £100 savings per year (Energyshare, 2012) because they no longer had to import as much electricity from Energy Utilities because they were now generating electricity independently (M 3). The energy projects that MOZES have developed have also helped the Meadows become more self-sufficient, with the first phase of PV systems generating sufficient electricity to satisfy the needs of approximately 25 homes per year (Energyshare, 2012).

MOZES's activities have also extended to the provision of energy efficiency advice and measures. For instance, MOZES has advised approximately 400 people in relation to saving energy, as well as managing their energy bills and debt issues (MOZES, 2012h). It has also provided 26 homes with energy efficiency measures, such as solid wall insulation or highly efficient gas boilers (MOZES, 2012d)

To achieve its objectives via these activities, MOZES has relied heavily on the expertise, experience and determination of its Board of Directors, many of whom are highly qualified (e.g. two Professors of Architecture, former MP, former teacher, social enterprise business consultant etc):

> *'The staffing is absolutely important really…You can have the best system in the world but if you don't have the right people, it could be a mess…We are very fortunate…there are some really talented people here' (M 4)*

MOZES is dependent on these individuals volunteering their free time to operate MOZES (M 1). The willingness to do so has been attributed to *'the enthusiasm of people and the strength of the [Meadows] community'* (M 1). This 'community spirit' in turn was attributed to the Meadows being a relatively isolated community due to a combination of factors such as its location close to the River Trent, the implementation of the council's town planning strategy that served to cut the community off from adjacent communities in 1970s and its history of various socio-economic problems, all serving to help reinforce the community's strength and solidarity (M 1).

Despite the depth of its community's technical resources, MOZES relies heavily on key partners to enable it to deliver its energy service contracts. For instance, MOZES has forged a strong relationship with the Meadows Partnership Trust (MPT) largely because *'the synergy between the two organisations is very strong and so there are a lot of things which we can genuinely work on together'* (M 1). MPT has been responsible for the day-to-day running of MOZES, which they earn a fee for (MOZES, 2012a). Furthermore, the charity's expertise and experience has also been instrumental in the delivery and management of MOZES's energy projects, in particular its accountancy expertise (M 1 & 3). Furthermore, MPT has supported MOZES financially, helping to finance Phase 2 of the PV installations. In recent months, as funding has become harder to secure, MOZES has become extremely reliant on MPT's financial support: *'we exist at the moment financially courtesy of Meadows partnership trust'* (M 1). MPT has also helped MOZES to win grant funding, by acting as principal bidder:

> *'MOZES had been incorporated for 1 month. They had a bank account but nothing in it, no staff, no record of delivery…We thought there was very little chance of them winning [the DECC] money. Whereas MPT is a registered charity, which had run lots of projects and was in a much stronger position' (M 3)*

Another important partnership has been with Nottingham Energy Partnership (NEP), which was strongest during MOZES's formative years, as NEP *'played a crucial role in initiating projects and ideas [as well as] giving advice and support'* (MOZES, 2012a):

> *'Initially at the start up stage they came along with expertise, as we started to get the project under way' (M 2)*

For instance, NEP was on the Steering Group that helped to set up to develop MOZES. They continue to play an important role today, with NEP's CEO sitting on the Board of Directors. NEP is also helping MOZES to develop a number of its current projects (Section 6.2.2.8).

British Gas are another key partner of MOZES, having partnered them on the successful DECC funding bid, which funded the first phase of the PV energy service contract (Section 6.2.2.6) (M 1). They were also responsible for managing the installation of the PV systems (M 3):

> *'We realised we needed a partner from a large energy company to help us to deliver some of our aims...British Gas seemed to be the most aligned with what we wanted to achieve [and] the way we wanted to achieve it' (M 3)*

In return British Gas was able to discharge some of its energy company obligation commitments (e.g. CERT & CESP), as well as improve its brand and reputation as an Energy Utility by supporting low-carbon community development (M 1). Furthermore, it gained valuable practical experience in developing energy projects in conjunction with community organisations, which was seen as a potentially useful means of preparing for the forthcoming Green Deal:

> *'They get valuable experience which no other energy company will have and I think they see that as being very useful for them in negotiations with government. I think that they see this community interface will be useful for them as things move forward' (M 1)*

Finally, MOZES forged an extremely important partnership with Alan Simpson their local MP (at the time), who provided MOZES with the necessary political 'clout' to make things happen (M 1), i.e. a voice within key political circles and a number of important contacts to help aid its development.

6.2.2.5 Customer Interface

MOZES's customer base is primarily the residents of the Meadows community. Residents are invited to become guarantors and thus members of the ESCo by pledging £1 to become members. This pledge also represents their maximum financial exposure if MOZES were to become bankrupt (M 2) (Brodies, 2008). Each member has the same degree of control as one another and members have control over the direction of the organisation, by voting on the election of Board members and the passing of resolutions (M 2) (Brodies, 2008). 'The future direction of MOZES and what projects it works on is decided by the 'Board of Directors'' (MOZES, 2012c), which is also made up of residents in the Meadows as well as representatives of other key stakeholders of the Meadows community (e.g. members of Nottingham City Council & Nottingham City Homes) (MOZES, 2012c) and associates who provide expert advice on projects (MOZES, 2012c).

MOZES relies heavily on its website, handing out leaflets, making visits to people's homes, word-of-mouth and holding community events to communicate with prospective and existing customers (M 3 & 4). Furthermore, customers are able to provide feedback to the Board of Directors at annual meetings (M 2).

Some of MOZES's members have also signed energy supply contracts with MOZES to receive electricity via the PV systems (M 2). The contracts have been signed with the individual rather than the property because the costs of registering it with the Land Registry were considered too high:

> *'They have signed a contract with us to say if we don't get into an arrangement with the new purchaser [of their home] then they are financially liable' (M 3)*

To be eligible for a PV system at no upfront costs residents had to be owner-occupiers who resided within a suitable property and in a suitable location (e.g. south facing, pitch roof etc), to ensure the PV panels would be most productive (M 2). Furthermore, eligibility for the PV project was 'means tested', i.e. favouring those on *'lower income…because they need the most help'* (M 2). The energy supply contract dictates that MOZES retains ownership and is responsible for maintenance of the panels. As part of this contract, the customer is financially liable if they move home and the occupiers of their old residence do not continue the same arrangement (M 3).

6.2.2.6 Revenue Streams and Expenditure

MOZES has been very dependent on capital grant schemes to fund its projects to date, most notably the £615,000 won in 2009 as part of the DECC's *Low Carbon Communities* competition, which was used to fund the installation of first phase of PV installations. During this phase 10 customers covered half the upfront cost of purchasing and installing the PV systems (M 3). Subsequently MOZES also received £100,000 from British Gas *Green Streets* scheme (NESTA, 2012), which was used to fund efficiency measures across 22 homes (e.g. insulation, boilers etc), which were donated to residents instead of being provided as energy service contracts (Energyshare, 2012).

Recently grant funding has been much harder to come by for MOZES (Section 6.2.2.7) and it is existing at the moment on more piecemeal funding such as from Nottingham City Council, National Energy Action etc (M 1). In fact, the 9 PV systems installed as part of Phase 2 of the energy supply contract were not grant funded but financed via loans from a combination of the MPT and a long-term affiliate of MOZES (M3). As yet no finance has been received from the major banks, in part because it was felt that *'a lot of the banks don't really understand social enterprise'* (M 2). However, participants indicated that talks are on-going about securing finance for future projects from the Co-operative Bank (M2 & 3).

In terms of revenue MOZES receives FiT payments for the electricity the PV systems generate, i.e. a combination of the generation and export tariffs (MOZES, 2012e) (see Section 5.4 for breakdown of FiT). For Phase 1 alone, it is estimated that £22,000 per year will be generated in FiTs for MOZES (Clark and Chadwick, 2011, Energyshare, 2012). MOZES uses this revenue stream to cover its running costs and generate a small surplus which is recycled into future projects (M3) to *'develop the business of the ESCo rather than [be] distributed as profits to its stakeholders [or] paying dividends to members'* (Brodies p.6). To date, MOZES's largest outgoing has been the delivery of Phase 1 of the PV installations, which cost a total of £633,000, with each household installation (i.e. purchase and fitting of the PV system) costing on average £9,200 (Energyshare, 2012). The cost of collecting the meter readings, public liability insurance and business administration costs for Phase 1 equate to approximately £5000 per year, in addition to other maintenance costs, such as the PV system inspections and repairs (Energyshare, 2012).

6.2.2.7 Drivers and Barriers

Without securing funding from DECC's Low Carbon Communities fund MOZES would have not been able to fund Phase 1 of its PV project (see Section 6.2.2.6). Winning this grant funding also provided MOZES with the credibility to form the partnerships and secure the resources necessary to be able to implement the community's ideas (M 4). However, MOZES has continued to rely heavily on capital grant funding, which has become increasingly scarce in recent years as the government has moved away from capital grant schemes and towards on-going financial incentives (e.g. FiT);

> *'You have to understand that MPT and [MOZES] are finding it harder to get money… it is also a time when there is no money…The funds [MPT & MOZES] usually go for are much, much more limited' (M 1)*

Some capital grant schemes do still exist for communities (e.g. Local Energy Assessment Fund, Community Low Carbon Heating scheme etc), however MOZES's experience to date was that these were designed to support new community enterprises, as opposed to established ones such as MOZES (M 1). Although these schemes have become rarer, demand for this money from communities has increased, meaning funding is extremely competitive and difficult to secure (M 4).

Despite the challenges that the decline of capital grant schemes has brought, the introduction of the FiTs has been a real boon for MOZES, providing them with a long-term, reliable revenue stream: *'Without [the FiT] we would all be stuffed really. They are incredibly generous payments'* (M 1). However, MOZES will still need to secure the necessary upfront capital to fund its energy service projects in the future, to be able to develop the *'capacity to generate its own income'* (M 3). In the absence of grant money, MOZES has had to look to the banks for finance however they have been unsuccessful to date in securing any. It was thought that the banks were unwilling to support community enterprises because they had a poor understanding of how social enterprises operate (M 2). MOZES's limited financial and technical resources (e.g. staff) have in turn limited the scope of the projects it can realistically develop (M 1). However, MOZES has been able to mitigate this lack of resources to a large extent by working closely with other organisations (see Section 6.2.2.4), such as MPT and their local MP.

Despite the support these partnerships offer MOZES, they have not all been without difficulty. For instance their relationship with British Gas (see Section 6.2.2.4) has been strained at times because it was felt by MOZES that British Gas was working towards fundamentally different objectives than itself and was keen to impose its own strategy in the Meadows over MOZES's (M 1 & 2). For instance, British Gas rejected MOZES's suggestion of a rising block tariff for energy supply where *'the more you use the higher the price becomes'* (M 2):

> *'The energy companies have their own criteria and ways of doing things that they want to replicate elsewhere. They come round and say 'we do this well, we want to do it in your place. That may or may not fit with what we see as our priorities' (M 2)*

MOZES's relationship with Nottingham City Council has also proven difficult at times. In part this was due to the council already operating their own 'Arm's Length' ESCo in Nottingham, known as Enviroenergy (M 1). Consequently, their efforts were originally directed towards supporting this organisation rather than MOZES: *'they were a bit sceptical about how far they could support [our project] because they were locked into this contract with Enviroenergy'* (M 2). Additionally, the council also proposed a Private Finance Initiative (PFI) project in the Meadows that would have involved the re-development of a number council houses in the Meadows, creating an obstacle for the PV project, which hoped to install systems on these homes (M 1). However, in recent times the relationship between MOZES and the council has improved, with one of the Councillors now sitting on the board.

In terms of infrastructural constraints, MOZES was limited by how many PV systems it could install per street due to electricity network load restrictions imposed by the DNO (Clark and Chadwick, 2011, Energyshare, 2012). Other infrastructural constraints included households' electrics not being sufficiently up-to-date or safe enough to install the panels (Clark and Chadwick, 2011, Energyshare, 2012). Furthermore, some homes were not suitable for the PV system installation due to their location and design (e.g. aspect, roof pitch etc) but also because many of the houses were relatively small due to the historically deprived nature of the Meadows, which meant that only a small number of panels could be installed, limiting the economies of scale that could be captured for each installation:

> *'You can't get any more than 6 panels on each house…If you had 20 panels, you would pay more for the panels but no more for the installation' (M 3)*

A key enabling factor has been the strength of the community in the Meadows (see Section 6.2.2.4). However, communicating with the community has proven difficult in some respects due to the high incidence of non-English speaking residents and the high rate of illiteracy in the area, making it difficult for MOZES to communicate its aims and thus recruit customers/members for on-going and future projects:

> *'I think that is where in a deprived community, you haven't got [many] people who are literate and haven't got people who speak English or can read English' (M 4)*

Additionally, many residents were unfamiliar or uncomfortable with some of the key concepts integral to energy service contracting. For instance, many residents were *'not sophisticated in terms of finance'* and were consequently sceptical of it (M 1) and by extension energy service contracting because financing (i.e. the lending and owing of money) forms the bedrock of energy service contracts. Another example was that some residents who had recently arrived in the UK had limited experience of enjoying both electricity and heat supply;

> *'We have a lot of people who don't speak English, coming from Africa etc. I have a neighbour who is still getting her head around electricity, let alone saving it' (M 4)*

6.2.2.8 Expectations for Future Development

MOZES has a number of planned projects going forward. For instance, MOZES intends to (1) continue to raise awareness in the Meadows of cost-effective energy efficiency measures; (2) explore the economic viability of a 330kW communally owned wind turbine owned, which NEP are assisting them with undertaking the necessary wind surveys to identify suitable areas for its location (NEP, 2011); (3) develop an eco-taxi service; and (4) secure funding to retrofit some council houses to 'demonstrate what can be done to reduce the energy use and 'carbon-footprint' of older properties' (M 3) (MOZES, 2012f). However, MOZES does not appear to have any plans to implement additional energy service contract projects at present. Future PV projects in particular have been '*stopped in their tracks*' because the FiT cuts have meant that they are longer financially viable for MOZES to implement (M 3). This is because the generation tariff for retrofit PV ≤ 4kW has fallen from 43.3p (prior to 2nd March 2012) to 16p (from 1st August 2012) (Feed-In Tariffs Ltd, 2012). Furthermore, the swift and unexpected nature of these cuts serves to illustrate how MOZES's *'environment is changing daily, weekly, monthly'* (M 3), which has made it difficult for the ESCo to plan for the future.

A high proportion of housing in the Meadows is rental (ONS, 2001). Consequently, it was thought that MOZES could play a key role in helping the Meadows community to sign-up to the Green Deal, where MOZES would work closely with key landlords in the area to educate them about the opportunities in relation to the Green Deal and to help facilitate large-scale efficiency retrofits of multiple landlord-owned properties by acting as a trusted intermediary between them and the community (M 1):

> *'There is a lot of nervousness around in terms of the Green Deal. British Gas are wondering how the hell they are going to deal with…the rented market. [That is] one of the areas we think we really can help as a community organisation' (M 1)*

MOZES are working in conjunction with Nottingham Energy Partnership to explore how they might engage with the Green Deal (M 1).

Finally, MOZES's future plans are subject to the council's re-development of the Meadows, with a number of council houses earmarked for demolition and a new tram to be built through the area (M 4). However, beyond these details the council's plans for re-development are relatively unclear at the moment, making it difficult for MOZES to formulate plans in the Meadows area without knowing how the built environment will change in the near future.

6.2.2.9 Summary

MOZES has served to illustrate how the ESCo model can be applied by a community to help improve the quality of life of residents in a deprived neighbourhood via the provision of community inspired energy service projects. It owes its existence and success to a combination of factors including community strength, government funding and key partnerships with local energy stakeholders, most notably local charities and political figureheads. However, it has faced a number of challenges, which have predominantly been financial, such as the FiT cuts and a lack of external capital grant funding or 'high-street' finance. MOZES continues to seek funding opportunities going forward but it faces an uncertain future considering the lack of specific regulatory and financial support for community led energy initiatives.

6.2.3 Honeywell

6.2.3.1 Overview

Honeywell UK	
Commencement of UK ESCo Operations	Mid 1990s (H 3)
Location	International
ESCo Variant Type	Energy Services Provider
Ownership	Honeywell International Inc.
Type of Contracting	Energy Performance Contracting
Turnover	UK EPC Operations - £8-10 million in 2012 (H 4)
Number of Staff	UK EPC Operations – Approx. 30 in EPC operations (H 4)
Energy Savings	Worldwide total of £1.7 billion by 2008 (Honeywell, 2008, Petersen, 2008b)

Table 6.11 Key Facts and Figures for Honeywell UK

6.2.3.2 Brief History

Honeywell's history begins in 1885, when the inventor Albert Butz patented the furnace regulator and alarm, and subsequently formed the Butz Thermo-Electric Regulator Company in Minneapolis (Honeywell, 2012e). During the 20th century the company, Honeywell Inc was eventually formed following a series of corporate mergers. Today Honeywell operates internationally and is a Fortune 100 company, with a turnover of $36 billion in 2011 and 130,000 employees (Honeywell, 2011).

Traditionally Honeywell's business has been focused upon the development and sale of building control technologies, however today its business activities are much broader, incorporating the sale of both products and services. Its operations are split between 4 divisions: (1) Aerospace, (2) Automation and Control Solutions, (3) Performance Materials and Technologies and (4) Transportation Systems (Honeywell, 2012d). Within the Automation and Control Solutions division sits its Building Solutions arm, which '*installs and maintains automated building control solutions that keep workplaces safe, secure, comfortable, cost-effective and energy-efficient'* (Honeywell, 2012b). Part of this division's operations is the provision of Energy Performance Contracts (EPCs) to commercial customers, which it has been delivering in the UK since the mid-1990s and has invested heavily in the past 3 years (H 4).

6.2.3.3 Objectives and Value Proposition

As a private sector, publicly traded company, Honeywell's core objective is to generate profit. However, due to its Corporate Social Responsibility commitments it seeks to fulfil a number of non-profit oriented objectives, predominantly the reduction of GHG emissions via energy efficiency measures (Honeywell, 2012c), which is aligned with the outputs of its EPC operations.

The core value proposition of Honeywell's EPCs is that they can guarantee a significant reduction in their customers' energy consumption, typically around 20% (Petersen, 2009, Honeywell, 2012a), which translates into significant cost and carbon savings for the customer. For instance, Honeywell's EPC with Gwent Healthcare NHS Trust in South Wales delivered over £1.5 million worth of energy savings between April 2007 and March 2008, which represents approximately a 30% reduction in their energy bill (Brind, 2008). Furthermore, Honeywell reduced Gwent's CO_2 emissions by 7.6% (Brind, 2008). Similarly, Honeywell's EPC with Transport for London provides a saving of £769,128 and 3,648 tonnes of CO_2 annually (Petersen, 2009).

Honeywell is able to provide these energy efficiency measures at no upfront cost to the customer (Honeywell, 2008), meaning that even if their customer does not possess the necessary capital to implement an upgrade of its energy facilities, it can still benefit from the improved levels of reliability and comfort Honeywell's efficiency measures offer (Honeywell, 2008, Petersen, 2009, Petersen, 2011a, Petersen, 2011b). This upgrade not only improves the level of comfort both its staff and clients enjoy when located on-site (Honeywell, 2012a, Petersen, 2011a) but also adds value to the customer's estate (Honeywell, 2008). Once the contract is signed with Honeywell, their customers can enjoy 'piece of mind' (H 3) that their equipment will function correctly because Honeywell guarantees its performance and is contractually responsible for its operation and maintenance (Honeywell, 2008, Mewis, 2009, Petersen, 2009). Furthermore, Honeywell ultimately financially benefits from the energy savings this equipment generates (Honeywell, 2008).

Figure 6.15 Examples of the energy efficiency lighting and boilers installed at Gwent Healthcare NHS Trust (Brind, 2008)

Honeywell has a wealth of experience of delivering EPC to a range of organisations throughout the world, particularly in the US. This experience also forms an important part of its value proposition as it provides many public sector organisations with the confidence that Honeywell will deliver on its performance guarantees (M 3) (Petersen, 2008a, Petersen, 2008b, Petersen, 2011a, Honeywell, 2008):

> *'Well we have 25 years' experience of doing EPCs in the US and we do somewhere between $500-750 million of EPCs in the US' (H 2)*
>
> *'[Honeywell] was a pioneer of the Energy Performance Contracting concept Over the past 25 years it has successfully implemented more than 5,000 energy efficiency projects around the world for customers in the public and private' (Honeywell, 2008 p.6)*

Additionally, Honeywell is a very wealthy company meaning that customers can be confident that it will continue to exist for the duration of the EPC, which typically last for a number of years: *'we are very much here to stay… whilst others may come and go in the marketplace'* (H 3). Again this provides the customer with confidence that Honeywell will continue to deliver on its performance guarantees over the coming years.

Honeywell is able to provide most aspects of the EPC independently, such as the auditing, as well as the design and delivery of its Measurement and Verification plan (H 3). They seek to provide these services 'in-house' because it was believed that sub-contracting too many of its EPC responsibilities could mean it could *'lose sight of exactly how it all ties together'* (H 3), which could put it in danger of defaulting on its performance guarantees. However, Honeywell does use sub-contractors to install its energy efficiency measures, in turn helping to create jobs in the local area, which can be attractive to Local Authorities (H 1) (Honeywell, 2012a, Petersen, 2011a).

Honeywell provides comprehensive, holistic energy solutions that look *'right across the organisation'* (H 1) in order to provide a suite of solutions that *'tie together nicely'* (H 3) and thus, deliver the largest degree of energy savings possible from the client's property. Honeywell also works closely with its customers to ensure the solutions satisfy their customer's needs: *'it's a very involved solutions sales process that involves a lot of consultation with the client and you need to take the time to really dig into their business and understand it'* (H 3). Furthermore, Honeywell takes a technologically agnostic approach, using the *'best products on the market that fit the requirements of the customer'* (H 3).

6.2.3.4 Key Activities, Resources and Partnerships

Honeywell engages in four key consecutive activities as part of its EPC operations (Figure 6.16) (Petersen, 2009). The first is a preliminary audit whereby it evaluates the potential energy savings in its customer's buildings (Honeywell, 2012a), to identify whether there are sufficient energy inefficiencies to warrant an EPC (H 1). The second involves the detailed design of the EPC in partnership with the customer, to develop a suite of measures that suit the needs of both parties (Petersen, 2009): *'[the process of] proposing a solution of some energy conservation measures that will deliver the outcome required'* (H 4). The third key activity is the implementation of these measures, which Honeywell out-sources to sub-contractors (Section 6.2.3.3) but it is ultimately responsible for managing the works programme (H 1). The sub-contractors are often consulted at the design stage to ensure they can implement Honeywell's proposed suite of measures (H 4). Finally, Honeywell is responsible for providing the engineers who operate and maintain these measures, as well as the staff to undertake the measurement and verification of the savings they provide in order to prove to the customer whether it has fulfilled its guarantee or not (H 4) (Honeywell, 2012a, Petersen, 2009).

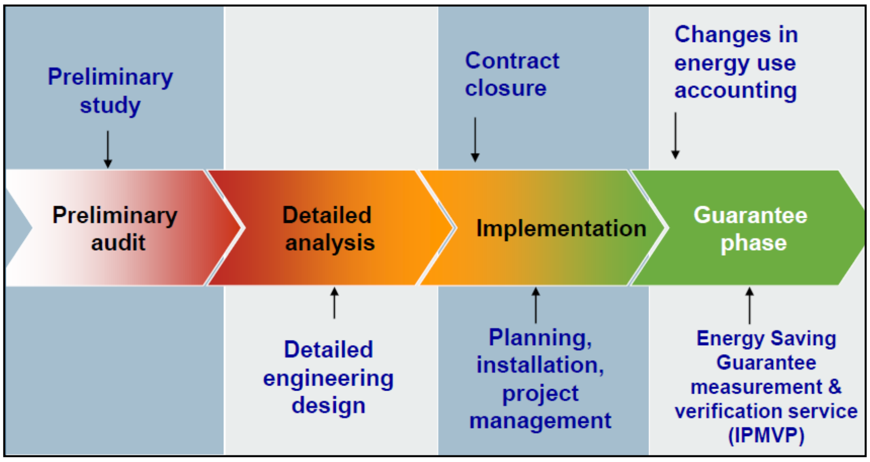

Figure 6.16 The 4 stage process of Honeywell's EPC (Petersen, 2009)

Honeywell typically implements three forms of energy solutions. The first is the installation of more energy efficient primary conversion equipment than that which is currently installed in the client's property and/or micro-generation technologies, such as solar technologies, CHP and anaerobic digesters (H 2) (Mewis, 2009). Although this is traditionally associated with ESCs, some comprehensive EPCs incorporate generation too (Section 2.6.2). The second is the installation of more energy efficient secondary conversion equipment (e.g. LED lighting, heat recovery), demand management controls (e.g. lighting sensors, thermostats) and building fabric (e.g. insulation, draft proofing) compared to that which is currently installed in the client's property (H 2) (Mewis, 2009, Petersen, 2008a, Brind, 2008). The third is to change the customer's energy consumption behaviour so that they consume less energy: *'typically by* *getting them to participate in efficient interaction with the building you can get between 6 and 10% additional savings'* (H 2).

6.2.3.5 Customer Interface

Honeywell's core customer base for EPCs has been the public sector, particularly local authorities, government departments and health trusts (H 1 – 4). This can in part be explained by the recent public sector funding cuts in the UK, which has put cost savings high on the agenda for public sector organisations (Petersen, 2009), thus encouraging some of these to turn to EPCs as an effective means of reducing their overheads, whilst maintaining the same quality of their public services and avoiding the need to make the significant upfront capital investment required to deliver these cost reductions (Honeywell, 2008).

Carbon savings are also valuable to public sector organisations considering that most public sector organisations are subject to carbon reduction targets, such as the Carbon Reduction Commitment Energy Efficiency scheme (CRC) and/or internal governmental targets[37] (Honeywell, 2008) but also tend to occupy very inefficient properties, which often sit below the efficiency standards stipulated by these obligations (Petersen, 2009, CAMCO, 2011). The high level of energy inefficiency also means that Honeywell can normally identify sufficient energy savings to make the EPC financially viable. Public sector organisations also tend to often occupy large, single site complexes meaning that energy efficiency measures can be implemented with better economies of scale than on a large number of smaller sites:

> *'If you have got some very small buildings on their own, it doesn't matter how inefficient they are, there won't be enough financial potential there to pay for the improvements. So you are looking for very large single sites [such as] hospitals, NHS trusts, campus like facilities, universities, government buildings'* (H 1)

Honeywell has been drawn to public sector organisations, such as Social Housing Providers, as a means of accessing the residential market because these organisations are capable of aggregating lots of residential units together, which helps Honeywell to attain better economies of scale than serving homes individually (H 1).

Public sector organisations are also attractive to Honeywell because they're backed by government, meaning they can be quite confident that these organisations will exist for the duration of the EPC (H 1). Additionally, the public sector normally own their own buildings, which means they are able to take a long-term perspective on their estate management (H 1),

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[37] The UK government has a 10% target to reduce carbon emissions from central government departments (DECC, 2012r)

as well as make the executive decision to sign an EPC for that property. In contrast private sector organisations normally lease their premises on a relatively short-term basis meaning that they are unable to take the same long-term perspective required with EPC and because they are tenants, they are unable to make the executive decisions necessary to sign an EPC for the building they occupy (H 1). Public sector organisations can also access cheaper finance than private sector organisations via schemes such as the Public Works Loan Board, enabling Honeywell to utilise this cheaper source of finance to fund the energy service project rather than rely on traditional, more expensive sources of finance from financial institutions such as banks (H 1). Taking this approach helps Honeywell to reduce the overall cost of its energy service projects. Although Honeywell typically engages with the public sector it was explained that some private sector organisations are also beginning to consider EPCs (H 3 & 4).

Honeywell relies on a sales team to identify and recruit its customers:

> *'[To] create or identify prospects for potential jobs, you clearly need some sales resource. At a minimum they need to have a conceptual understanding of the model…, the kind of elements an EPC will address [and] the sort of outcomes that can be delivered through that solution' (H 4)*

It was explained that Honeywell relies heavily upon support or 'buy-in' from senior personnel within an organisation, such as the Finance Director, if an energy service contract is ever to materialise (H 1 – 3): *'Typically we would be prospecting at that senior level of people, through a variety of channels, via events, cold calling or referrals etc'* (H 3). This commitment was required because the organisation would need to make large, quarterly repayments to Honeywell as part of the EPC, which would be drawn from its energy savings (Brind, 2008). Furthermore, the EPC requires Honeywell to not only monitor but sometimes intervene in the organisation's activities: *'We need to be all over the site doing a lot of work and analysis, also a heavy amount of support from the management to provide us with the right amount of information'* (H 3). To date Honeywell's experience was that senior public sector managers were generally very open to the notion of engaging in EPCs (H 2).

6.2.3.6 Revenue Streams and Expenditure

As part of its energy service contracting, Honeywell operates a typical EPC ESCo model, whereby its major revenue stream is the cost savings on its customer's energy bills (6.1.1.9). In the case of Honeywell's EPC with Gwent Healthcare (Section 6.2.3.3), the NHS trust paid an agreed annual fee to Honeywell in quarterly instalments, which covered Honeywell's upfront and on-going costs, as well as its profit margin (Brind, 2008, Petersen, 2011b). As part of its EPC activities Honeywell has to cover the costs of the technologies and materials it requires to implement its efficiency measures, such as a replacement boiler (H 4). However, Honeywell's main cost is labour:

> *'From business development of the solutions, delivery of the install and servicing and measurement and verification, there is a hell of a lot of cost around labour. That is the predominant cost here with an EPC' (H 4)*

Where the customer is unable or unwilling to provide the upfront capital investment, Honeywell does not normally directly finance the costs of its EPC measures, instead relying on a third party to cover the cost of the measures. Subsequently, the customer is responsible for repaying the cost of these measures to the third party. The customer covers this cost using the savings Honeywell achieved on its energy bill delivered via the EPC (H 1 – 3) (Petersen, 2011a, Petersen, 2011b):

> *'The financial deal is between the customer and the bank, not between the customer, the ESCo and the bank. If the customer defaults, whether we have achieved the savings or not, we are not required to pay back the financing that the customer has' (H 2)*

Although the customer is responsible for these repayments, Honeywell effectively *'underwrites the revenue stream generated by savings'* (H 2) by providing a performance guarantee to the customer, whereby if it doesn't achieve these savings Honeywell is contractually obliged to make up the value of missed energy savings as part of a cash payment. Consequently, the customer is safe in the knowledge that it will be able to meet its finance repayments to the third party financier because of Honeywell's energy performance guarantee. However, because the loan is between the customer and the financial institution, the bank may not be prepared to lend money to Honeywell's customer if they have a poor credit rating (H 1). It was thought that the financial institutions were particularly attracted to financing EPC with public sector customers because they were financially supported by government and thus unlikely to *'go out of business'* (H 1). Furthermore, financial institutions were attracted to EPCs due to the long-term debt they represented, which meant a low-risk revenue stream 'for the next 10 or 12 years' (H 1).

6.2.3.7 Drivers and Barriers

One of the key supporting factors of Honeywell's EPC operations has been the emergence of a regulatory framework in the UK that is broadly supportive of low-carbon energy projects (H 1, 3 & 4). This was in fact a key factor in Honeywell's decision to enter the UK market (H 2), alongside a growing appetite in the UK for EPCs (H 3). This could be attributed in part to the EU Directive 2006/32/EC on energy end-use efficiency and energy services (Honeywell, 2008, Petersen, 2008a), which amongst other requirements mandates Member States to adopt and achieve an indicative energy saving target of 9% by 2016 and to repeal or amend national legislation and regulations that unnecessarily impede or restrict the use of energy performance contracting (EU, 2006).

Another important piece of regulation supporting Honeywell's EPC operations was the UK's CRC scheme (see Section 6.1.1.1) (H 1, 3 & 4) (Mewis, 2009): *'I guess the CRC was a big piece of legislation…[It] put energy and carbon on the agenda of more senior people in business and public sector'* (H 3). However, one interviewee explained that the cost of carbon levied by this scheme was *'not big enough for people to really take notice'* (H 3), explaining that more stringent regulation around the cost of carbon was required (Petersen, 2009). The Energy Performance of Buildings Directive (EPBD) was also highlighted as another regulatory driver, as it *'introduced higher standards of energy conservation for new and refurbished buildings'* (RICS, 2007 p.3), increasing demand for EPCs (H 1).

Despite these regulatory drivers some of the interviewees explained that unexpected changes and revisions to regulations such as the CRC and FiT had meant that many organisations were unsure whether to act to improve their levels of energy efficiency or not (H 2 & 3):

> *'You have to then adopt a 'wait and see' policy because you can't be sure what you will be targeted to achieve when they reform or replace the legislation you are trying to achieve at the moment…So what do I prioritise, on the basis that I don't know what legislation is going to incentivise me to do' (H 2)*

Honeywell has in fact been able to shape government policy to some extent, as it shares a number of key relationships with political stakeholders: *'we sit on a variety of committees and bodies and provide advice'* (H 3). For instance, they have advised on such policies as the Green Deal, with government responding to a number of their suggestions (H 2). However, they emphasised that their influence of policy had been relatively small to date (H 2 & 3).

In terms of market developments, the rise in popularity of Corporate Social Responsibility (CSR) reporting and sustainable branding has also supported Honeywell's EPC activities and has helped to drive energy and sustainability up the agenda of public and private sector organisations (H 1 & 3):

> *'There is a sustainability drive in the private sector, green branding, corporate social responsibility (CSR). All of those drivers are very positive for energy retrofitting and energy efficiency improvements' (H 1)*

An extremely important market-based driver for Honeywell has been the introduction of the RE:FIT procurement framework by the London Development Agency (LDA), which is a procurement framework led by the LDA designed to facilitate the public sector uptake of EPCs by ‘providing pre-negotiated, EU-regulation compliant framework contracts through which a group of prequalified ESCos can undertake the design and implementation of energy conservation measures’ (Managenergy, 2011 p.2). Honeywell was selected as one of these 12 ‘approved suppliers’.

The bespoke nature of EPCs has traditionally meant that it had been difficult for Honeywell to replicate EPC projects from one organisation to another: *‘every single EPC will be bespoke in some form or another because the buildings are unique and so the energy consumption and provision is unique’* (H 2). However, the interviewees explained that RE:FIT’s introduction of standardized EPC contracts had addressed this barrier to some extent by reducing Honeywell’s EPC transaction costs because it no longer needed to draft new contracts for each customer (H 3). For instance the procurement period for EPCs is normally 12 – 18 months in accordance with the traditional Official Journal of the European Union (OJEU) regulations but via RE:FIT it took only 3 – 6 months (Managenergy, 2011). Additionally, LDA also took responsibility for marketing the framework’s EPCs to public sector organisations, saving Honeywell further time and expense (H 3). In doing so the LDA acted as a ‘trusted intermediary’ between the public sector organisations and Honeywell, helping to increase the level of trust these organisations had in Honeywell’s offerings (H 3). Marketing the framework has also helped to raise the profile of EPCs in the public sector, as well as the private sector, helping to stimulate further demand for Honeywell’s services:

> *‘We have had some enquiries outside of RE:FIT from the private sector, who have obviously seen what is going on there and have got in touch with the LDA to contact us. [There is] a great pipeline of opportunities coming through for us and the other big EPC providers.’ (H 3)*

Despite how RE:FIT has helped to raise the profile of the ESCo model, the awareness of the model continues to remain low in the UK predominantly due to the *‘lack of referenced [EPC] examples and case studies that people can draw [on]’* (H 2). Consequently, a lack of awareness of the ESCo model was cited as a key barrier because organisations were still unsure how to go about procuring EPCs and also had little confidence in EPCs’ ability to satisfy their needs. Furthermore, because of the generally poor understanding in the UK of what EPCs involved, many felt it *’sounded too good to be true’* (H 1). However, it was believed that as more ESCos offering EPCs had entered the market and more EPCs had been delivered by ESCos, organisations' awareness and understanding of the ESCo model had begun to improve (H 2 & 3):

> *'There is a clear sign that other businesses see this as a market opportunity and when other organisations see that and act, that can actually get the model into a more mature state where customers will feel more comfortable with it' (H 3)*

It was believed that Honeywell had also played an important role in helping the EPC to grow by providing other organisations, such as the Energy Utilities, with a successful business model template to replicate:

> *'The Energy Utilities [are] coming in because they want to get in on the act. They recognise the growth of the market and the opportunities that lie there. They inevitably would have seen the likes of Honeywell or Schneider and said that's a good model, let's think about offering that. A lot of the new players in the market would certainly look at Honeywell as one of the best practice EPC model and something they'd try and replicate' (H 3)*

Finally, the growing availability of finance from financial institutions for EPCs was identified as a key driver (see Section 6.2.3.6). However, many of these institutions consider EPCs as *'upfront [capital] debt on the balance sheet of the organisation that takes [the EPC] on'* (H 1). This has posed a problem for Honeywell because organisations, particularly in a poor economic climate, are either unwilling or unable to take on additional debt, meaning they might avoid EPCs (H 1). Other financial stipulations had also proven troublesome, such as the Treasury rules that prohibit Local Authorities to use cost savings to invest in other activities (which is the purpose of EPCs) (H 1) and where the *'UK Treasury doesn't facilitate government bodies putting private finance into EPCs [because] if these chose to borrow through us, then the treasury cuts it back from their operational budget'* (H 2). Therefore, many of the UK's financial rules and regulations were not considered supportive of Honeywell's EPC operations.

6.2.3.8 Expectations for Future Development

In a broad sense, the interviewees were very positive about Honeywell's future prospects as an ESCo. They believed that demand for EPCs would most likely increase as more EPCs were completed, thus providing potential customers with greater confidence in EPCs as a means of satisfying their needs (H 2). In terms of finance, it was expected that the introduction of the Green Deal and Green Investment Bank, as well as the European Energy Efficiency Fund (EEEF) (supported by the European Investment Bank and European Commission) would help to make finance more easily available to Honeywell (H 1): *'any way in which an organisation can access* *funding is going to help things'* (H 1). Another potential driver are the expected changes to the RE:FIT framework that would enable private sector finance to be raised to deliver EPCs to public sector organisation via this framework, helping to improve Honeywell's prospects of funding these contracts (H 2).

It was expected that continuing energy insecurity issues and energy price increases would help to ensure demand for EPCs either remained high or increased over the coming years (H 3) (Mewis, 2009). However, it was acknowledged that energy prices are likely to remain volatile in the coming years, meaning Honeywell could not rely on this development (H 3). Honeywell does however have some degree of control over the direction of technological innovation in the UK considering it is a major energy technology developer. For instance it is currently helping to lead the development of SMART grids in the UK as a form of automated demand response system, which could form an important part of its EPCs in the future (H 3). Additionally, it was expected that Honeywell's EPC operations were likely to increase market awareness of energy efficient technologies and thus help to increase uptake of these (H 2 & 3).

Finally, it was explained that Honeywell's future prospects as an ESCo very much hinged upon it being able to identify a means of easily replicating EPCs from one customer to the next, considering the bespoke nature of EPCs: *'The golden egg is what is a model that is easily adoptable?'* (H 2). It seemed that this would require a combination of system change, such as changes to the procurement framework, the introduction of standardized contracts etc, as well as refinements being made to the EPCs Honeywell offers and more broadly its business model.

6.2.3.9 Summary

By drawing upon its vast experience of delivering EPCs in North America, Honeywell has enjoyed success in the UK market, which it had originally decided to enter predominantly due to the growing appetite of public sector organisations to reduce their GHG emissions and energy costs, as well as the presence of a regulatory framework that is broadly supportive of low-carbon energy projects. It has to date faced relatively few major challenges in developing its EPC business in the UK, although it has struggled to find a means of replicating these contracts at scale due to their highly bespoke nature. Looking forward, it considers that most emerging developments are likely to be supportive of its operations, particularly the growing availability of 'green finance' both in the UK and Europe more broadly.

6.2.4 Energy Utility X

Please note that this case study has been fully anonymised at the request of the case-study organisation. Consequently, an alias has been provided for the organisation: Energy Utility X. Documentary evidence was used in an identical manner to the other case studies, however the documents are not identified here in order to protect the anonymity of the organisation. Instead, the documents are referenced as *Doc A, Doc B* etc. In order to uphold transparency the author is able to provide details of the corresponding documentation relating to each reference on request. However, consent will first be required from the case-study organisation. The interview referencing system used here is the same as the other case-studies.

6.2.4.1 Overview

Energy Utility X	
Commencement of UK ESCo Operations	First EPC provided c.2010
Location	UK
ESCo Variant Type	Energy Utility Energy Service Provider
Ownership	Subsidiary of larger, private sector organisation
Turnover	EUCo X - £4.8 billion in 2011/2012 (Doc J)
Number of Staff	Over 2,500 people employed to reduce energy consumption and cost through organisation (Doc F)
Type of Contracting	Mainly Energy Performance Contracting, some Energy Supply Contracting
Energy Savings	N/A

Table 6.12 Key Facts and Figures for Energy Utility X

6.2.4.2 Brief History

Energy Utility X (EUCo X) emerged following an intense period of privatisation of the UK energy system during the 1970s and 1980s (Section 5.2). Since its formation it has grown to hold 33% of the energy retail market (i.e. gas and electricity), which represents the largest share of all the six major Energy Utilities in the UK (Doc K). It has traditionally operated an Energy Utility (EUCo) model (see Section 6.1.2), where its revenue increases in line with the number of units of gas and electricity it sells to its customers. Today the company continues to operate the EUCo model generates extremely healthy profits in doing so, for instance in 2011/2012 it generated £345 million in profit (Doc J). However, in recent years EUCo X has looked to diversify its core business activities, by operating the ESCo model and providing energy service contracts (see Section 6.1.2*): 'we want energy services to be just as big a part of [EUCo X] as energy supply' (EUCo X Chief Executive – Doc M)*. Consequently, Energy Utility X has begun to operate two contrasting business models side-by-side, i.e. the ESCo and EUCo models. To date most of its activity in the ESCo market has involved the delivery of energy performance contracts (EPCs) to large public sector organisations, however it has also begun to develop its capacity to provide energy supply contracts (ESCs) as well.

6.2.4.3 Objectives and Value Proposition

As a private sector organisation and a publicly held company (plc), EUCo X's primary objective is to generate profit. However, EUCo X also seeks to fulfil a range of non-directly profit-oriented objectives, such as investment in community development (Doc I). These objectives have emerged in response to a range of government obligations (e.g. Carbon Emission Reduction Target, Community Energy Savings Programme etc) as well as its own Corporate Social Responsibility (CSR) policies, designed to establish and maintain positive relationships with their customers, partners and suppliers, which support EUCo X's continued commercial success (Doc I):

> *'[EUCo X] has a value base and a culture that means we are not going to walk away from many of the socio-economic challenges that exist in our market' (X 2)*

EUCo X has traditionally fulfilled these objectives by operating the EUCo model, i.e. the sale of units of electricity and gas. However, as outlined in Section 6.2.4.2, EUCo X has in recent years begun to move towards operating the ESCo model. We highlight the key factors that have triggered this transition in Section 6.2.4.7. Prior to doing so we explore the value proposition EUCo X extends to its customers via the provision of energy service contracts. As part of its EPC offering, EUCo X guarantees its customers a minimum level of energy savings over a defined contract period (Doc D, E, G, Q), which translates into significant cost savings per annum. For instance, EUCo X signed an EPC contract with a major national government department in 2010 across 350 of its buildings (Doc C) and in the first 8 months of the contract the government department reduced its energy bills by £212,000, which has set them on course to save approximately £1.3 million over three years (Doc B). EUCo X has also signed an EPC with a Local Health Board in Wales, which consists of 4 Hospital Trusts. The contract is set to deliver £862,000 per annum (Doc E). These guarantees around energy performance also provide the customer with some long-term assurances with regards to the energy costs they will incur in the future to satisfy their energy needs, reducing the risk of unplanned and unbudgeted maintenance costs (Doc E & G).

EUCO X's customers typically enjoy both lower energy costs and a greater certainty around their future energy costs without the need to make any upfront investment (Doc B, D, E, F, Q). This cost is normally covered by a combination of EUCo X and third party financing from one its investment partners, which is recouped over a number of years, whilst the customer still enjoys a reduction on their energy bill:

'So instead of paying £10 million upfront, they might pay £1 million for the next 10 years. What we try and do is structure the length of the financing deal to make it such that it is cash positive for the customer. [So] the savings might be £1.2 million per year [and] the customer benefits from the extra £200k per year over the lifetime of that contract. After that 10 years you don't need to pay that capital anymore, so you will be benefitting from the full £1.2 million of energy savings going forward' (X 5)

EUCo X also assumes the technical responsibility of delivering the energy efficiency measures, i.e. the installation, operation, maintenance, monitoring and verification etc (Doc D, E, F). This transfer of responsibility means EUCo X's customers are able to spend less time managing their energy equipment and procuring energy (Doc E & F). Furthermore, EUCo X's EPC customers can also address the maintenance backlog they have by replacing *'aging assets that are approaching the end of their life'* (Doc G p.14), which constitutes a form of retrofit or 'infrastructure upgrade' (X 4). This upgrade of the customer's secondary conversion equipment and building controls, alongside EUCo X's management can mean that the customer enjoys greater comfort because the energy system is both now more comprehensive and responsive (Doc E). In some cases this can improve not only the EUCo X's customer's comfort, but also the clients of their customers, e.g. hospital patients (Doc E).

Another aspect of EUCo X's EPC value proposition is that they can reduce their customer's GHG emissions via energy efficiency measures. For instance, in its first 8 months of EUCo X's contract with the major national government department, it achieved a reduction of 1,200 tonnes of carbon (Doc B). Emissions reduction can be desirable because they can *'generate significant brand and CSR value'* (Doc G p.14) for the customer. Furthermore, it can help them to meet obligations, such as the Carbon Reduction Commitment Energy Efficiency scheme (CRC) or government department efficiency targets (Doc E) (we explore this further in Section 6.2.4.7).

EUCo X offers their customers bespoke solutions as part of its EPC (X 2, 3 & 5), where EUCo X consults with its customer to develop a suite of efficiency solutions that best suit their needs, without bias towards any particular type of energy technology (X 2):

'[We] try and understand what they are trying to achieve. This isn't the sort of thing you just turn up and say here is a standard offer for an EPC, do you want to buy one? It is a very consultative sales process. We sit down with the customer, work out what their objectives are and…put together [a number of] probable packages for the customer' (X 5)

EUCo X's size and heritage were seen to inspire confidence that they would continue to exist for the term of the EPC contract (normally between 10 and 15 years) and thus fulfil their commitment: *'We are going to be around for a long period of time, because of who we are'* (X 4). Finally, it was believed customers were attracted to EUCo X's EPC offer because they represent a 'one-stop shop', i.e. a business that possesses the necessary capabilities to provide all aspects of the EPC independently: *'[The customers] don't want someone to do a bit of this and another to do a bit of that. They want someone to come in and do all of it'* (X 3).

6.2.4.4 Key Activities, Resources and Partnerships

The delivery of EUCo X's energy performance contracts follows three distinct stages: auditing, implementation and monitoring (Doc E). The first stage is designed to identify opportunities for energy savings and subsequently, identify a suite of energy solutions to achieve these savings and package these into a financially viable EPC (Doc E & Q). The second stage relates to the implementation of this suite of efficiency measures (X 5) (Doc E), which normally includes the installation of new building controls (e.g. boiler optimisation, building-management systems, air-conditioning controls) and/or the implementation of behavioural changes amongst the customer's workforce (e.g. installation of portable meters to show how much energy the employees are consuming) (Doc Q). The third stage includes the operation and maintenance of these measures, as well as the monitoring and verification of the energy savings these provide during the length of the contract (X 2) (Doc E).

Considering that Energy Utility X has traditionally operated the EUCo model, which demands a different set of resources to the ESCo model, Energy Utility X has in recent years had to acquire the necessary staff from other leading ESCos in the UK (e.g. Honeywell) to both develop and implement EPCs: *'We have built a very capable team to tackle this market. It is not like we are a bunch of supply oriented people who can't make EPC work'* (X 5). Additionally it has sought to bolster these in-house resources to deliver EPCs by acquiring a number of other companies, along with their staff, infrastructure, contacts etc. For instance, in 2009 they acquired a leading building management solutions company, which specialised in implementing and managing energy efficiency solutions. By acquiring both personnel and companies with energy service contracting expertise, EUCo X has brought these resources 'in-house' and has gained greater control over being able to fulfil its energy performance guarantees (X 5).

EUCo X's activity in the ESCo market has predominantly been around EPCs, however it has engaged to a lesser extent with Energy Supply Contracting (ESC) (Section 2.6.1). For instance, EUCo X recently offered to install PV system free-of-charge on customers' roofs in return for the FiT, whilst the customer enjoyed free electricity[38] (X 3). However, this was discontinued following the FiT cut announced in late 2011. To bolster its capacity to provide ESCs, EUCo X has acquired a number of other companies. For instance in 2009 it acquired a leading UK biomass boiler installation company, which specialises in the provision of biomass oriented Energy Supply Contracts (X 3) (Doc N). Consequently, EUCo X has broadened its key activities to include the financing, design, installation, operation, maintenance, metering and billing of biomass energy centres (Doc L). EUCo X has also recently acquired a heat pump specialist and the UK's leading provider of solar energy technologies to further bolster its energy supply contracting capabilities (X 3) (Doc N). EUCo X has subsequently had to engage in major organisational restructuring in order to integrate these newly acquired companies into its organisation:

> *'We have made a decision that we are very serious which means we have…changed the shape of the organisation so it is less focused on the home' (X 2)*

Although EUCo X's policy is *'to do that as much as possible with [its] own employees'* (X 5), it still outsources some of its energy service contracting activities. For instance, they have a *'supply chain of approved mechanical contractors for some of the heavier engineering stuff that [EUCo X doesn't] do every day'* (X 5). EUCo X has also developed other key partnerships such as with a leading facilities management (FM) company, as part of its EPC with the major national government department (Section 6.2.4.3). The FM company had been responsible for the management of the government department's facilities for the 9 years prior to commencement of the EPC. During this time the FM provider has developed a strong and trusting relationship with the government department (Doc A). This relationship constituted a good base from which EUCo X could develop an EPC and so a partnership with the FM provider seemed the most appropriate way forward (X 2).

It was highlighted that EUCo X has also developed key partnerships with North American ESCos in the past in order to facilitate the delivery of its Energy Performance Contracts (EPCs) in the UK. They wanted to draw upon these companies' 20 years of experience to assist in the design of their EPCs (X 2). Furthermore, partnering with these companies lent credibility to EUCo X as an EPC provider in the UK, even though it was a new entrant to the ESCo market (X 2). EUCo X also has a number of key partnerships with financial institutions, predominantly banks, pension funds and investment companies that are interested in investing in projects with guarantees around performance (X 2) (Doc R). These partners act as 3rd party financiers that

[38] In a very similar fashion to MOZES's PV offer

purchase the assets installed as part of the EPC to ensure that there's no liability on either the EUCo X's or the customer's balance sheet (X 3) (Doc E) (see Section 6.2.4.6):

> *'We have an abundance of banks, finance companies and [pension] fund managers wanting to invest in the types of programmes I have spoken about…They want big projects, £10-15 million projects and a solid guarantee around performance. So it is very attractive from their point of view, so investment definitely isn't a problem for us' (X 2)*

6.2.4.5 Customer Interface

Although EUCo X has traditionally supplied its energy mainly to households, EUCo X's customer base for EPCs predominantly consists of public sector organisations, such as government departments and health care providers (Section 6.2.4.3). This was generally for the same reasons outlined in the Honeywell case study (Section 6.2.3.5), i.e. large energy bills, large single sites providing good economies of scale, public sector cuts, CRC efficiency scheme, government GHG reduction targets (X 2 & 4) (Doc A, C, E, R). The EPCs that EUCo X signs with public sector organisations typically last for anywhere between 3 and 15 years (X 5) (Doc E & G).

A key aspect of this long-term relationship is trust, where the customer has to be able to trust that EUCo X will deliver on its guarantees and operate at a high standard considering that EUCo X *'spend so much time in the customer's building and have such a major impact on their operations by renewing their assets and improving their infrastructure*' (X 5). In many instances EUCo X has *'become an extra arm to their [customer's] internal teams and a very trusted advisor in terms of what is possible'* (X 5).

6.2.4.6 Revenue Streams and Expenditure

With respect to covering the upfront costs of the EPC *'there are [typically] two options: one is the customer funds it and the other is that we fund it'* (X 3). In reality, sometimes it becomes a mixture of these (X 5) (Doc E, H, R). As outlined in Section 6.2.4.3, when the customer does not have the necessary capital to invest in the project, EUCo X becomes responsible for covering the upfront costs of the EPC measures, normally in conjunction with a third party (X 3) (Doc E):

> *'We would finance it only for the construction period [but after that] we would look to sell those assets on to a third-party, so there's no liability on the balance sheet. By bringing in the third party we are able to keep the liability off the balance sheet of the customer and EUCo X' (X 3)*

However, if the customer does have the necessary capital to cover some or all of the cost, then they may invest in the energy service project (X 5) (Doc R):

> *'If the customer has capital then it becomes more like a standard construction project to a large degree, whereby you charge the customer a capital amount for a series of measures. You go and implement those measures and then a smaller amount is charged every year after that to maintain the systems, provide the monitoring service, uphold that guarantee for the life of that contract' (X 5)*

Where the customer is unable to cover any or all of the upfront costs, EUCo X often in conjunction with a third party take responsibility for meeting the costs of purchasing the new equipment, designing the energy system design, installing the equipment etc: *'about 80% of the cost is tied up in the capital investment, so actually installing the measures'* (X 5). Following this design and installation period, EUCo X has a number of on-going costs it has to meet such as the operation and maintenance of the equipment installed, as well as the measurement and verification of the savings EUCo X delivers (X 5).

EUCo X looks to not only cover the upfront and on-going costs of implementing these energy solutions but to also generate a profit by appropriating a share of the energy savings on the customer's energy bill. Consequently, EUCo X receives a proportion of these savings via regular customer payments (normally monthly) over the lifetime of the contract (Doc E). In some cases EUCo X will enter into a shared savings contract with their client, whereby both companies are paid a percentage of how much money is saved on the client's energy bill (Doc B).

6.2.4.7 Drivers and Barriers

An important factor driving EUCo X's movement towards operating the ESCo model was the recognition that the existing energy market in the UK is currently undergoing radical change, due to pressures such as energy security, climate change, rising energy prices etc, which are serving to drive a major transformation of the UK energy market (Doc M). Combined, these factors were considered a threat to EUCo X's future commercial success (Doc M), encouraging it to transform its business model as 'a reaction to this change' (X 2):

> *'Indeed as I see it, the old utility business model is dead…It is my belief that the energy company model we know today will, within this decade, seem just as much a thing of the past as the Gas Light and Coke Company. And from where I stand, I can already see it happening…We have to do nothing less than develop a new business model for a new, low carbon world' (Chief Executive of EUCo X's Parent Company – Doc M)*

Consequently, EUCO X made the decision to diversify into the ESCo market as a means of repositioning itself to ensure it would remain profitable in the face of this system change (X 1). For instance, it recognised that there was a growing trend amongst its customers to consume less energy and so it had begun to make efforts to accommodate this demand (X 1 & 5):

> *'So whilst it seems counterintuitive that we are helping people to use less of what our core business is, I think we are under the impression that that is going to happen anyway. People are out there reducing their energy consumption, regardless of their energy supplier. So we have tried to be at the forefront of helping people to go down that road' (X 5)*

Although, EUCo X viewed these market developments as a threat to their business, they had in fact approached these developments largely as an opportunity to grow their business (X 1 & 2): *'Existing companies like ours will have to change to survive. I relish the challenge. EUCo X is developing the capability not just to survive, but to thrive' (EUCo X Chief Executive – Doc M).* Diversification into the ESCo market was also deemed necessary to ensure that EUCo X didn't become over-reliant on the competitive pricing of energy units (X 2), considering the volatility of energy prices. Transforming EUCo X's business model was considered important as a means of differentiating itself from the other major Energy Utilities, which together form a relatively homogenous market. By offering 'value-added services' and a more compelling value proposition compared to the sale of energy units, EUCo X sought to set itself apart from its competitors, with a view to capture a larger share of the UK energy market (X 1 & 2).

Another important reason EUCo X has moved into the ESCo market was its desire to develop longer-term relationships with its customers, considering that most Energy Utility customers at present *'tend to shop around and chop and change their supplier quite regularly [and] don't have much allegiance to their supplier and it is all based on price'* (X 5). Additionally, it was thought that moving into the ESCo market could enable EUCo X to fulfil some of its Corporate Social Responsibility (CSR) obligations, such as alleviating fuel poverty (X 1, 2 & 4) and consequently improve consumers' perception of EUCo X (X 2), helping it to not only retain customers but attract new ones.

EUCo X has however faced a number of challenges in attempting to transform its business model, such as shifting EUCo X's organisational culture or mind-set from selling energy as a commodity towards saving energy (X 5). Restructuring the organisation to accommodate the new personnel and recent corporate acquisitions in order to effectively deliver energy service contracts has also proven difficult (see Section 6.2.4.4):

'I think it is difficult for a company like [EUCo X to move towards the supply of energy services], compared to smaller organisations that can set themselves up as an ESCo from the start. We obviously have to do a lot of redesign within our own organisation to get there' (X 2)

'[I think of EUCo X] as a large oil tanker and turning that oil tanker around from its current position is going to take some effort and it is going to take a bit of time…to become that Energy Services Company that offers energy supply as an add-on…I think it is a continuation of the journey I think we already on' (X 1)

EUCo X has also faced a battle to change its customers' perception of it because many of them still considered the company to operate exclusively as an traditional Energy Utility, as opposed to a company that also provides EPCs (X 2).

There have also been a range of external influences on EUCo X that have acted as drivers and barriers to its entry into the UK ESCo market. For instance the severe recession in the UK and the associated public sector cutbacks has encouraged public sector organisations to sign EPCs as a means of reducing their overheads (Section 6.2.4.5). Regulation has also proven to be an important driver such as the CRC Efficiency Scheme (X 5) (Doc H), which has made energy efficiency measures much more financially attractive (Section 6.1.1.1). The continuation of the energy supplier obligations (i.e. CERT & CESP) was also cited as a factor that had encouraged EUCo X to develop partnerships with community organisations (e.g. MOZES) and engage in energy service contracting, as a cost-effective means of fulfilling its supplier obligations (X 3). Conversely, public sector procurement rules have meant that the tendering process for EPCs takes approximately 18 months (X 4), which was considered too long and thus undesirable to both EUCo X and its customers.

Finally, market developments were also cited as key drivers and barriers. For instance, low levels of awareness of EPCs, coupled with a poor understanding of the *'core constructs of the [EPC] contract terms and guarantees'* had limited customer demand (X 4 & 5):

'If there was a challenge in life, it is that energy performance contracting isn't that well known throughout the customer base and so they don't know these exist. The first comment will always be 'this is too good to be true' and 'does this really work?' So there is a whole thing around the market not really understanding that EPCs exist and that it is a common way of doing business in the energy services business' (X 5)

Conversely, the financial sector was considered to possess a strong awareness and understanding of EPCs, with many financiers regarding such contracts as a good investment opportunity (Section 6.2.4.4), thus making finance more freely available to EUCo X to fund its EPCs (X 2) (Doc E).

6.2.4.8 Expectations for Future Development

EUCo X plans to continue developing its energy services division so that it becomes *a 'dominant part'* of their overall business model (X 5), to the extent where energy services become just as big a part of EUCo X as energy supply (Doc M). Ultimately, EUCo X hopes to become the leading EPC provider in the UK (X 1, 2 & 5), which could mean it becomes a real driver of change in the UK energy system (X 2), helping to '*lead the transition to a low carbon economy*' (X 1). However, it is expected that this move towards the ESCo model is unlikely to happen quickly:

> *'It is going to take some time before we get to that place and I think it is a continuation of the journey I think we already on' (X 1)*

Its move towards energy service contracting is likely to help boost growth in the UK ESCo market, as it provides other energy actors with confidence in this niche market, considering that EUCo X is such a wealthy incumbent organisation in the energy sector. Furthermore, EUCo X's move could also encourage other incumbent Energy Utilities to follow suit and transform their business models.

The introduction of the Green Deal (GD) was identified as a factor that is likely to support EUCo X's move into both the residential and commercial ESCo markets because it:

> *'will help start to make people think about investing in energy savings measures and recouping the capital cost of that over the savings…[It will also] help to stimulate the market [and] to make it more mainstream, rather than just a niche market' (X 5).*

Despite its potential to support EUCo X's energy service business, their pilot version of the Green Deal scheme[39] identified a number of potential issues with the GD, such as the cost of finance to fund the measures and the complexity of the arrangements. It was felt these factors would discourage householders to sign-up to the GD independently (Doc P). Therefore, in order to get residential customers to engage with the Green Deal, interviewees explained that EUCo X would have to engage with a range of new, strategic partnerships with trusted energy stakeholders, in particular Local Authorities, Registered Social Landlords and communities,

[39] This scheme was to some extent different from the Green Deal. For instance, although the customer made no upfront investment for efficiency measures, this was covered by a personal loan, as opposed to a loan attached to the property (EUCO X 4) (Doc P)

because these represent important gatekeepers to large numbers of households that EUCo X could contract with in order to capture the economies of scale (X 1, 2 & 4) (Doc P).

The Green Deal will be underpinned by the Energy Company Obligation (ECO) by making funds available for energy efficiency measures in homes that do not fulfil GD's Golden Rule, whereby expected savings from measures repay the costs (DECC, 2011d), such as the typically expensive solid wall insulation. Like its predecessors CERT and CESP, ECO will continue to obligate Energy Utilities such as EUCo X to use some of their profits to reduce their carbon footprint and alleviate fuel poverty (X 4). EUCo X is likely to continue to seek ways of implementing cost-effective efficiency measures and may indeed turn to household energy service contracting as a solution, as it has to date (X 3). However, as outlined in Section 6.1.4.2 & 6.1.4.3, there is no obligation for them to fulfil these energy company obligations via energy service contracting.

6.2.4.9 Summary

EUCo X has for a long time been a leading Energy Utility in the UK, selling both units of electricity and gas predominantly to residential customers. However, in recent years it has begun to develop an energy services division capable of providing EPCs and to a lesser extent ESCs, predominantly to commercial customers. The main reason for this shift has been the organisation's realisation that the UK energy system is undergoing a radical transformation due to a combination of pressures (e.g. climate change, energy insecurity, energy affordability etc), which could seriously undermine the profitability of EUCo X in the future. This shift to the ESCo model has not proven easy considering Energy Utility X's history of operating the EUCo model, however it has already delivered a handful of successful EPCs in the UK, serving to illustrate how ESCo and EUCo models can co-exist. Looking forward, EUCo X hopes to provide energy service contracts to the residential sector as part of the forthcoming Green Deal.

6.2.5 Cross-Case Analysis

In this sub-section we briefly discuss the common and divergent themes that have emerged from these 4 ESCo case studies. Firstly, the case studies help to highlight the common characteristics these ESCo variants share, which mean they can be grouped together as a population. Primarily the common characteristic these organisations share is that they assume a significant degree of financial and/or technical responsibility from their customers in order to provide them with energy services capable of satisfying their energy needs. These energy services included *useful energy streams* (e.g. electricity, hot water, cooling) or *final energy services* (e.g. heating, lighting), the latter normally in conjunction with a guarantee regarding quantity, quality and cost of these services. This contrasts against the Energy Utilities' sale of energy units (e.g. gas, electricity) to their customers, where it is the customer, not the supplier, who is mainly responsible for converting this energy into *useful energy streams* or *final energy* *services*, which is what the customer ultimately desires (e.g. hot water, lighting). Another common characteristic between the ESCos was their desire to capture the economies of scale to reduce their transaction costs and thus improve their profitability.

Despite these characteristic similarities, the ESCo case studies highlight how these ESCo variants were also characteristically different in a variety of ways. For example, both Thameswey's and MOZES's core objectives were to alleviate fuel poverty, promote local economic growth and mitigate climate change. In contrast, both Honeywell and Energy Utility X's main focus was to generate a financial profit. Another important characteristic difference was the resources each variant had at its disposal. MOZES and to a lesser extent Thameswey had relatively few technical and financial resources available to them, whilst Honeywell and Energy Utility X are extremely wealthy, multi-national corporations in comparison.

These characteristic differences meant that to some extent these ESCos were sensitive to different enabling and inhibiting pressures, emanating from the wider UK energy system. For example, considering MOZES's limited financial resources, the reduction in government capital grants for low-carbon energy projects in recent years had meant it had struggled to secure the necessary funds to cover the upfront capital costs for its proposed energy projects. In contrast, Thameswey could borrow money from Woking Borough Council, whilst Energy Utility X and Honeywell were able to draw on their own financial reserves, as well as secure finance from financial institutions. The ESCos also differed in how they had been affected by the economic recession. The economic downturn has halted Thameswey's operational expansion for the foreseeable future, whilst it has made MOZES's task of securing finance from the banks even more difficult. In contrast, the public sector cutbacks have represented a boon for Honeywell and Energy Utility X's EPC divisions, considering how they had increased public sector organisations' desire to reduce their energy expenditure. In terms of drivers, both Honeywell and Energy Utility X identified the CRC Energy Efficiency scheme as a key driver because it had raised the issue of minimizing carbon emissions up the corporate agenda of large organisations. However, this had done little to support the activities of MOZES and Thameswey who engage with either residential or small to medium sized enterprises (SMEs).

Although the variation between these ESCos meant that they were often influenced by different environmental pressures, the ESCo variants were still influenced by some of the same developments in the UK energy system. For example, rising energy prices in the UK were identified as a driver in all the case studies, considering that they had raised demand from consumers for any service capable of reducing their energy spend. Additionally, the UK government's support for a transition to a low-carbon, secure and affordable energy system had positively influenced all four of the ESCos in some form or another.

In summary, the case studies have served to highlight the strong degree of heterogeneity in the ESCo population. Furthermore, they have illustrated how these different ESCo variants have been influenced by some of the same environmental pressures in similar ways (e.g. rising energy prices). However, they have also underlined how these variants have in some instances been influenced by the same environmental pressures in very different ways (e.g. economic downturn). This demonstrates how the ESCo population has not reacted to changes in the UK energy system in a uniform manner and how some changes have served to support or inhibit certain variants' operations more than others. We examine this further in the following chapters, as well as how the heterogeneity of the ESCo population has characterized the influence it has had on the wider UK energy system.

6.3 Chapter Summary

In this chapter we presented the findings from our empirical investigation. We began by outlining the core characteristics of the ESCo business model (Section 6.1.1), thus addressing RQ 1 and subsequently compared these with the incumbent EUCo model (Section 6.1.2) to highlight the characteristic differences between the two business models. We also introduced the strengths and weaknesses of the ESCo model (Section 6.1.3) to address RQ 2, which represent an important consideration when seeking to understand why the model has proliferated to the extent it has in the UK so far. Subsequently, we then explored the external factors that have influenced the uptake of the ESCo model in the UK (Section 6.1.4), serving to underline the multitude of pressures the ESCo population is subject to. In this sub-section we also identified the emerging factors interviewees believed would soon have an important bearing on the UK ESCo population's evolution, most of which were centred around imminent or probable regulation. We then introduced the key variants of the ESCo population in the UK, outlining their core characteristics, as well as the factors that had been responsible for their emergence. Finally, we introduced four case studies of ESCos operating in the UK, each of which corresponded to one of the ESCo variants identified in Phase 1, i.e. *Local Authority 'Arm's Length'; Community Owned & Run; Energy Service Provider* and *Energy Utility Energy Service Provider*. These served to highlight the different ESCo models being applied in the UK at present and how both similar and dissimilar factors have been responsible for these companies' successes and failures. Furthermore, they illuminated how different types of ESCo have been responsible for influencing the UK energy system in different ways.

In the following chapters we draw upon these findings to discuss how and why the ESCo population has evolved in the UK and the extent to which this can be explained by the co-evolutionary dynamic between ESCos and the various different dimensions of the UK energy system (Section 7). Furthermore, we look to the future and discuss not only how the ESCo population is likely to evolve but the influence it might have on the evolution of the wider energy system (Section 8).

7 Co-evolution of the ESCo model with the UK energy system

The aim of this chapter is to address research questions 3 & 4 (Section 1.5), which relate to the past and present co-evolutionary relationship between the ESCo population and the UK energy system. Consequently, this chapter seeks to provide valuable insight into how the various key dimensions of the UK energy system have causally influenced the evolution of the UK ESCo population to date and vice versa. In order to generate this insight we examine the findings of our empirical investigation presented in the previous chapter (Section 6) using our integrated analytical framework (Section 3).

The chapter examines whether co-evolutionary mechanisms, and in particular positive feedback loops, can help to explain the persistent dominance of the EUCo model and the marginalisation of the ESCo model. Furthermore, we explore how co-evolutionary mechanisms might help to explain how the selection environment has begun to exhibit a greater fitness with the ESCo model in recent years. Taking a co-evolutionary perspective will also provide insight into how the ESCo population, as a niche market of organisations practicing a novel, sustainable business model, has influenced changes to the UK energy system. Doing so will help to elucidate our understanding of how the ESCo model might influence and even accelerate a transition to a sustainable energy system, which is discussed in detail in Section 8.

This chapter begins by examining the various environmental factors that have served to shape the evolution of the ESCo population, focusing on the processes of *variation, selection* and *retention* (Section 7.1). Focusing on these factors is designed to help explain the heterogeneity of the ESCo population (*variation*); the extent to which the ESCo model has been adopted (*selection*) and the reasons why this model has persisted in the UK (*retention*).

In Section 7.2 we broaden our analysis to examine the coevolutionary interactions between the ESCo business model population and the various dimensions that make up the UK energy system: *incumbent business model, ecosystems, institutions, technologies, and user practices*. Moving beyond an evolutionary analysis, we examine not only how these dimensions have causally influenced the evolution of the ESCo population but also how the evolution of these dimensions has been causally influenced by the activities of the ESCo population. We apply this co-evolutionary focus to provide additional insight into the factors responsible for the evolution of the ESCo population and the UK energy system. This is possible because a co-evolutionary analysis, unlike a purely evolutionary analysis, takes into account how the ESCo population has in fact shaped the wider UK energy system, which constitutes the very environment that causally influences its own evolution. Unlike with the ESCo population, we do not undertake a full evolutionary analysis of the other UK energy system dimensions due to both time and resource constraints, i.e. focusing on how the ESCo population has specifically influenced variation, selection and retention processes. This is identified as an avenue for future research in Section 10.3. Instead we focus on how the ESCo population has influenced characteristic changes in these systems and thus focus on their evolution in broader terms.

7.1 Evolution of the ESCo population

This section provides an initial analysis of the evolution of the ESCo population, which is expanded upon in the subsequent sections to take into account the coevolutionary interactions of this population with the wider UK energy system.

Section 6.1.1 highlighted the characteristics common to the ESCo business model, enabling us to set ESCos apart from other organisations such as Energy Utilities, the differences of which were underlined in Section 6.1.2. Within the ESCo population, 4 key variants were identified that shared the core characteristics common to all ESCos but were also characteristically distinct from one another (Section 6.2):

> *'Everybody does everything slightly differently. You have got in the truest sense, the traditional [ESCo] model but in reality, it operates in different ways with different people' (EUCo Senior Manager – B28)*

Both our sectoral and ESCo-level empirical investigation highlighted that ESCos can often vary with respect to following characteristics in the UK:

- Sector (private, public, third)
- Ownership (wholly owned, joint-venture, shareholders)
- Organisational form (Public limited company, Charity, Community interest company)
- Contract types (Energy Supply Contracting, Energy Performance Contracting)
- Core objectives (profit, carbon reduction, fuel poverty alleviation etc)
- Size (number of employees, size of premises)
- Wealth (financial resources, technical resources)

We now ask the question, which factors are responsible for this degree of variation in the UK ESCo population? This can be explained in part by how accessible ESCo model is to adoption by a broad range of organisations (e.g. Local Authorities, communities, equipment manufacturers etc). For instance, ESCos tend to deliver small to medium sized generation and demand management projects, making it much more accessible than the EUCo model, which instead focuses on the development of costly, large-scale centralised generation projects. The ESCo model's focus on bespoke contracting (Section 6.1.1.1) also means it can be applied to fulfil a wide variety of customers' energy needs (e.g. commercial, residential, industrial etc), reflecting the flexibility of the model.

The ESCo model's degree of accessibility and flexibility is reflected by the wide range of organisations who have adopted the model, many of whom have not traditionally engaged in energy service provision, such as Local Authorities (e.g. Woking Borough Council, Aberdeen City Council), communities (e.g. Ashton Hayes, the Meadows), property developers (e.g. Galliford Try, Willmot Dixon), equipment manufacturers (e.g. Honeywell, Siemens) and facilities management companies (e.g. Mitie, Amey) (Appendix G – Section 12.6). This spectrum of organisations seeks to fulfil a range of primary objectives (e.g. profit generation, alleviation of fuel poverty, mitigate climate change etc). Consequently, variants of the ESCo model have emerged (Sections 6.1.5 & 6.2) as a result of these organisations actively moulding the ESCo model to fit their specific organisational needs:

> *'There are very large, sophisticated, multisided, multi-International or national companies and then you get smaller, medium-sized commercial buildings… [there are] different ESCos to meet different requirements' (ESCo Senior Manager – B 15)*

Alongside this influx of new entrants into the UK ESCo market has also emerged a number of new actor partnerships between a range of public, private and third sector organisations. Some of these have taken the form of joint-venture ESCos, such as the Birmingham Energy Savers ESCo developed by Birmingham City Council and Birmingham Environmental Partnership (a Local Strategic Partnership which serves to deliver a better quality of life in Birmingham) (BEP, 2012), whilst others have taken the form of contractual agreements, such as between Cofely and Southampton City Council (Section 6.1.5.2) or British Gas and the community run MOZES (Section 6.2.2.4). Many of these partnerships have emerged as a means of pooling the different organisations' resources and capabilities, in order to deliver a more successful energy service project (Section 6.1.1.7). The emergence of these partnerships has helped to increase the variation of the ESCo population as characteristically distinct organisations have formed hybrid, joint-venture ESCos.

The lack of energy service market regulation, such as official standardized contracts or market rules, has meant few constraints or incentives currently exist that discourage business model experimentation or encourage a standard ESCo model to emerge:

> *'There isn't a standard at the moment…Every scheme seems to be different at the moment… it is quite new and quite fluid. Therefore, people are making it up as they go along' (Senior EUCo Manager – A8)*

Variation has however been constrained to some extent by the length of energy service contracts, which typically last for between 5 to 25 years. This is because both the ESCo and its customers are contractually locked into a particular type of service agreement for a long period of time, making it difficult for either party to engage in new forms of energy service contracting:

> *'It is very hard if you have a 20 year contract…to modify or change it to become a completely new type of contract……That in itself becomes a barrier to implementing other [business] models' (Senior Investment Manager – A5)*

Evolutionary explanations can also provide valuable insight into the extent to which the ESCo model has proliferated in the UK to date, i.e. the *selection* process. In part this can be explained by the strengths and weaknesses of the business model from the perspective of not only the customer, i.e. the value proposition (Section 6.1.3), but also from the perspective of the organisations considering adopting and operating the ESCo model. However, the empirical investigation illustrated how the environment in which the ESCo model is applied also plays an important role in determining how widely it is adopted. This is evident from the plethora of extrinsic drivers and barriers that have either enabled or inhibited the adoption and subsequent operation of the ESCo model (Section 6.1.4). Therefore, the uptake of the ESCo model cannot purely be explained by the extent to which the model is perceived to satisfy the needs of a business and its customers but also the fitness of the model with its prevailing selection environment, such as with institutions, technologies etc. For instance, the ESCo model might be considered to represent a strong fit for both the needs of a particular actor looking to establish an energy company and a specific group of energy consumers. However, the ESCo model may not ultimately be applied because of numerous extrinsic barriers, which may for instance make applying the model too costly and/or difficult. Therefore, the ESCos' selection environment represents an important consideration if we are to understand why the ESCo model has struggled to proliferate in the UK, even though it has enjoyed wide-scale uptake elsewhere (Section 5.5).

Retention of the ESCo model refers to its characteristics being 'preserved, duplicated, or otherwise reproduced' (Aldrich and Ruef, 2006 p.17) from the present group of ESCos to future generations of ESCos operating in the UK ESCo market. Retention of the ESCo model is challenging at present because there is a distinct lack of awareness of the business model amongst both consumers and businesses, which has limited demand to replicate the model (Section 6.1.4.2). Furthermore, whilst the EUCo model only changes incrementally from customer to customer, the bespoke nature of the ESCo model means that it: '*It doesn't tend to be highly replicable and that is a problem' (Energy Services Provider Senior Manager - B 18)*. This issue could be addressed via the introduction of a variety of standardized energy service contracts to satisfy the needs of different types of consumers and ESCos. However, the immaturity of the ESCo market has meant the ESCo model has not yet become institutionalized, in the form of market regulation. For instance, there is lack of nationally recognised standardized contracts for either ESCs or EPCs, by either government or trade associations, making retention of the ESCo model difficult. Recently however, local energy service contract procurement frameworks such as RE:FIT (Section 6.2.3.7) have improved the ESCo model's prospects of retention via the introduction of standardised energy service contracts.

In this sub-section we have applied evolutionary theory to help explain how and why the ESCo population has grown to exhibit the characteristics it does today. However, we argue that applying evolutionary theory alone can only go so far to improve our understanding of the role ESCos are likely to play in a transition to a sustainable UK energy system. This is because even though it takes into account how the ESCos' socio-technical environment has characterized the ESCo population via evolutionary process (i.e. variation, selection and retention) and thus the size and characteristics of the ESCo population, it does not account for how the ESCo population has simultaneously causally influenced the evolution of the UK energy system. Consequently, it does not acknowledge how the ESCo population has shaped its own environment and the impact this may have had on its own evolution, via positive feedbacks for example. The same can be said for the EUCo model. Therefore, we apply our co-evolutionary analytical framework (Section 3.3) to identify how the UK energy system and ESCo and EUCo populations have simultaneously causally influenced one another's evolution and how this has contributed to the marginalisation of the ESCo model and the continued dominance of the EUCo model.

7.2 Coevolutionary interactions

In this sub-section we examine how the ESCo population has coevolved with the key dimensions of the wider UK energy system, for the reasons outlined in Sections 7 & 7.1.

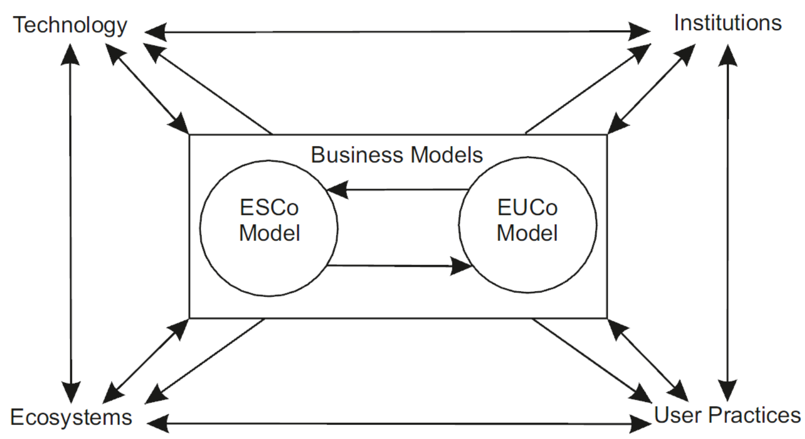

Figure 7.1 The coevolutionary relationship between the ESCo & EUCo business models and the wider UK energy system

7.2.1 ESCos and Ecosystems

Firstly, we examine how the ESCo business model has coevolved with ecosystems.

The ecosystem dimension's causal influence on the wider UK energy system is largely mediated through the other dimensions of the UK energy system, such as institutions. For instance, over the last 30 years, the UK has relied heavily on the extraction of oil and gas from its North Sea reserves to satisfy its energy needs. However, these reserves have gradually dwindled, with the UK becoming a net importer of energy in 2004 (DECC, 2011g), posing a real threat to the UK's energy security (Section 1.3.2). Additionally, extraction and combustion of fossil fuels has resulted in a number of adverse environmental effects, namely climate change, air pollution, disposal of solid waste, destruction of natural habitat etc. These adverse ecosystem effects have placed pressure on UK energy system stakeholders to implement energy solutions capable of not only improving the UK's energy security but also conserving the natural environment, consequently adding momentum to the pursuit of developing and implementing business models capable of delivering such solutions in a manner that is attractive to both suppliers and consumers:

> *'It just isn't sustainable. Gas and oil are going to run out...It is about [re]positioning [our business] now' (Senior EUCo Manager – B 27)*

No major ecosystem change can yet be attributed to ESCo activity, however it is likely that existing ESCos have reduced the UK's reliance on fossil fuels to a very small extent, by reducing consumers' consumption of fossil fuels either using renewable energy as the primary energy input to generate useful energy streams instead of fossil fuels or improving the efficiency with which fossil fuels are generated, distributed and consumed. This will have not only have resulted in a small reduction of fossil fuel related pollution (e.g. sulphur dioxide, nitrogen oxides etc) but also in the UK's GHG emissions. This reduction can be illustrated by the various projects implemented by the ESCo case studies (Section 6.2), as well as Cofely's ESCo operations, where their district heat schemes deliver approximately 77,000 tonnes of CO_2 savings per annum (Cofely, 2012). However, it is important to note that these carbon reductions are likely to have been partially offset by the rebound effect (Section 2.6.4).

7.2.2 ESCos and Institutions

Secondly, we examine how the ESCo population has coevolved with institutions.

New regulation that either requires or incentivises organisations to engage in sustainable energy supply and demand side management solutions has helped to improve the business case of ESCos. These policies include financial incentives (e.g. Feed-in Tariffs, Renewable Heat Incentive), capital grant schemes (e.g. Local Energy Assessment Fund), finance schemes (e.g. Green Deal, Salix[40]) and low-carbon obligations (e.g. Low-Carbon Building Regulations, CRC Energy Efficiency Scheme, CERT) (see Section 5.4 for details of some of these policies). One of the most important regulatory developments for ESCos has been the introduction of financial incentives (e.g. FiT, RHI) in place of many of the capital grant schemes (e.g. Low Carbon Buildings Programme). These incentives provide a long-term revenue stream (normally up to 20 years) rather than upfront capital grants (see Section 5.4). In the past residential and commercial consumers could access capital grants to cover the upfront costs of sustainable energy measures themselves. However, their decline has effectively created a role for organisations such as ESCos to cover the upfront capital costs of delivering these measures in place of the grant schemes. In return they are able to capture low-carbon energy financial incentives as a revenue stream, such as the FiT & RHI:

> *'The barrier [to energy projects] is the upfront capital cost, so why are we giving them a long-term revenue stream?...The institutional and policy arrangements might lead you to an ESCo [because] if you gave a grant, what is the role for ESCo? [But] if you've got a FiT, you might get a role for an ESCo. The RHI will be the same issue' (Energy Efficiency Expert - A 7)*

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[40] Salix is a not for profit, independent social enterprise that provides funding to public sector organisations, via loans and grants, for proven technologies which are cost effective in reducing GHG emissions (SALIX, 2012)

The emergence of this new regulatory framework has helped to provide ESCos, as well as their partners and customers, with greater certainty that there is a significant national commitment to a low-carbon transition and that this commitment will last. This has helped to attract investment and encourage employers to develop the skills necessary to take advantage of this new market opportunity, a lack of which had been cited as a traditional barrier to ESCo market development. However, swift and unexpected changes to the regulatory framework have served to undermine ESCos' confidence in the government's commitment, raising questions around the robustness of the framework. For instance, the cases of Honeywell, MOZES and Thameswey all help to illustrate how severe and unexpected cuts to the Feed-in-Tariff (FiT) have significantly reduced their management's confidence in how the regulatory framework would develop in the future. A series of major amendments to the CRC Energy Efficiency scheme has also had a similar effect for Honeywell (Section 6.2.3.7).

Actors' lack of confidence in the shape the regulatory framework will take in the future and their lack of ability to foresee how their selection environment will develop going forward have together served to limit their capacity to plan ahead. This has in turn encouraged indecision and inertia from these actors. This had a negative impact on ESCos taking the necessary decisions to make additional investments in their energy service operations and is likely to have dissuaded some entrepreneurs from taking the decision to adopt the ESCo model:

> *'If the government keeps chopping & changing, there isn't a stable platform to go forward and start planning' (Thameswey Energy Managing Director – T 2)*

> *'You have to then adopt a 'wait and see' policy because you can't be sure what you will be targeted to achieve when they reform or replace the legislation you are trying to achieve at the moment…So what do I prioritise, on the basis that I don't know what legislation is going to incentivise me to do' (Honeywell Senior Manager – H 2)*

The complexity of the regulatory framework, and the difficulty associated with identifying and navigating the various regulatory drivers and barriers has also made this decision making process more challenging.

Despite the regulatory framework being broadly supportive of ESCo activity, many interviewees argued there was still much more that could be done to improve the uptake of the ESCo model. For example, they cited the lack of a mandatory GHG reduction target for cities and a law similar to Denmark's 1979 Heat Supply Law[41]. Conversely, although some

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[41] Provides Danish local authorities the power to mandate that new and existing buildings connect to public heat supply (DEA, 2005)

recently introduced regulation has proven supportive of the ESCo model (see earlier in sub-section), other energy regulation has presented a challenge to ESCos. For instance, Ofgem's recent provision for third party access to private gas and electricity networks, in reaction to a change in European law following the Citiworks case in Germany (Section 6.2.1.8), customers now have the option to switch energy suppliers and thus avoid being subject to a monopoly (OFGEM, 2011). Although this is likely to promote fairer competition, it will also undermine ESCos confidence in the number of customers they are likely to supply via their own private wire and thus their ability to predict how commercially viable an energy supply project might be. This is likely to adversely affect an ESCo's ability to secure the necessary funds to cover the upfront capital costs of the scheme. Non-energy regulation has also served to undermine ESCo growth, such as the Landlord & Tenant Act and OJEU procurement law (Section 6.1.4.2).

Institutions also encompass the 'rules of the game' governing the financial sector. The emergence of a low-carbon regulatory framework has improved ESCos' prospects of securing finance, as it has provided investors (e.g. banks, hedge funds etc) with greater confidence in the projected rate of return they might expect from sustainable energy and thus ESCo projects. However, many investors were considered unfamiliar with the ESCo model, meaning that many of them had failed to seek out opportunities to support ESCos, whilst others were sceptical of those opportunities that had presented themselves[42]. Moreover, they have continued to support the larger, more lucrative centralised Energy Utility led energy projects, which they have traditionally financed, channelling valuable financial resources away from ESCos and towards Energy Utilities, helping to reinforce their dominance, a process outlined by Aldrich and Ruef (2006). The difficulty ESCos currently face in securing finance from private sector investors is particularly damaging considering the decline of grant schemes in recent years. We elaborate upon this phenomenon in Section 7.2.5.

Interviewees broadly agreed that the ESCo population has so far had a limited impact on regulation and thus the evolution of energy related institutions. This impression is supported by the little attention the ESCo model has received in recent white paper publications. For instance, it received only a passing mention in the previous government's 2010 *Warmer Homes, Green Homes; A Strategy for Household Energy Management* (DECC, 2010f), despite being referred to extensively in the preceding 2009 *Heat & Energy Saving Strategy* consultation (DECC, 2009). ESCos also barely featured in the current government's *The Future of Heating: A strategic framework for low carbon heat in the UK* (DECC, 2012n), despite

[42] Uncertainty in future developments coupled with an economic recession had meant financial institutions had 'less of an appetite for risk' (B 29) encouraging many to shy away from investing in the ESCo model because they were generally unfamiliar with it

representing a business model well suited to the provision of *useful energy streams* such as heat.

To date no regulation has been introduced with the explicit purpose of supporting ESCo activity. However, the ESCo model was referred to a number of times in the impact assessment for the government's planned Green Deal (DECC, 2011f) (Section 6.1.4.3). Additionally, ESCos played some role in the government's removal of an article within the Local Government Act 1976, which had prohibited Local Authorities (LAs) from selling electricity not generated in conjunction with heat (DECC, 2010b) and thus restricted LAs scope to operate in the energy sector. For instance, Thameswey's activities were cited by the Energy Minister at the time as having helped to demonstrate the value of LAs being able to sell electricity and how the existing regulatory framework was undermining their business (Section 6.2.1.7).

7.2.3 ESCos and Technology

Thirdly, we examine how the UK ESCo population has co-evolved with energy technologies.

The financial viability of energy service contracts is strongly influenced by the costs and performance of the energy conversion and demand management technologies ESCos utilise to provide energy services. In recent years the cost-effectiveness of a range of sustainable energy technologies has improved, such as low-carbon primary conversion technologies, including PV, solar thermal and wind generation technologies (Nemet, 2006, Hearps and McConnell, 2011). This can mainly be attributed to 'learning and economies of scale associated with large-scale global deployment – not just improvements in technical efficiency' (Hearps and McConnell, 2011 p.1). Although ESCos have enjoyed falling costs for some energy technologies, a number of other measures are still considered too expensive to be cost-effective for ESCos. For instance external wall insulation, which can improve the energy efficiency of properties without wall or loft cavities, was often considered non-cost effective because despite providing greater reductions on the customer's energy bills than loft and cavity wall insulation, it costs significantly more, outweighing this cost benefit (EST, 2012).

In some cases new technologies have entered the market, such as residential and commercial LED lighting, which has considerably improved the business case of ESCos offering EPCs by presenting them with the opportunity to identify significant cost savings in their customers energy bills compared to the use of incandescent or compact fluorescent ligthbulbs (CFL) (EST, 2011, USDE, 2012):

'The thing about LED lighting is that instead of saving 10 or 30%, you can save 80%[43]. And then the idea of a performance guarantee finance project becomes very easy, because the returns are so huge you can say to the client I guarantee I will save you 40% of your lighting costs' (Senior Investment Manager - A 5)

Infrastructural constraints were also cited as an important barrier, such as the load capacity of district electricity distribution networks, which has served to limit the number of PV installations that can be linked to the grid on anyone line (Section 6.2.2.7). Numerous key infrastructural constraints relating to District Heat (DH) networks were also identified, such as the technical difficulty and cost of implementing a DH network in a historical, densely populated area. Despite these infrastructural limitations, the age and inefficiency of the UK's housing stock represents a large market for demand side management solutions with approximately only half of all households having been fitted with loft and cavity wall insulation (DECC, 2011c). The ESCo model has also been supported in some instances by existing infrastructure, such as private electricity and heat networks, which ESCos have been able to utilise to provide energy services, as illustrated by the case of Thameswey Energy. Consequently, technologies and infrastructure (i.e. systems of technologies) can be considered to play an important role in shaping the ESCos' selection environment.

The adoption of the ESCo model has triggered some small-scale but important changes to the UK's mix of energy technologies, as well as its energy infrastructure. For instance, 123,758 PV installations at or below 4kW (approximately 360,291kW of capacity) were registered for the Feed-in-Tariff scheme during 2011 (DECC, 2012k)[44]. A significant number of these were domestic roof-top installations, installed free-of-charge to the consumer by ESCos, as part of long-term energy supply contracts where the ESCo captured the feed-in-tariff whilst the consumer enjoyed the electricity generated by the systems (Section 6.2.2.4). For instance, *A Shade Greener*, a leading ESCo, claims to have installed nearly 10,000 free PV system installations since 2010 (ASG, 2012).

The case of Thameswey Energy also helps to illustrate how ESCos have had a major impact on energy infrastructure in some local areas. In Woking for instance, TEL has installed 2.6MW of electricity, 3.2MW of heat and 1.7MW of cooling generation capacity (Thorp, 2007), which mainly consists of CHP and PV generation technologies. This is sufficient to satisfy the electricity and heat needs of over 2,000 households (Thameswey, 2012d). They have also had a

[43] LED lights costs significantly more than CFL and incandescent light bulbs but use approximately 80% less energy than a 60W incandescent to provide similar lighting levels and lasts for a much longer period of time, providing a significant lifetime cost saving (USDE, 2012)
[44] PV systems installed after the 15th July 2009 is eligible for the FiT (Feed-in-Tariffs Ltd, 2012)

profound impact on Milton Keynes' energy infrastructure, installing two CHP units, with an electrical output of 6.4 MW, which serves approximately 1,100 businesses and households in the town (Thameswey, 2012c).

Other ESCos have had a much wider impact on the nation's energy infrastructure. For example, Cofely GDF Suez is responsible for the operation, maintenance and management of 300MW of boilers, 74MW of chilled capacity, 40MW of CHP and 55km of district heating and cooling pipework in the UK (Cofely, 2012). Their energy supply contracting extends throughout most of England, covering major cities such as London, Manchester, Birmingham, Southampton and Leicester (Cofely, 2012). These examples help to emphasise that whilst the operations of ESCos cannot be considered to have dramatically altered the UK energy infrastructure, they have had a significant impact on the infrastructure of some major towns and cities, throughout the UK.

7.2.4 ESCos and User Practices

Fourthly, we examine how the UK ESCo population has evolved with energy consumers' user practices.

Technological innovation, greater GDP per capita and falling energy prices have combined to make energy services increasingly attainable for much of the UK population during the 19th and 20th centuries (Fouquet and Pearson, 2006). However, in recent years, the high level of demand for energy services, coupled with significant international oil and gas price rises (DECC, 2011g) and falling real wages due to the economic downturn, has meant that the costs of energy services have increased for most domestic and commercial consumers. Therefore, whilst demand for energy remains high, consumers have found it increasingly difficult to be able to afford to satisfy their energy needs. This has helped to generate demand for services that can reduce customers' current energy costs, such as energy service contracting.

User practices have also begun to alter in reaction to the challenges of reducing carbon emissions and other environmental impacts associated with energy use. A number of interviewees recognised that recently there had been a significant increase in the demand for environmentally sustainable products & services, particularly amongst commercial consumers. This can mainly be attributed to the various environmental regulations organisations are now subject to (e.g. CRC energy efficiency scheme, low-carbon building regulations etc) (Section 5.4). This trend can also be attributed to these organisations' desire to improve the value proposition they extend to their more environmentally minded customers. This trend is encapsulated by the proliferation of Corporate Social Responsibility commitments, which many organisations have sought to fulfil by engaging with energy service contracting.

An important user practice related barrier to the uptake of the ESCo model was the lack of consumer awareness and understanding of the ESCo model. However, in recent years it was explained that awareness and understanding were slowly improving. In part this change can be attributed to the work of a small and informal social network of ESCo champions, some of whom have worked together to promote awareness and understanding of the ESCo model by engaging with energy stakeholders outside the energy service market niche outside this niche. It can also be attributed to a positive feedback where as more and more energy service contracts have been completed, more and more energy stakeholders have come into contact with the ESCo model. Consequently, consumer and stakeholder awareness and understanding of the ESCo model has improved. This has not only meant that the profile of the ESCo model has been raised but that a range of unfounded, negative preconceptions of the ESCo model have been addressed, helping to reduce consumer and energy stakeholder scepticism of the model. Consequently, this has increased the likelihood of more energy service contracts being signed, bringing us back to the beginning of the loop (Figure 7.2):

> *'The only thing that is going to accelerate the business [model] is more EPCs being completed…We need the innovators to be innovative and crack on with putting EPCs in place…[to show] the [energy] savings are proven, to demonstrate this is how you do one and procure one, [in order to make people] more comfortable with it' (H 2)*

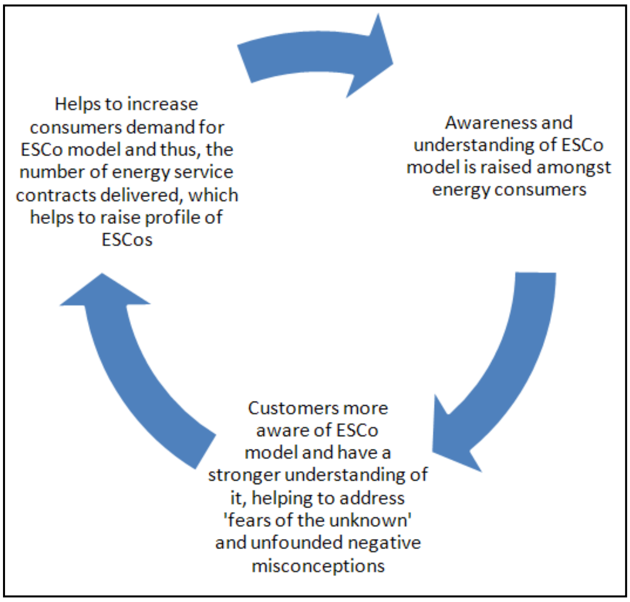

Figure 7.2 Positive feedback loop involving customer awareness and understanding of the ESCo model

In some cases the ESCo model, has reduced consumers' control over fulfilling their energy needs as the ESCo takes the majority of the responsibility for doing so. However, in other cases it has served to increase consumers' control over how they fulfil their energy needs by providing them with ownership and control over the ESCo responsible for these needs. This can probably be best illustrated by the emergence of a number of community ESCos, such as MOZES, which is owned and managed by local energy users, who take responsibility for financing, installing, operating and maintenance of PV systems to generate electricity for the community. Customer controlled ESCos, such as MOZES and TEL, enable the user to identify ways of fulfilling their energy needs that are in synergy with their broader set of objectives. These ESCos may be economically, environmentally, socially and/or politically oriented, such as supporting the local economy or alleviating fuel poverty. Furthermore, these types of arrangements fundamentally change the consumer-supplier dynamic because the consumers, via the ESCo, act as generators and suppliers. The case of Thameswey Energy illustrates a similar dynamic, where instead of the community owning the ESCo, it is the council. Furthermore, TEL provides the council with much of its heating, electricity and cooling needs.

User practices have also exhibited change even they have contracted with an external Energy Service Provider (Section 6.1.5.2), which they have neither direct ownership nor control of. For instance, traditionally the relationship between Energy Utilities and their customers has been distant. In contrast, as part of an energy service contract, there is a large degree of communication and collaboration between the user and the ESCo. Both supply and performance contracts often require the user to engage at the project-design stage, so that the ESCo designs a project that is in synergy with their consumption needs and behaviours. Furthermore, EPCs often stipulate that the customer alters their consumption behaviour in certain ways to ensure sufficient energy savings are delivered to cover the capital costs of the project (Section 6.2.3.4).

7.2.5 Competition between ESCos and Energy Utilities

Finally, we examine the co-evolutionary relationship between the ESCo population and the incumbent EUCo population.

As Section 5.4 explained, the Big 6 Energy Utilities currently dominate the UK energy sector and continue to generate extremely healthy profits, which dwarf those of the ESCo market in the UK. Interestingly, the Energy Utilities continue to dominate the UK energy market despite delivering poor levels of customer satisfaction, where only 42% of surveyed customers believed their Energy Utility’s services represented value for money in 2011 (uSwitch, 2011). Although the rise and continued dominance of the EUCo model is likely to be a product of a multitude of factors at work over a number of decades, it can in part be explained by positive feedback mechanisms, which represent a particular type of co-evolutionary dynamic (Unruh, 2000) (Section 2.3.3.1).

One particular group of positive feedback mechanisms are increasing returns, as outlined by Arthur (1989) and North (1990) (Section 2.3.3.1). Drawing on our empirical evidence, the Energy Utilities can be understood to have benefitted from *scale economies*, meaning that as they have become larger and increasingly vertically integrated, their transaction costs have fallen for each unit of energy they supply, helping them to become more cost-effective[45]. Lower costs have in turn attracted more customers, which has helped to further improve their economies of scale:

> *'[They] all have one or 2 million customers. Their overhead costs of supply, billing etc are as low as you can get them…It is difficult to see how you are going to be able to undercut British Gas or n.Power on a cost basis' (A 7)*

Adaptive expectations have also helped the EUCo model to gain traction, where increasing adoption of the business model has served to reduce levels of uncertainty surrounding its use. Over the years key energy stakeholders (e.g. investors, policymakers, customers etc) have become increasingly familiar with the model, reducing their uncertainty of it and making them more comfortable about engaging with it[46].

Turning to other forms of positive feedbacks that have helped lock-in the EUCo model, the wealth and political power the Energy Utilities currently wield has meant they have both advertently and inadvertently influenced the evolution of various aspects of the energy system, which has broadly helped to cultivate a selection environment that is supportive of their operations (Wüstenhagen and Boehnke, 2008). A good example of this relates to the persistence of Energy Utilities obligations (e.g. EEC, CERT, CESP) (Section 5.4), which arose out of the necessity to reduce the GHG emissions content of Utilities' energy supply in the context of mounting pressure to mitigate climate change. At first glance these obligations seem to undermine the EUCo model (Section 5.4), however the Energy Utilities have traditionally discharged these obligations *'without any sort of detailed intervention on a house by house basis [meaning that] it hasn't changed their business model fundamentally' (Energy Efficiency Expert – A 7)*. Therefore, the obligations neither encourage nor obligate the Utilities to fundamentally change their business model, enabling them to continue to operate as normal, where their revenue is coupled with the sale of energy units normally sourced from fossil fuels. Additionally, the obligations have served to legitimize the EUCo model as the UK government has designed these flagship, low-carbon energy policies *around* the Energy Utilities' business

[45] If an increase in operational scale continues unabated, the company may suffer from the diseconomies of scale (e.g. duplication of effort, increase internal communication costs etc)
[46] Later in this sub-section we provide an example relating to investment from financial institutions to help illustrate this

model, reflecting the government's belief that the EUCo model forms part of the solution to decarbonising the UK energy system, as opposed to part of the problem.

The energy company obligations have therefore enabled the Energy Utilities to operate their business as usual and thus retain their current levels of political power and wealth in the UK, continuing to afford them considerable influence over regulatory developments. A number of leading academics have explained that incumbent companies, such as the Energy Utilities, tend to wield their political power to actively shape the regulatory landscape to suit their needs, normally via such means as political lobbying (Wüstenhagen and Boehnke, 2008, Unruh, 2000, Mitchell, 2012, Gkiousou, 2011, Murmann, 2003, Stenzel and Frenzel, 2008, Hekkert et al., 2007) and by seconding members of their companies to the Department of Energy & Climate Change (Mitchell, 2012). Although our investigation did not reveal specific empirical evidence to indicate that the Energy Utilities have actively shaped CERT, CESP and ECO in such a way that benefits their cause, we find that a number of the large Energy Utilities have responded to consultations on these obligations in an effort to shape their development. For example, both British Gas and Scottish & Southern Energy responded to DECC's Energy Company Obligation and Green Deal consultation, with a specific set of recommendations (Centrica, 2012, SSE, 2012). Consequently, it is possible that the influence of the Energy Utilities on the design of the new Energy Company Obligation (DECC, 2011f) helped to ensure that the policy continues to place no obligation on the Utilities to fundamentally alter their business model so that they are incentivised to satisfy their customers' energy needs sustainably (Section 6.2.4.8), bringing us back to the beginning of the positive feedback loop (Figure 7.3).

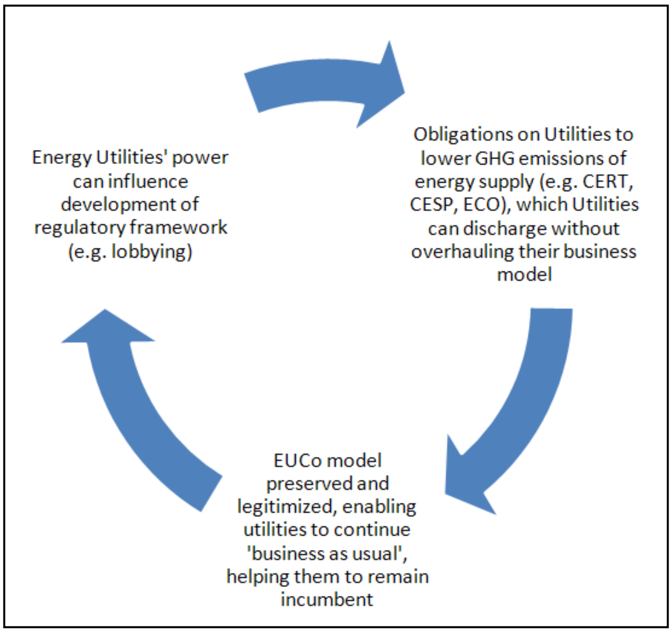

Figure 7.3 Positive feedback loop between Energy Utility population and UK regulatory framework

The dominance of the Energy Utility population has also had an important bearing on the evolution of the ESCo population. Some of the positive feedback mechanisms that have served to 'lock-in' the EUCo model by creating a more favourable selection environment for Utilities have in turn helped to 'lock-out' the ESCo model by cultivating a more hostile selection environment for ESCos. Even though ESCos and Energy Utilities operate in the same selection environment, the two perform differently because they are characteristically distinct. This helps to explain why in the UK energy system, the EUCo model has thrived and remained the incumbent, whilst the ESCo model has merely enjoyed niche applications. We now illustrate this dynamic with a couple of examples.

Earlier in this sub-section we identified how the increasing return *adaptive expectations* (North, 1990, Arthur, 1989) could help to explain the dominance of the utilities. This phenomenon was observed with respect to the Energy Utilities and the financial institutions. The Energy Utility market is mature, having existed in one form or another for most of the 20^{th} and 21^{st} centuries and in the form of the Big 6 since the late 1990s/early 2000s (Section 5). During this time the financial institutions (e.g. banks) have become increasingly familiar with the EUCo model and importantly with the risk-reward trade-off associated with investing in the Utilities' energy projects. However, they are not as familiar with the ESCo model, considering its niche status, meaning they are typically less willing to invest in ESCo projects as they are unfamiliar with the risk-reward trade-off (Section 7.2.2). Consequently, many financial institutions have favoured investment in Energy Utility projects because they are more comfortable with the associated risk-reward trade-off that than with ESCo projects.

This has consequently stunted the growth of the ESCo market because some ESCos, particularly with the decline of capital grant schemes, have been unable to obtain the necessary upfront capital to successfully deliver and complete energy service contracts. Doing so would help to raise the profile of the ESCo model and in turn help to alert financial institutions to the investment opportunity the ESCo model represents. However, the lack of finance available to ESCos has limited the number of delivered energy service contracts delivered in the UK so far and has in turn limited the financial institutions' exposure to ESCos, thus constraining their awareness and understanding of the ESCo model. The effect has been that many of these institutions have remained sceptical about investing in ESCos and have continued to favour investment in the Energy Utilities' projects, bringing us to the beginning of the feedback loop. Figure 7.4 illustrates these positive feedbacks, with the feedbacks locking-in the EUCo model on the right and the feedback locking-out the ESCo model on the left.

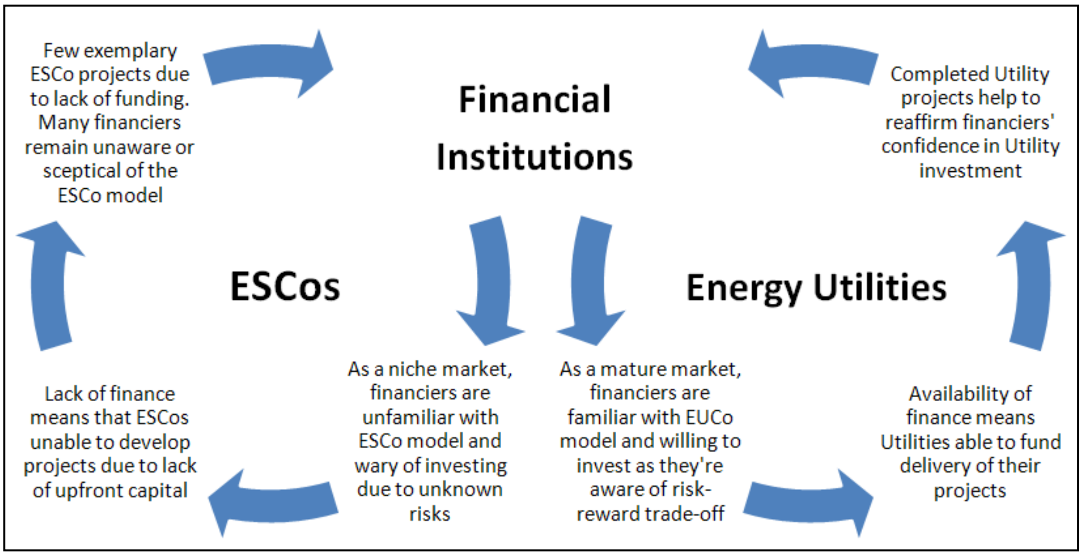

Figure 7.4 Co-evolution of ESCo and Energy Utility populations, focusing on financial institutional arrangements

This process can however work in reverse for ESCos. As illustrated in Section 6.1.4.1, awareness of the ESCo model has increased within the financial community over the past few years as more energy service contracts have been provided, thus helping to increase the availability of finance for ESCos:

> *'One of the initial barriers was the financial community catching up and recognising it as a viable business model [now] I think there are people looking to invest in ESCos' (B 30)*

As ESCos have found funding easier to come by they have encountered fewer barriers to delivering energy service contracts, helping to increase the number of contracts being delivered. This in turn has helped to raise the profile of the ESCo model in the financial community and again improve their prospects of securing finance, helping the ESCo model to gain momentum. This could serve to channel funds away from the Energy Utility population in the future and potentially adversely affect the development of large-scale, centralised generation projects.

Another example of how lock-in of the EUCo model has adversely influenced the prospects of the ESCo model can be illustrated by the case of the British Electricity Trading and Transmission Arrangements (BETTA) (Section 5.3). These arrangements were introduced in 2005 to foster competition in the wholesale electricity market and help to balance electricity supply and demand. BETTA is designed to support large-scale, centralised, predictable fossil-fuelled and nuclear generation (which forms the bedrock of the EUCo business model) to ensure sufficient energy capacity is delivered at low cost, as opposed to intermittent, small-scale, decentralised generation (Mitchell, 2008, Woodman and Baker, 2008), as frequently practiced by ESCos providing ESCs.

The manner in which BETTA does not support ESCos providing ESCs can be illustrated by the case of Thameswey Energy (Section 6.2.1.7), where due to high costs associated with joining the 'electricity pool' (e.g. connectivity) meant that Thameswey made the decision to opt out of joining it. Opting out of the electricity pool has in some respects reduced their overheads compared to other companies who are members of the pool, helping Thameswey to offer a competitive price for electricity to its customers via private wire (Section 6.2.1.7). However, the trade-off is that Thameswey has to adhere to the terms of the electricity licence exemptions, which have restricted the scale of its generation, distribution and supply operations (Section 6.2.1.7). Furthermore, by not being party to this pool, Thameswey has had to cover the substantial capital costs of a installing and managing a private wire network in order to supply electricity to its customers. By opting out of the pool, the size of Thameswey's customer base is also limited by the size of its private wire network. This example illustrates how BETTA limits ESCos' economies of scale, thus constraining their profit margin and in turn limiting growth of the ESCo market. This can in turn mean the ESCo community does not wield sufficient power to alter these arrangements in their favour.

Conversely, BETTA does not place the same restrictions on the scale of licensed electricity companies' operations of Energy Utilities and as a member of the pool they also have access to a much larger customer base than private wire electricity suppliers (e.g. Thameswey). This means they can enjoy stronger economies of scale and thus, lower transactions costs per kWh of energy sold, which helps to strengthen their profit margin. Consequently, we concur with Mitchell (2008) that BETTA has served to 'maintain the status quo' (p.145) by fortifying the dominance of the Energy Utilities. In turn, the Utilities have had the opportunity to wield this power to influence market developments and preserve these market rules in a bid to ensure their business model remains profitable. We present these positive feedback mechanisms in Figure 7.5. Here the feedback locking-in the EUCo model is presented on the right and the feedback locking-out the ESCo model is on the left.

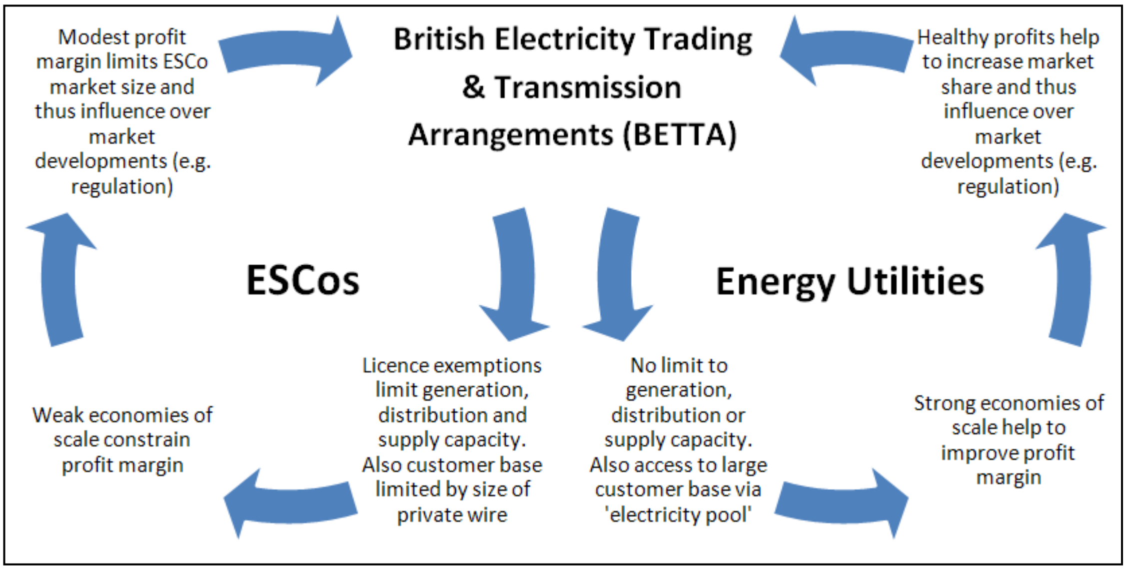

Figure 7.5 Co-evolution of ESCo and Energy Utility populations, focusing on electricity market institutional arrangements

For a relationship to be co-evolutionary, the two populations must causally influence one another's evolution (Murmann, 2003, Norgaard, 1994, Nitecki, 1983). So far we have predominantly illustrated how the Energy Utility population has co-evolved with other dimensions of the UK energy system (particularly institutions) and emphasised how this has had an impact upon the evolution of the ESCo population. As a result, we now examine how the emergence of the ESCo model in the UK has influenced the evolution of the Energy Utilities.

The emergence of the ESCo market has had the effect of triggering variation in the traditionally homogenous Energy Utility population, as we have observed many of the Utilities diversifying their operations to include energy service contracting (Sections 6.1.5.3 & 6.2.4), despite the continued profitability of the EUCo model (Consumer Focus, 2012). Five of the six major Energy Utilities were found to have recently delivered demand and/or supply side energy service contracts to their customers, with 3 of the Utilities offering both demand and supply side energy services. For example, EDF has recently signed an EPC contract with the supermarket Morrisons, guaranteeing £1 million worth of energy savings per year across its stores (EDF, 2011). EDF also currently hold a 34% stake in Dalkia, one of the world's leading providers of energy supply contracts for heat provision. Energy Utility X has also made great strides to develop its energy service contracting capabilities by recruiting energy service experts and acquiring both ESCos and specialist energy solutions firms (Section 6.2.4).

The Energy Utility X case study helps to illustrate the reasons why some Energy Utilities have exhibited variation by adopting aspects of the ESCo model. For instance, they regarded energy service contracting as an effective means of adding value to their service propositions, which could help them to gain competitive advantage over their competitors and grow their market share. Additionally, this move was also a reaction to the Utilities' acknowledgement that a period of accelerated energy system change was underway, which could conceivably pose a long-term threat to the viability of their traditional business model by transforming their selection environment. They highlighted developments such as the introduction of low-carbon regulation, changing customer demand, rising energy prices etc as indicators of this change. Adopting the ESCo model, at least in part, is evidence of the Utilities acting to restructure their business model and thus reposition their business in a bid to ensure they are able to operate successfully in this new selection environment, rather than being a victim of it. This strategy is embodied by a speech delivered by the CEO of Energy Utility X's parent organisation (Section 6.2.4.8):

> *'Within a few years, we want energy services to be just as big a part of [Energy Utility X] as energy supply…Indeed as I see it, the old utility business model is dead…It is my belief that the energy company model we know today will, within this decade, seem just as much a thing of the past as the Gas Light and Coke Company. And from where I stand, I can already see it happening' (Chief Executive of EUCo X's Parent Company)*

7.3 Chapter Summary

This chapter has served to highlight how the ESCo population has co-evolved with the key dimensions of the wider UK energy system. Importantly, it has demonstrated how co-evolutionary processes and in particular positive feedbacks have helped the EUCo model become and remain dominant in the UK, at the expense of the ESCo model. However, similar mechanisms are also responsible for improving the ESCo model's degree of fitness with its selection environment and thus, helping to explain why the ESCo model has begun to gain momentum in the UK in recent years. Consequently, the ESCo population is beginning to have a more pronounced effect on the evolution of the UK energy system, even to the extent where the incumbent Energy Utilities are beginning to restructure their business model to deliver energy service contracts. This indicates that the ESCo model may indeed play an important role in the transition to a sustainable UK energy system, which constitutes the focus of the following chapter.

8 Future evolution of the ESCo model in relation to a low-carbon transition of the UK energy system

In the previous chapter we outlined the past and present co-evolutionary relationship between the ESCo population and the wider UK energy system. We now examine how this relationship is likely to develop in the future by drawing upon insight from the ESCo population's past and present coevolutionary relationship with the energy system, as well as evidence from our empirical investigation and other research relating to emerging developments that will have an important influence on UK energy system change (e.g. regulatory changes, energy prices, climate change, economic development etc). This will in turn provide us with a stronger understanding of the role ESCos are likely to play in a transition to a sustainable UK energy system. For comparison, at the end of this chapter (Section 8.2.6), we discuss how this research's vision of how the UK energy system and ESCo market will evolve in the future compares with that provided by the *Transition Pathways* research project (Foxon, 2012). Subsequently, we identify a number of policy recommendations that could help the ESCo model to gain additional traction in the UK.

It is important to note that it is difficult to predict with any strong degree of certainty the role ESCos will play in a transition of the UK energy system, considering that a lot of uncertainty continues to surrounds the nature of this transition, as illustrated by the three potential transition pathways presented by (Foxon, 2012) and the six presented by DECC's 2050 pathways (DECC, 2010a). Uncertainty exists because of the potential for unforeseen perturbations in the energy system to take place, such as the emergence of radical technologies innovations, unexpected changes to regulation or major energy crises such as in Chernobyl and Fukishima, which can serve to dramatically change the direction of a socio-technical transition and consequently severely alter the selection environment for ESCos.

8.1 Expected changes to the ESCo population

A strong degree of variation is expected to continue to characterise the UK ESCo population due to the expectation amongst interviewees that the different ESCo variants introduced in Sections 6.1.5 & 6.2 are likely to continue to exist in the future. However, it is expected that some variants are likely to struggle more than others, in particular Community ESCos (Sections 6.1.5 & 6.2.2), who are likely to continue to find it difficult to secure the necessary financial resources to deliver energy service projects in light of the decline of capital grant schemes and the difficulty they have faced securing finance during a prolonged economic downturn. In contrast, it is expected that the Energy Service Providers will enjoy the greatest traction amongst all the ESCo variants as their personal wealth and strong connections with financial institutions means that securing funding presents a much less significant barrier when compared to the other ESCo variants. However, whilst it is expected that some ESCo variants are likely to proliferate more than others going forward, it is expected that there will continue to be a broad range of characteristically distinct organisations operating the ESCo model in the UK (e.g. Local Authorities, communities, energy equipment manufacturers), with a view to satisfy the needs of a variety of different customers.

The empirical investigation identified that a number of new entrants may indeed enter the UK ESCo market, such as supermarkets and foreign ESCos (e.g. the US's Amerseco). In relation to the former it was thought supermarkets (e.g. Tesco) could capitalise upon their experience of harnessing both efficiencies and the economies of scale, as well as their focus on branding as a tool to increase the uptake of their products and services to provide a competitive energy service contract package. However, it was expected that supermarkets would have to forge partnerships with more traditionally energy focused organisations to effectively develop and deliver energy service contracts. Focusing briefly on the entrance of foreign ESCos into the UK, it was considered that these organisations would be particularly attracted by the potential in the UK to deliver either ESCs or EPCs, when considering not only the nascent nature of the UK ESCo market at present but also consumers' high energy demand and the inefficiency of its antiquated building stock:

> *'There is a huge market there, far too big for the ESCos that exist today…You may start getting the US companies, the Amarescos of this world may come across and into this market. I know they are looking at the European market' (Senior ESCo Manager – H 1)*

It is possible however that instead of increasing variation, the influx of larger, wealthier and longer established international ESCos into the UK could serve to constrain variation. This is because, in a similar vein to Honeywell, they are likely to draw upon their experience of their energy service operations in other countries, to apply a 'tried and tested' formula for energy service contracting. Consequently, these new international ESCos are unlikely to engage in business model experimentation, which constitutes a key driver of organisational variation.

One emerging development that is likely to increase variation is the proliferation of organisational partnerships, as organisations look to pool their complementary resources to provide profitable energy service contracts, particularly with the introduction of the Green Deal (Section 8.2.2):

> *'There will probably be quite a lot of actors in the space and my vision would be that these actors work and engage with each other effectively and efficiently, and therefore bring projects to fruition'(Law Firm Partner - B 14)*

As characteristically distinct organisations join forces to deliver energy service contracts, innovative ESCo models are expected to emerge to suit their contrasting organisational structures and objectives. Another important driver of variation in the ESCo population is the imperfect replication of business models (Murmann, 2003), either due to accident, experiment or design (Hodgson and Knudsen, 2004b). Conversely, variation will be moderated as some ESCos fall victim to selection pressures, which means they are consequently disbanded, as has happened previously (e.g. London ESCo, Caithness Heat & Power): *'I think some ESCos will do very well and some ESCos will disappear without trace' (Head of Environment for Council - A 2)*. Variant failures, coupled with learning effects (Section 6.3) may lead to one or more ESCo variants becoming dominant, analogous with the concept of dominant technological designs (Nelson and Winter, 1982):

> *'You get innovation in a sector where out of necessity from a certain set of drivers, you get this ballooning and refining [of business models]…[The market] is starting to consolidate' (Senior ESCo Manager - A 6)*

Additionally, variation is likely to be moderated by the introduction of standardized energy service contracts, as outlined in Article 14 of the proposed European Energy Efficiency Directive (EC, 2011). A growing awareness and understanding of the ESCo model via the completion of more energy service contracts, alongside the emergence of more exemplary cases of ESCo operations will also help to make replication more accurate, in turn limiting the incidence of replicative imperfections of the ESCo model, i.e. copying errors from generation to generation of ESCos. Taking into account the various factors encouraging and inhibiting variation in the ESCo population we expect the degree of variation in the population to remain broadly similar and thus, the *type* of influence this population exerts on the wider UK energy system to remain broadly similar to that at present. However, the co-evolutionary relationship between the ESCo population and the different dimensions of the UK energy system is likely to change to some degree in the future, which we now explore in greater detail.

8.2 Future Coevolutionary Interactions

In this sub-section we examine how the co-evolutionary relationship between the ESCo population and the various dimensions of the UK energy system is likely to change in the future. We do so by drawing upon insight from the ESCo population's past and present coevolutionary relationship with the UK energy system, as well as evidence from our empirical investigation and other information relating to emerging developments that will have an important influence on UK energy system change.

As Section 7.2 illustrated, the ESCo population has had some causal influence on the UK energy system, however this has been relatively minor to date. Broadly the empirical investigation indicated that the ESCo population would grow as their selection environment gradually improved (Sections 6.1.4.3 & 6.2). As such, it was expected that their influence on the various dimensions of the UK energy system would increase, with some interviewees indicating that the ESCo population could indeed have a profound effect on a UK low-carbon transition:

> *'If it takes off, then…energy performance contracting, the flexibility it offers and the fact that it delivers guarantees of savings will fundamentally change the market' (Senior EUCo Manager - B 28)*

However, some interviewees were less convinced that the ESCo population would have a major impact on the UK energy system in the future, due to the persistence of key barriers:

> *'I think at the moment there's no killer reason why [the ESCo model] should take off now. I don't think ESCos are going to suddenly become really important now, I think the factors that have inhibited them will continue to apply' (Think Tank Economist - B 29)*

Taking into account the variety of interviewee responses relating to expected future UK energy system and ESCo market developments we now discuss how the co-evolutionary relationship between the ESCo population and various key dimensions of the UK energy system is likely to change in the future.

8.2.1 ESCos and Ecosystems

Firstly, we examine how the ESCo business model has coevolved with ecosystems. This is largely mediated through the effects ecosystem changes have on institutions and other dimensions of the UK energy system, as illustrated below.

It is expected that the triumvirate of energy challenges facing the UK at present (i.e. climate change, energy insecurity, affordability of energy) will persist and potentially worsen, over the coming years (Section 1.3). Consequently, ecosystem pressures are likely to continue to have an extremely important influence on the evolution of the various dimensions of the UK energy system. For instance, the regulatory framework (as part of the institutional dimension) is likely to continue to be characterized by legislation and government policies that promote sustainable energy solutions (Section 8.2.2). Another example might be the way that technologies and infrastructure research and development (as part of the technological dimension) are conducted with a view to develop technological innovations that help consumers to satisfy their energy needs in a sustainable manner (e.g. low-carbon generation, building controls etc) (Section 8.2.3). Finally, user practices may also alter as the effects of these challenges are felt and consumers seek to make their own contribution to addressing these issues (Section 8.2.4). Therefore, it is expected that ecosystem developments will help to cultivate a selection environment that is broadly supportive of ESCo operations over the coming years.

If the ESCo model does enjoy greater uptake, partly at the hands of ecosystem crises, then the ESCo population will in return gradually exert a larger influence on ecosystem change by reducing consumers' reliance on fossil fuels to satisfy their energy needs. However, considering that these ecosystem challenges are global in scale, application of the ESCo model in the UK going forward is unlikely to have any significant impact upon ecosystem change (Section 7.2.1). To achieve such a change will require a suite of compatible and effective energy solutions, applied at an international scale. However, the application of the ESCo model could constitute an important part of this strategy to protect the environment.

8.2.2 ESCos and Institutions

Secondly, we examine how emerging regulatory developments are likely to influence the evolution of the ESCo population and vice versa.

As outlined in Section 6.1.4.3 changes to the regulatory framework can be foreseen months or even years prior to these being enacted, considering the typically lengthy process in the UK for developing and passing legislation. The imminent introduction of the Green Deal was highlighted as an important emerging driver to ESCo operation (Section 6.1.4.3). Despite some important flaws, which are likely to limit its impact, the Green Deal is expected to improve the ESCos' selection environment by helping to open up the residential market to energy service contracting. Specifically it will help to achieve this by: (1) making finance more freely available to implement domestic energy service contracts; (2) enabling the cost of the sustainable energy supply and/or demand management measures to be repaid via the householders' energy bill and (3) ensuring that the debt remains with the property not the householder. The ESCo case studies teach us that the Green Deal is likely to improve the prospects of selection for all the various different ESCo variants.

The Green Deal is expected to increase the degree of variation the ESCo population exhibits as the opening up of the residential market will present a business opportunity that encourages new entrants into the ESCo market, who perceive themselves to be strongly suited to providing large groups of households with energy service contracts in order to capture the economies of scale (e.g. Local Authorities, Registered Social Landlords etc) '*Partnerships and* *collaborations will be absolutely critical' (Senior ESCo Manager - A 10)* to enable these organisations to access the necessary resources to act as Green Deal Providers (Section 8.2.2). One interviewee explained that Local Authority 'Arm's Length' ESCos could play an important role as an interface between large Energy Utilities and local-level organisations to facilitate Green Deals:

> *'The Green Deal [will help] the sort of companies we represent take off because we operate in the interface between the large multinational, such as your British Gas, Scottish Power etc and the community groups and civil society, district councils, housing associations etc… [For] multi-nationals to get down to that level is really difficult and yet community groups and civil society [need help] to effectively reach into multi-nationals [and access their resources' (Local Authority ESCo Manager – A 1)*

The Green Deal is also likely to impact upon retention of the ESCo model, considering that a Green Deal Code of Practice will be introduced which 'defines the minimum standards required of those participating in the Green Deal whether as Green Deal Providers, assessors, or installers' (DECC, 2011c p.3). These standards, as well as the increase in awareness and understanding of the ESCo model the Green Deal is likely to generate, will help to make replication of the ESCo model both easier and more accurate[47].

Section 6.1.4.3 also identified how other emerging regulation is likely to support the uptake of the ESCo model, such as the introduction of the Green Investment Bank, the Electricity Market Reform and the European Energy Efficiency Directive. The latter, rather like the Green Deal, is also likely to improve retention of the ESCo model as it stipulates that member states will need to make provision for energy service contract templates that could be easily adopted by new entrants to the ESCo market. Another important development will be if national government continues to promote its localism agenda (Section 6.1.4.1), which will help to improve the selection environment for the Local Authority and Community owned and led ESCos by providing new rights and powers for communities and local government to enable them to engage in activities outside their traditional remit.

It is unclear from the empirical investigation how ESCos are likely to influence the formal institutional landscape in the future and at what level they might exert change (e.g. local, regional, national, international). However, if the institutional landscape continues to be supportive of ESCo activity (Section 6.1.4.1) then the ESCo population can be expected to grow, thus exerting a greater influence on institutional change in the UK.

[47] As we outlined in Section 6.1.4.3 a Green Deal Providers take responsibility for identifying, designing, installing, financing and servicing energy solutions, essentially acting as an ESCo

8.2.3 ESCos and Technology

Thirdly, we examine how the ESCo population is likely to co-evolve with energy technologies in the future.

As highlighted in Section 6.1.4.2, one of the key barriers to ESCos in the UK at present is the high cost of existing sustainable energy technologies, however even though certainty in this development remains low, the costs of these technologies in the UK ‘are expected to fall over time as supply chains develop, technical challenges are overcome, and the cost of capital reduces with lower risk’ (DECC, 2011h p.6). The latter here is an effect of *adaptive expectations,* where the articulation of visions and expectations associated with technological innovations reduces consumers’ scepticism of innovative energy technologies (Arthur, 1989) (Section 2.3.3.1). The effect on ESCos would be a reduction in their energy service contracting costs, thus improving the cost-effectiveness of their business.

As Section 7.2.3 illustrates, technological innovations have played an important role in improving the cost-effectiveness of energy service contracts, as illustrated by the impact of domestic and commercial LED lighting on ESCos delivering EPCs. It is difficult to predict what types of technological innovation will emerge in the future but if the trend of increasing investment in sustainable energy research and development (R & D) continues both in the UK and internationally (IEA, 2012a) (Figure 8.1) then the introduction of new energy technologies or major advances in existing ones could help to improve the cost-effectiveness of energy conversion and control equipment, thus supporting wider uptake of the ESCo model.

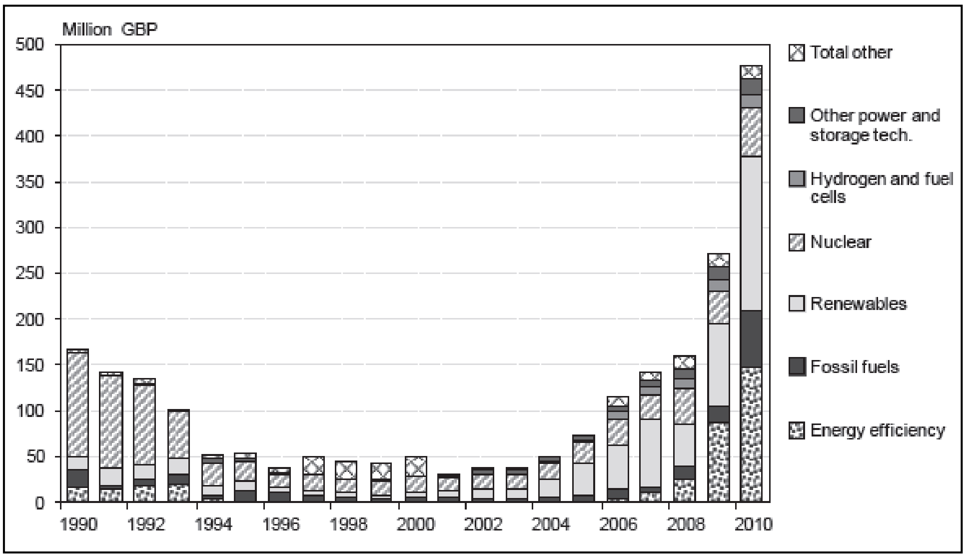

Figure 8.1 Government energy R&D expenditures 1990 to 2010 (IEA, 2012a)[48]

[48] The IEA have sourced data from the OECD (2011) and other countries

However, technological research and development may lead to a different set of technological innovations that could serve to reinforce the dominance of the EUCo model. For example, the emergence of carbon capture & storage (CCS) presents a means of storing the carbon emissions emitted from large-scale, centralised fossil fuel combustion, thus undermining the need to identify alternative lower carbon energy solutions. Another emerging technological innovation that could prove to undermine the prospects of the ESCo model gaining additional traction is the process of hydraulic fracturing or ‘fracking’, which has made vast reserves of shale gas available for extraction that were not accessible before. These reserves could be utilised in place of renewable sources of energy (Stevens, 2012).

Interviewees did not expect that the UK ESCo population would have a major direct influence on research and development agenda, which drives technological innovation, considering that most ESCos are not engaged in technological research and development. However, some energy technology companies, such as Honeywell, also provide energy service contracts and play an important role in shaping technological innovation in the UK. For instance, they are currently driving forward the development of SMART grids (Section 6.2.3.8). However, even those ESCos who focus on adopting rather than developing sustainable energy technologies are likely to have an important indirect influence on technological innovation. For instance, as the case studies of Honeywell and Thameswey help to demonstrate, the adoption of sustainable energy technologies as part of ESCos’ operations has helped to raise awareness and understanding of demand energy management or sustainable energy supply technologies, particularly with regards to the value they are capable of creating for customers and businesses. Going forward this could encourage greater investment in the research and development of these technologies, with a view to improve their cost-effectiveness via innovation. In turn, this is likely to make these technologies even more attractive to ESCos and other companies, bringing us to the beginning of the positive feedback loop (Figure 8.2).

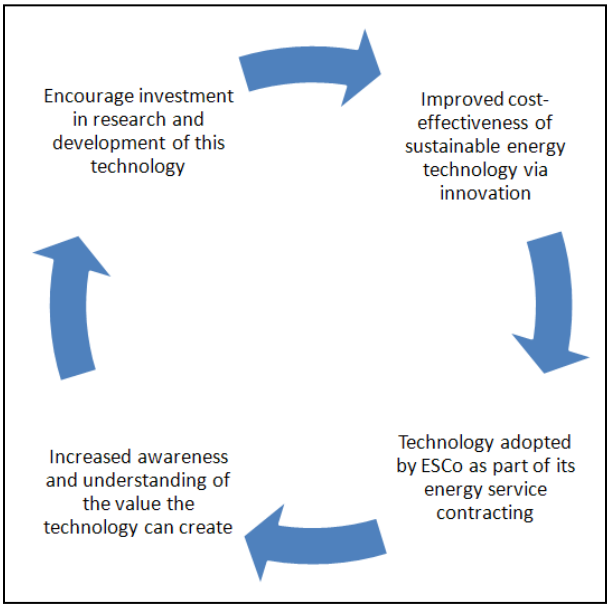

Figure 8.2 An emerging positive feedback loop between ESCo population and energy technologies

8.2.4 ESCos and User Practices

Fourthly, we discuss how the UK ESCo population and energy consumers' user practices are likely to co-evolve in the future.

The empirical investigation did not identify any significant emerging developments to the user practices dimension i.e. the habits, behaviours and routines of individuals or groups associated with the fulfilment of their energy needs, other than a broad continuation of the key user practice trends identified in Section 7.2.4. For instance, UK energy prices are expected to remain high or even rise (DECC, 2011a), whilst the economic downturn is projected to continue for the foreseeable future (IMF, 2012). These developments are likely to ensure that there remains high demand amongst consumers for solutions capable of reducing their energy bills, such as energy service contracting. Another important development will be if UK energy consumers begin to personally experience the adverse effects of impending ecosystem crises, such as climate change (Jenkins et al., 2009), which may encourage them to adopt sustainable consumption practices to help mitigate these effects. It is important to note however that economic, energy price and climate change projections incorporate a significant degree of uncertainty and we also have a poor understanding of how these developments might influence energy related user practices in the future.

In relation to how the ESCo model is likely to influence user practices, it is expected that the positive feedback relating to a growing customer awareness and understanding of the ESCo model, as highlighted in Section 7.2.4 and Figure 7.2, will persist considering that it is a virtuous cycle. This will have the effect of improving the prospects of the ESCo model.

Energy user practices in the UK today are characterised by the EUCo model's supplier-consumer relationship, where the customer is detached from the processes of energy generation, distribution and supply: *'[When] we turn the light on, we have no idea how it gets there. There is no connectivity whatsoever' (Local Authority Chief Executive – T 1)*. The Thameswey and MOZES case studies help to illustrate how the proliferation of Local Authority 'Arm's Length' and/or Community ESCos in the future, driven in part by the government's localism agenda (Section 8.2.2), could help to *'reconnect what happens locally'* (*Local Authority Chief Executive – T 1*), via locally managed decentralised energy generation, distribution and supply. This could help to encourage consumers to think 'beyond the meter', and trigger a shift away from the traditional mind-set where consumers consider the fulfilment of their energy needs to be the responsibility of multi-national private sector corporations, towards one where consumers consider this to be a fundamentally local undertaking, which requires a combination of grass-roots activity and local resources to achieve (Section 7.2.4):

> *'A shift in mind-set from customers individually saying they want [X amount of] energy, which the energy companies provide, which is the [current] model, to one where communities decide how they're going to decarbonise [potentially via] ESCos' (Think Tank Economist - B 29)*

8.2.5 Competition between ESCos and Energy Utilities

Finally, we examine how the UK ESCo and Energy Utility populations are likely to coevolve in the future.

There is evidence to suggest from our empirical investigation, particularly the Energy Utility X case study, that the Energy Utilities are looking to expand their energy service contracting operations, largely as a result of their belief that their traditional EUCo model is likely to struggle in the emerging selection environment, which is currently being reshaped by a range of developments across the various different system dimensions (e.g. ecosystem, institutions etc) (Sections 6.1.5.3 & 6.2.4). A move from these incumbent firms into the ESCo market would send a strong signal to other energy actors (e.g. financial institutions, energy technology firms, fuel suppliers etc), emphasising not only that the Energy Utilities' believe their own business model could face an uncertain future but that the ESCo model may be better positioned to take advantage of this new selection environment. In turn this is likely to influence these actors' own visions of the future, particularly about how the ESCo and EUCo models will perform, which may consequently alter these actors' strategies going forward. If these actors begin to act in accordance with the incumbent Utilities' expectations and start to make efforts to accommodate the ESCo model, then the Utilities are likely to observe changes to their selection environment that are considered to favour the ESCo model. Consequently, the

Utilities would observe their own predictions coming true, helping to reinforce their belief that it is necessary to diversify their business to incorporate aspects of the ESCo model. This process could represent a form of a self-fulfilling prophecy and thus a positive feedback mechanism, which could help the ESCo model to proliferate in the future (Figure 8.3).

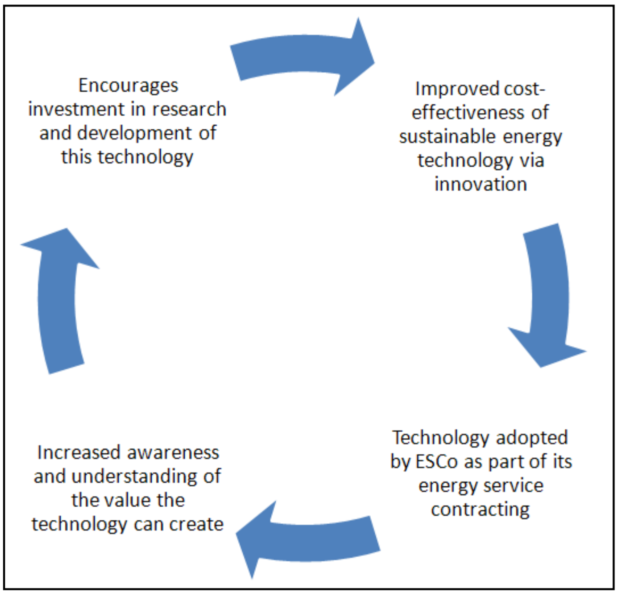

Figure 8.3 Positive feedback loop involving Energy Utility movement into the ESCo market

Despite the evidence that the UK Energy Utilities have begun operating the ESCo model, it is important to note that they continue to focus the majority of their efforts on operating the EUCo model. Consequently, it is difficult to ascertain how sweeping this transition to the ESCo model may be going forward, considering that they continue to generate extremely healthy profits from operating the EUCo model (Consumer Focus, 2012). This presents a persuasive argument to shareholders and board members alike to continue operating the EUCo model:

> *'People are sitting there making money on those contracts…The innovation models say you should innovate and change but the reality of life is that people don't most of the time because [they] are making money' (Senior Investment Manager – A5)*

It is possible that the Energy Utilities are merely 'testing the waters' of the UK ESCo market, to ensure they have a sufficiently large presence in the ESCo market to be able to scale-up their operations to take advantage of the ESCo market in case their selection environment radically changes and their traditional EUCo model becomes significantly less profitability. However, by continuing to operate the EUCo model, the Utilities are able to fall back on their traditional business model if the selection environment remains broadly the same: *'they are all dabbling but dabbling is probably the right word'* (*Energy Investment Company Manager* – A5). If the Energy Utilities continue to focus the majority of their efforts on operating the EUCo model, i.e. sale of units of gas and electricity as commodities, then this will adversely affect the future of the ESCo market for similar reasons to those identified in Section 7.2.5, where the Energy Utilities continue to advertently or inadvertently shape dimensions of the UK energy system to favour their operations.

It is also important to note however that even if the Energy Utilities, such as Energy Utility X, maintain their current momentum towards the ESCo model, it is expected that this transition would take a long period of time to complete: *'It is going to take some time before we get to that place and… [it's a] journey I think we are already on' (Energy Utility Manager – B27/X1)*

8.2.6 Summary ESCo Model's Role in a Low-carbon UK Energy System Transition

Drawing on the insight generated from Sections 7 and 8, we now seek to address research question 5, which relates to how the ESCo model is likely to influence the nature of a UK low-carbon transition (Section 1.5). It is important to reiterate here that we make these predictions with a low degree of certainty taking into account the complexity of the UK energy system and the potential for small perturbations to result in considerable changes, which could serve to undermine the prospects of the ESCo model. Furthermore, a multitude of significant barriers still exist, which continue to limit ESCo operation to niche deployment in the UK (Sections 6.1.4.2 & 6.2) and these may persist for a number of years to come.

Taking into account the past, present and likely future coevolutionary relationship between the ESCo population and the various dimensions of the UK energy system we anticipate that the ESCo model's degree of fitness with its selection environment over the coming years will gradually improve. This development can largely be attributed to developments beyond the control of ESCos, such as climate change, economic downturn, rising energy prices, depleting fossil fuel resources etc. However, by applying our coevolutionary analytical framework we have been able to identify a number of positive feedbacks mechanisms that have meant that application of the ESCo model has in fact helped to create a more favourable selection environment for ESCos. Taking these factors into account, steady but moderate growth in the ESCo market is expected over the coming years, as too is an increase in their causal influence on the evolution of the wider UK energy system. Therefore, ESCos are expected to gradually exert a stronger influence on a transition to an alternative UK energy system state. We now summarise how the ESCo population is likely to shape the various different dimensions of the UK energy system going forward.

Beginning with its influence on *technology and infrastructure* we expect a growth in ESCos providing ESCs to encourage a shift away from centralised energy generation via fossil fuels towards decentralised generation via renewable energy sources. Therefore, we expect to see a greater number of district energy generation and supply systems, as well as micro-generation systems to be deployed over the coming years by ESCos. Furthermore, a growth in ESCos delivering EPCs mean we are likely to observe an improvement in the energy efficiency of our residential and commercial building stock. The greater deployment of these sustainable energy technologies by ESCos could also influence the direction of energy technology research and development. This could have the effect of improving the cost-effectiveness of low-carbon energy technologies and in turn, the cost-effectiveness of energy service contracting (Section 8.2.3).

We expect a greater uptake of the ESCo model to influence *user practices* in two key ways. The first is the behavioural constraints imposed upon consumers as part of energy service contracts, particularly with EPCs. Here the consumer has to tailor their user practices to a set of pre-determined behaviours regarding the duration and intensity of their energy consumption on a day-to-day basis, as outlined in the contract. The second is a less direct influence and refers to a shift in the consumer's mind-set relating to their culturally embedded beliefs about how we approach the challenge of satisfying our energy needs. For instance, as outlined in Section 8.2.4, this may involve consumers coming to regard the generation, distribution and supply of energy as a fundamentally local undertaking. This focus may encourage a greater connectivity between national and local energy decision making, which would involve actors at various scales (national, regional, local) operating in partnership with one another.

The ESCo model has to date had only a minor influence on the UK's formal energy *institutions*, barring the obvious similarities between the structure of energy service contracts and the Green Deal. However, a greater uptake of the ESCo model in the UK will place greater direct or indirect pressure on UK government to make adjustments to the regulatory framework so that it is more supportive of ESCo operation, as illustrated by Thameswey Energy's role in the deregulation of the law prohibiting Local Authorities to sell electricity (Section 6.2.1.7).

It is possible that the ESCo model could threaten the dominance of the EUCo model in the future, which represents the *incumbent business model* in the UK energy system at present. This is evident in the way that the Big 6 Energy Utilities have begun to diversify their operations to include energy service contracting in recent years. If this trend continues, which remains uncertain (Section 8.2.5), then we may observe an abatement in EUCo operations at the expense of a proliferation of ESCo operations. It is however quite likely that the EUCo model will remain dominant over the coming years as the Energy Utilities continue to operate this as their core business model, due to its continued profitability, thus making only a partial transition from EUCo to ESCo model (Section 8.2.5). The trend for other organisations, such as

Equipment Manufacturers, Property Developers, Local Authorities and Facilities Management Companies, to alter their traditional business model to incorporate energy service contracting is also expected to continue in the future (Sections 7.1 & 8.1).

Finally, and in some respects most importantly, we outline the expected influence of ESCos on the *ecosystem*, which can help us to gauge the extent to which the ESCo model will help reduce the environmental impact of fulfilling our energy needs and help drive a transition to an environmentally sustainable energy system. Although the remit of this research did not include a quantitative examination of the environmental impact of energy service contracts compared to Energy Utility offerings, both Section 7.2.1, as well as the ESCo case studies (Section 6.2) illustrated how ESCos have helped to reduce consumers' reliance on fossil fuels to date, which has helped to reduce the adverse environmental effects associated with fossil fuel extraction (e.g. destruction of habitat) and combustion (e.g. carbon emissions, air pollution etc). As Section 8.2.1 outlined, a greater role for ESCos is likely to continue to help alleviate key ecosystem challenges associated with fossil fuel consumption, such as climate change, however in the context of these crises being global, UK ESCo activity will not make a tangible difference alone.

8.3 Comparison of Results with Transition Pathways

Having summarised the role we expect the ESCo model to play in a transition to a sustainable energy system, we now compare this with the role the Transition Pathways project has reserved for ESCos (Foxon, 2012), undertaken by a consortium of scholars across different universities in the UK. The project outlines three different pathways the UK energy system could potentially take towards a low carbon electricity future by 2050[49]. In a similar fashion to this project, these scenarios have partly been constructed by drawing upon co-evolutionary theory. We select the Transition Pathways research for comparison, as these pathways provide more in-depth details relating to business model and institutional change than the DECC 2050 pathways referred to earlier in the chapter (DECC, 2010a). The pathways include:

- Market Rules – 'the continued dominance of the market-led logic for the governance of UK energy systems' (p.7)
- Central Coordination – 'envisions the dominance of the government-led logic [where] the UK government [takes] greater direct government involvement in the governance of UK energy systems' (p.9)

[49] The Transition Pathways consider only electricity, not the generation and supply of heat, which normally forms a core part of Energy Supply Contracts

- Thousand Flowers – ‘envisions the growing dominance of civil society in the governance of UK energy systems’ (p.10)

Examining the *Market Rules* pathway first, our results support the view presented by this scenario that private-sector actors are likely to continue to shape market developments in the UK energy system in the future. Furthermore, our results also support the view that the incumbent Energy Utilities are likely to remain dominant for a number of years to come. However, the *Market Rules* pathway makes no reference to the role of ESCos. In contrast, our results highlight how there is already a healthy ESCo market operating in the UK at present, predominantly consisting of private-sector organisations. Consequently, we expect that if the ‘market-led’ logic remains dominant, then the ESCo model could gain significant traction, predominantly in the form of private-sector Energy Service Providers. Additionally, whilst our results support the notion that the Utilities are likely to remain dominant, they indicate that it is possible they will do so by operating the ESCo model alongside their traditional EUCo model. This would mean the provision of Energy Supply and Performance contracts alongside their traditional supply of electricity units via centralised generation and distribution.

The *Central Coordination* pathway, in a similar way to the *Market Rules* pathway, does not explicitly reserve a role for ESCos. Instead the focus here is on the governance of national government, where large energy companies constitute the vehicles responsible for delivering government inspired energy projects. In light of our research findings, we would add to this scenario the potentially important role Local Authority ‘Arm’s Length’ ESCos could play in an energy system dominated by a government-led logic. Here national and local government may well establish these ESCos as vehicles to deliver their own policy objectives. This is because compared to private-sector energy companies, they would have greater control over LA owned ESCos. Furthermore, they could recycle the profits they generate to help fund other policy-inspired projects.

The *Thousand Flowers* scenario envisions the most important role for ESCos out of the three different pathways. This pathway constitutes a scenario whereby citizens, i.e. individuals and local communities, take the leading role in relation to how the UK’s local and national energy systems operate. Here central government plays a key role in facilitating this transition e.g. community/local investment, feed-in-tariffs etc. Of relevance to this research is the emphasis on the ‘move to the ESCo business model’ (p.8), whereby communities look to adopt the model, as well as Energy Utilities, who establish ESCo-type business units whose primary focus would be on implementing both domestic and commercial decentralised generation technologies as part of Energy Supply Contracts:

> 'Whilst some large energy companies continue to focus only on the centralised generation business model, with continuing large investments in coal CCS and nuclear power, others diversify by setting up ESCO-type business units to provide an alternative focus for the company's growth' (p.10)

Broadly, these developments align very closely with our own empirically grounded expectations. For instance, the pathway envisages that a range of new entrants will enter the UK ESCo market, which is in line with our own observations in Sections 7.1 & 8.1. Additionally, the range of ESCo variants outlined is also reflected in our own research (Section 6.1.5), including Community and Energy Utility ESCo variants. However, little mention is made of the role Local Authority ESCos might play. The characteristics of the Energy Utility ESCos envisaged by the pathway are very similar to those identified in Section 6.1.5.3, where the Energy Utilities establish separate business units or divisions for energy service contracting. Furthermore, the pathway emphasises how ESCos will play an important role in driving forward the development of decentralised generation, as observed in Section 7.2.3.

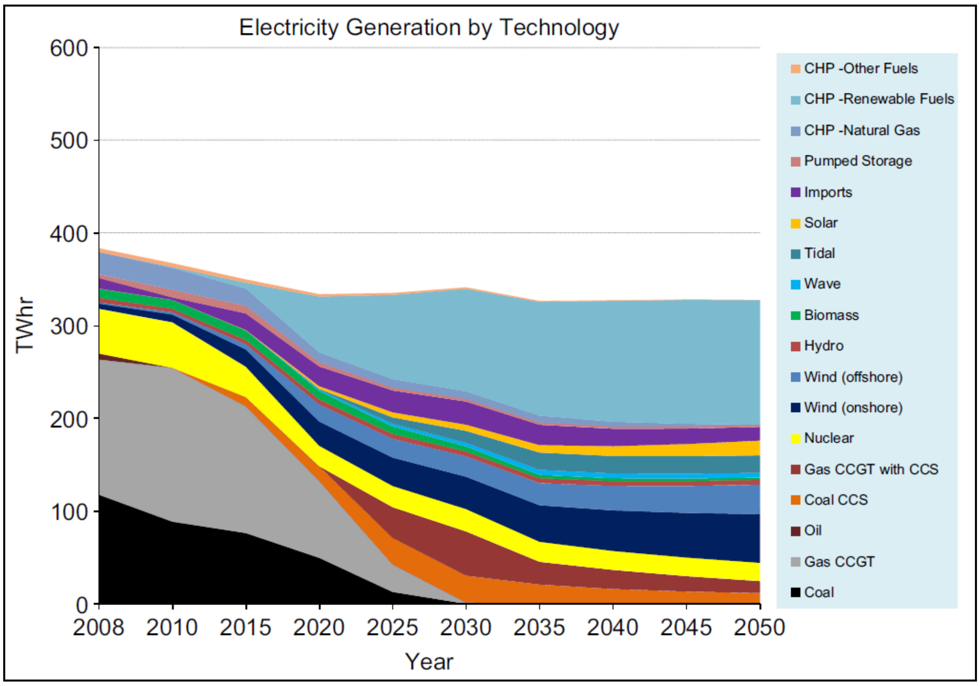

Figure 8.4 Electricity generation mix in the *Thousand Flowers* pathway (Foxon, 2012)

The *Thousand Flowers* pathway projects that non-civil society, private sector led ESCos are likely to work closely with LAs, housing associations and community groups, particularly in light of the introduction of increasingly strong obligations on energy companies, who see such partnerships as the most effective means of discharging these obligations. Again this aligns closely with this research's findings, where many new actor partnerships are expected to emerge in the future as a means of pooling resources and capabilities to enable organisations to deliver energy service contracts, particularly in reaction to the Green Deal (Section 8.1).

In a similar vein to this research, the *Thousand Flowers* pathway indicates that positive feedback mechanisms are likely play an important role in the development of this pathway and the rise of ESCos. Although the details of these are not provided, it is envisaged that these will exist between entrepreneurial activities, advocacy coalitions, early adoption of technologies and mobilization of financial and human resources (Hekkert et al., 2007).

Finally, a number of potential barriers to this pathway are identified, which are also reflected in our work. These include the high costs associated with the deployment of decentralised energy systems and energy efficiency measures (Section 6.1.4.2) as well as the rebound effect, where consumers use some of the savings on their energy bills to increase service demand levels (Sections 2.6.4 & 6.1.3). One important future barrier our investigation doesn't highlight is the potential backlash against local energy solutions considering the need to 'keep the lights on', which might be best served by large-scale, centralised energy solutions.

8.4 Policy recommendations

In both Sections 7.2.2 & 8.2.2 we illustrated the strong influence the regulatory framework has and is likely to continue to have on the uptake of the ESCo model. Consequently, we now take the opportunity to identify a number of changes to the UK's regulatory framework that could help to improve ESCos' selection environment and thus enable it to play a more substantive role in a low-carbon transition. These predominantly relate to addressing barriers identified in Section 6.1.4.2 and the various different ESCo case studies (Section 6.2).

8.4.1 Standardized Energy Service Contract Templates

Replication of energy service contracts for both EPCs and ESCs was regularly cited as a barrier to the proliferation of the ESCo model, particularly considering the bespoke nature of energy service contracting. We concur with Marino et al. (2011) and Sorrell (2007) that the uptake of the ESCo model could be improved by, such as in the US (Section 5.5.1):

> 'The standardisation of common core contractual provisions including clear frameworks, definitions, and measurement and verification standards (such as the International Performance Measurement & Verification Protocol)' (p.6195)

It is possible such standards may emerge if the energy service market becomes more heavily regulated, in a similar manner to the gas and electricity market under the governance Ofgem. They may also emerge as part of energy service contract procurement frameworks, such as

RE:FIT or be introduced by trade associations such as the Energy Services and Technology Association (ESTA) as examples of 'best practice'.

8.4.2 City-level GHG emissions Targets

The research supports the Committee on Climate Change's recommendation to introduce 'a statutory duty for local authorities to develop and implement low-carbon plans' (CCC, 2012b p.8) that translates into a high-level commitment on Local Authorities (LAs) to reduce their town or city's GHG emissions. This would require LAs to initiate and coordinate energy projects at the city-level that are capable of delivering the necessary carbon reductions to meet these targets, which could be undertaken via an Energy Service Provider or the council's own LA 'Arm's Length' ESCo. The author of this thesis has co-authored a paper that outlines how a LA might establish a Strategic Energy Body (SEB), responsible for coordinating and facilitating such sustainable energy projects to deliver such reductions (Bale et al., 2012). In this paper it is conceived that the council's own LA 'Arm's Length' ESCo would play an important role in implementing these projects and recycle profits generated by the schemes into the council's future energy projects.

This obligation could sit alongside a policy similar to the Danish Heat Law, which would provide LAs with the power to mandate owners of new and existing buildings connect to SEB inspired low-carbon energy schemes (DEA, 2005). This would offer the LA 'Arm's Length' ESCos the necessary powers to ensure that sufficient numbers of consumers were connected to their network to make the schemes financially viable.

8.4.3 Better Accommodate Decentralised Generation in BETTA

As Section 5.3 and the Thameswey case study (Section 6.2.1.7) served to highlight, the current electricity trading arrangements in the UK (i.e. BETTA) are not supportive of small-scale, decentralised energy generation, distribution and supply, particularly that which relies on intermittent sources of renewable energy. It is this form of electricity generation that ESCos providing ESCs typically engage in. Although we recognise the need to match supply with demand to avoid blackouts etc, we argue that in order to improve the fitness between BETTA and the ESCo model we would recommend the system is structured so that companies sourcing their electricity from intermittent (renewable) sources of energy are not penalised to the same extent, as they are now. This may be achieved via interventions in the pricing structures that artificially increase the value of renewable electricity (Mitchell, 2008).

It is also possible that changes to BETTA could improve ESCos' economies of scale. For example, relaxation of the constraints imposed by licence exemptions on the scale of generation, distribution and supply unlicensed organisations are able to engage in, could help unlicensed ESCos to operate at a larger scale and thus harness greater economies of scale. This would serve to reduce their transaction costs per kWh of electricity sold and consequently improve their profit margin. Alternatively, we would recommend that the system be re-structured so that smaller-scale electricity companies are not subjected to the same membership costs as larger scale companies, such is the high cost of connectivity to the grid.

8.4.4 Green Deal Recommendations

As outlined in Section 6.1.4.3, we find that contracts signed under the GD constitute a form of energy service contracting, i.e. the GD Provider covers the upfront costs of the low-carbon energy supply and/or energy efficiency measures and recoups these back over a number of years. Therefore, any measures that can be taken to increase the uptake of the GD we believe will translate into growth in the ESCo market. Therefore, we briefly outline a number of recommendations for the Green Deal (GD) that could help to encourage the uptake of the ESCo model.

Drawing on the Thameswey case study (Section 6.2.1.8) we suggest that because the GD is not mandatory it must be structured so that the householder enjoys an immediate saving on their energy bill that is considered large enough by the householder to off-set the time and effort they expend on contacting and engaging with a GD Provider, as well as the inconvenience and disruption caused by the installation of the energy measures. It is also important that householders are convinced that engaging with the GD constitutes an investment in their property, as opposed to the attachment of long-term debt to their home.

We argue that in order for the GD to be a success, the Energy Utilities will need to engage with the policy. This is because they already have a relationship with millions of residential energy consumers in the UK. Therefore, access to these homes is likely to be easier for them than for new entrants who do not currently possess such relationships. Furthermore, they also have the technical and financial resources to implement 'Green Deals' across the UK, unlike other, smaller new entrants. However, to ensure the Utilities engage with the policy it is important that the government makes the effort to underline the benefits this would provide them with. For instance, helping them to meet their energy company obligations, improve their reputation (or 'brand') and develop longer term relationships with their customers. Consequently, greater engagement by the Energy Utilities with the GD could add momentum to their movement towards the ESCo model and provide a major boost to the UK energy market as illustrated by Figure 8.3 in Section 8.2.5.

Finally, we recommend that 'green finance' schemes such as the Green Investment Bank and the Green Deal Finance Company (Section 6.1.4.3) are structured so that they make finance available to community organisations, not only private sector organisations. This would help to support growth of Community ESCos in the UK.

8.4.5 Alter Energy Company Obligations

We agree that the current energy company obligations (e.g. CERT) have successfully increased the deployment of cost-effective energy efficiency measures (e.g. loft and cavity wall insulation) (Eyre et al., 2009). However, we also agree that ‘the approach is less likely to be successful for measures that are innovative [but] not cost-effective, or to deliver change in customer attitudes or behaviour’ (Eyre et al., 2009 p.438). This is because this approach does not remove the Energy Utilities’ volume sales driver, neither does it address consumers’ growing demand for energy services nor provide incentives for consumers to change their user practices (Eyre, 2008). To achieve these aims, we recommend obligations that either mandate or encourage Energy Utilities to fundamentally restructure their business model so that they are intrinsically incentivised to satisfy their customers energy needs in a sustainable manner, as opposed to a set of obligations that only encourage the Utilities to ‘do the bare minimum’ in terms of GHG reductions and which can also be discharged whilst operating their traditional EUCo model, where their revenue is coupled with the sale of energy units, predominantly sourced from fossil fuels.

8.4.6 Adjust OJEU Procurement Process

We concur with Sorrell (2005) and Marino et al. (2011) that there is a need to alter the procurement process for energy service contracts, as it was frequently cited as a barrier by interviewees:

> ‘Firstly, adaptation of the public procurement laws in order to facilitate the evaluation of energy performance contracting providers by allowing the inclusion of energy efficiency in technical tender specifications and by taking into consideration the life-cycle cost in the project cost evaluation’ (Marino et al., 2011 p.6195)

Furthermore, procedures should be put in place to help support organisations seeking to procure energy service contracts, namely:

> ‘Clear, practical and ready-to-use guidelines on how to apply energy efficiency criteria in public procurement procedures [would] help the practical implementation of energy efficient public procurement’ (p.6195)

8.4.7 Landlord & Tenant Act

Currently the Landlord & Tenant Act stipulates that if a landlord is to pass on energy to its customers, it must procure this at best value and pass this on at cost-price to their tenants (Section 6.1.4.2). However, this obligation is at odds with landlords out-sourcing this obligation to ESCos, who want to sell their energy services at a price that incorporates a reasonable profit margin.

> *'The argument for an ESCo getting involved is that it has the experience, they can do things cheaper because of the economies of scale across multiple sites, they have expertise etc. So there is an argument that the ESCo is able to do better and ultimately costs everybody less' (Senior ESCo Manager - B 18)*

We recommend that this law is amended so that ESCos are able to provide energy services to tenants as a 'for-profit' activity, on behalf of the landlord. However, it is essential that legal provision is made to ensure that an impartial third-party examines whether the arrangement is beneficial to all parties involved (i.e. tenant, landlord & ESCo), especially the tenant.

8.4.8 Low Carbon Skills Training Schemes

A lack of skills necessary to deliver both EPCs and ESCs was highlighted as a barrier to ESCo proliferation in the UK, such as the measurement & verification of energy savings and the operation & maintenance of low-carbon energy equipment. Therefore, we support the introduction of schemes similar to Scotland's Low Carbon Skills Fund (SDS, 2012) and the UK government's Green Deal Skills Alliance (Green Deal Initiative, 2012a), which have been designed to ensure that the necessary skills exist in the UK to deliver sustainable energy measures. We would recommend that in order to support ESCo operations that specific schemes are established to offer training in a broad range of specialised skills necessary to deliver Energy Supply and Performance contracts.

8.4.9 General Policy Recommendations

The lack of confidence amongst energy actors with respect to how the regulatory framework will develop over the coming years was frequently cited as a barrier to ESCo activity. This was largely attributed to the government making swift and unforeseen changes to the regulatory framework, such as the FiT cuts (Sections 6.1.4.2 & 6.2.2.8). Consequently, a clear policy roadmap, alongside a strong commitment from the government to adhere to this strategy, would reduce actors' scepticism that an energy service project would be financially viable in the future. Also, we support the notion that the government should help energy actors to navigate the complex regulatory framework by providing them with greater information about new and existing regulation (Sorrell, 2007). This is encapsulated by DECC's move to introduce its Community Energy Online Portal (DECC, 2012d) as a means of helping to raise communities' awareness of energy funding, best practice case studies, planning issues etc, designed to support the establishment of community energy organisations such as Community ESCos.

Finally, we recommend that the financial incentives available for small-scale, low-carbon energy generation (e.g. FiT & RHI) are not subject to any further cuts until the costs of implementing these technologies (i.e. design, installation, operation, maintenance etc) fall sufficiently as a result of both technological and learning advances to off-set these cuts. Any additional cuts prior to a steady and prolonged fall in the costs of these technologies would serve to undermine the business case of ESCos delivering electricity or heat as part of ESCs.

8.5 Chapter Summary

In this chapter we have applied our co-evolutionary analytical framework to examine our empirical evidence, as well as a combination of academic and government literature in order to develop a better understanding of the role ESCos are likely to play in a transition to a sustainable UK energy system. Broadly, we expect the ESCo model to gradually gain wider-scale uptake over the coming years and as such, it is expected to exert a greater causal influence on the evolution of the UK energy system. In Section 8.2.6 we summarised the co-evolutionary dynamic between the ESCo population and the various dimensions of the UK energy system, and highlighted the ways in which a more pronounced role for the ESCo model is likely to characterize a sustainable energy system transition. In Section 8.3 we compared the role this research envisages for the ESCo model with that presented by the *Transition Pathways* project, highlighting both a number of similarities and differences. Finally, in Section 8.4 we presented a number of policy recommendations designed to encourage the uptake of the ESCo model in the UK. In the following chapter we reflect upon the implications of our findings in the context of the existing literature.

9 Discussion: Contribution of the Research to the Wider Literature

In this chapter we broaden our analysis from the previous chapter to reflect upon the insights generated by applying our integrated analytical framework to examine the evidence collected as part of our empirical investigation. The main purpose of this chapter is to relate our research findings back to the broader literature, as outlined in Section 2 and discuss the contribution this research makes to on-going debates in this literature.

9.1 Contribution of Research to Wider Literature

This sub-section is split into three different sections, each of which outline the contribution we consider this thesis has made to on-going debates in the sustainability transitions, co-evolutionary and innovation literature (Section 9.1.1); the business model, sustainable business model and Product-Service System literature (Section 9.1.2); and the ESCo and energy service contract literature (Section 9.1.3).

9.1.1 Socio-Technical System Change Literature

We begin by discussing the contribution this research had made to the socio-technical transition, co-evolutionary and innovation literatures, paying close attention to the work surrounding sustainability transitions and innovations.

> *Contribution 1:* This thesis synthesizes business model and co-evolutionary analytical frameworks to develop an integrated framework designed to examine how a population of organisations adopting a certain business model co-evolves with the various dimensions that make up the socio-technical system in which they operate

This thesis synthesizes Osterwalder & Pigneur's (2010) 9 business model building blocks analytical framework for business model characterisation and Foxon's (2011) co-evolutionary framework for analysing sustainability transitions. In doing so this thesis presents an integrated analytical framework (Section 3.3) designed to examine not only the co-evolutionary relationship populations of firms applying novel business models share with the various dimensions of the wider socio-technical system but also the co-evolutionary relationship of populations employing incumbent business models. Consequently, we can use this framework to improve our understanding of how the wider socio-technical system constrains and enables the uptake of novel, sustainable business models and conversely, how these business models can characterise socio-technical system change. The same examination can take place for unsustainable, incumbent business models. Furthermore, by separating novel, sustainable models and unsustainable, incumbent models we can explore how populations of firms operating these contrasting business models interact with one another and the implications this has for sustainability transitions. Therefore, a key contribution of this research is that it has helped to bridge the gap between the business model literature and the socio-technical transitions and co-evolutionary literatures.

Importantly, the analytical framework this research has developed and implemented can be employed by other researchers examining the role of business models in socio-technical system change, both within or outside of the context of sustainability transitions (Section 10.3). Furthermore, this research also develops, implements and clearly presents a methodology designed to mobilise this framework, which can also be employed by other researchers. Consequently, this has helped to address the need for a clearer, more rigorous methodology for sustainability transitions research.

> *Contribution 2:* This thesis highlights the coevolutionary relationship novel (sustainable) and incumbent (unsustainable) business models share with the wider socio-technical system they operate in. It also identifies that business models can be subject to positive feedbacks and thus, lock-in phenomena

By applying our integrated analytical framework to our empirical evidence, this research presents a multitude of examples that illustrate the co-evolutionary relationship the ESCo and EUCo populations share with the wider UK energy system. Consequently, this supports the view that both novel and incumbent business models share a co-evolutionary relationship with their social environment (Doganova and Eyquem-Renault, 2009, Mason and Spring, 2011, Teece, 2010, Hagberg and Kjellberg, 2010) and as such the evolution of a business model is not only influenced by the social environment in which they exist (Osterwalder, 2004, Teece, 2010, Mason and Spring, 2011) but that their implementation can in turn shape this social environment (Doganova and Eyquem-Renault, 2009, Mason and Spring, 2011).

A special form of co-evolutionary relationship is that of positive feedback mechanisms, i.e. 'the tendency for that which is ahead to get further ahead' and lock-out others i.e. 'that which loses advantage [, loses] further advantage' (Arthur, 1996 p.100). As illustrated in Section 2.3.3.1, the locking-in and associated persistence of some technologies (e.g. QWERTY, VHS etc) (Arthur, 1989) and institutions (North, 1990, Pierson, 2000) has been attributed to positive feedback mechanisms. At a broader scale, lock-in mechanisms (e.g. technological) can support other forms of lock-in (e.g. institutional), serving to reinforce one another, stabilizing the existing regime and consequently locking-in unsustainable socio-technical system states (Geels, 2011), such as fossil fuel based energy systems (Unruh, 2000). This research indicates that, in a similar manner to technologies (Arthur, 1989) and institutions (North, 1990, Pierson, 2000), business models can also be subject to positive feedbacks and thus fall victim to lock-in phenomena[50]. Although outside the remit of this research, it is possible that business models could help to reinforce the lock-in of other socio-technical components, in a similar way to how technological and institutional lock-in have served to reinforce one another (Unruh, 2000, Foxon, 2002). Consequently, this research emphasises the important role business models can play in the locking-in of unsustainable socio-technical system states and that they should be factored into future research examining sustainability transitions.

It is also important to note that whilst positive feedbacks may lock-out sustainable business models, they can also serve to help novel, sustainable business models to gain traction. This is supported by the positive feedback mechanism between application of the ESCo model and improving levels of customer awareness and understanding of the model as outlined in Section 7.2.4. Additionally, some positive feedback mechanisms that have traditionally contributed to the locking-out the ESCo model have begun to show signs of being reversed, such as the mechanism involving the co-evolution of the ESCo model and financial institutional arrangements (Section 7.2.5). Therefore, we emphasise that positive feedback mechanisms can play an important role in both helping and hindering sustainable business models to gain traction and thus the extent to which they shape socio-technical system change.

> *Contribution 3:* This thesis underlines how the implementation of novel sustainable business models represents a potentially important driver of sustainability transitions

As underlined in our Literature Review (Section 2.2.2.5) the manner in which innovative sustainable business models in shape sustainability transitions is currently under-researched and thus poorly understood. However, in recent years there has been a growing call from academics, industry and policymakers (Boons and Lüdeke-Freund, Schaltegger et al., 2011, Uren, 2010, COWI, 2008, Wilson et al., 2009) to improve our understanding of how the adoption of sustainable business models could help us to drive forward sustainable development. As outlined in the previous sub-section (Contribution 2), this research has sought to address this gap by taking a co-evolutionary approach to examine the factors responsible for enabling and inhibiting the uptake of the ESCo model and in turn, the influence the application of the ESCo model has had and is likely to have on a transition to a sustainable UK energy system.

As identified in the previous sub-section (Section 10.1) we observe that the implementation of novel, sustainable business models (e.g. ESCo model) can exert an important influence on the

[50] Different to the concept of customer lock-in (Amit and Zott, 2012, Zott and Amit, 2010)

evolution of the various dimensions that make up socio-technical systems (Sections 7 & 8). Consequently, novel sustainable business models could have an important bearing on the trajectory of sustainability transitions. In light of this, we concur with academics who have argued that sustainability transitions are not only shaped by technological innovations but also non-technological or social forms of innovation (Witkamp et al., 2011, Steward, 2008, Steward, 2012), such as business model innovation.

Despite our research supporting the view that novel, sustainable business models could help to facilitate sustainability transitions, their proliferation is far from guaranteed, considering the multitude of barriers sustainable business models face in achieving wide-scale adoption (Charter et al., 2008, COWI, 2008, Steinberger et al., 2009, Wilson et al., 2009). We find that a number of these challenges can be attributed to the poor degree of fitness novel sustainable business models share with their selection environment. In socio-technical terms this relates to the mismatch between the business model innovation and the prevailing socio-technical regime, i.e. the 'established practices and associated rules that stabilize [the] existing [energy] system' (Geels, 2011 p.26). This is evident in the various ways in which the ESCo model encountered barriers relating to both formal and informal institutions that had evolved during the history of the UK energy system (Section 6.1.4.2).

> *Contribution 4:* This thesis highlights that incumbent organisations can also play an important role in the proliferation of novel sustainable business models even though such models could potentially threaten their position of dominance

A particularly interesting finding of this research was that many of the incumbent Energy Utilities had made the decision to adopt the characteristically distinct and potentially disruptive ESCo model, despite the continued commercial success of their EUCo business model (Consumer Focus, 2012). The research found that the Utilities had made this move in light of their perception that current and emerging developments within their selection environment posed a critical threat to the success of the EUCo model going forward. This move can be considered to represent a strategy designed to avoid a repeat of other high-profile incumbent organisations that failed to adjust to their rapidly changing market place, such as Kodak (Koen et al., 2011) or Borders (Section 2.4.3.2).

The strategy they have employed mirrors the 'adopt the innovation by playing both games at once' strategy outlined by Charitou and Markides (2003), where the incumbent continues to operate its traditional model (i.e. EUCo model) but establishes separate business units that operate the characteristically distinct, novel business model (i.e. ESCo model). This choice was surprising not only because of the continued financial success of their model but also the risks associated with employing two models at the same time, where the new model is in direct conflict with the traditional model[51], which could result in a cannibalization of their existing customer base (Markides and Oyon, 2010, Porter, 1980). Although our research finds that it was the non-incumbent energy organisations (e.g. Honeywell, Thameswey Energy, Dalkia, Siemens etc) that constituted the main driving force behind the development of the UK ESCo market, this finding highlights that despite the threat novel sustainable business models may pose to the incumbents' position of dominance, incumbent organisations could also play a key role in the proliferation of such models in the future. For instance, the move of such wealthy and well-renowned organisations into the ESCo market could raise actors' confidence that the ESCo market is set to grow, helping to stimulate support for ESCo operations (Section 8.2.5). It is important to emphasise once again, as we did in Section 8.2.5, that the Energy Utilities could quickly change their strategy of developing their energy service contracting capabilities, to focusing on improving their traditional business activities.

The finding that organisations such as the Energy Utilities have moved to alter their business model on account of their perception that their environment is undergoing radical change supports the view held by Cordes (2006) that socio-technical evolutionary processes (i.e. *variation, selection and retention*), unlike in the natural world, are not entirely 'blind' but are instead influenced by actors' perceptions of how their environment is likely to change. For instance, without the strongly held belief amongst some of the Energy Utilities that their traditional business model could be threatened by emerging developments, it is unlikely they would have begun to alter aspects of their business (*variation*) in order to accommodate the ESCo model (*selection*), which in some cases has followed a very similar template to other high-profile ESCos (e.g. Honeywell) (*retention*). Therefore, this research indicates that actors' perceptions of how the socio-technical system will change plays a key role in socio-technical evolutionary processes, helping to address Smith et al.'s (2010) question of '*how do [actors'] decisions and action strategies reflect and anticipate selection environments and evolutionary dynamics?*' (p.446).

The manner in which the Utilities have reacted to the potentially disruptive ESCo model in some ways contradicts Christensen's (1997) notion that disruptive innovations are normally considered a threat to incumbents, considering their potential to radically change the existing market by introducing a different set of values that jar with the status quo. It was therefore surprising to observe that many of the Utilities' personnel considered the ESCo model to represent more of an opportunity than a threat. For instance, a number of Utility managers

[51] This refers specifically to EPCs where revenue is decoupled from energy throughput, which contrasts against the EUCo model where revenue is coupled with throughput (Section 6.1.2)

acknowledged that by adopting aspects of the ESCo model, they could enjoy benefits such as longer contractual relationships with their customers, healthier profit margins and greater differentiation from their relatively homogenous competitors.

To some extent our research supports the view that incumbents can struggle to adopt disruptive innovations (Macher and Richman, 2004, Walsh et al., 2002). This was illustrated by the case study of Energy Utility X (Section 6.2.4.7) that had faced a number of challenges, which included altering the mind-set of the organisation's personnel that had become aligned to the traditional EUCo model and developing key resources (e.g. skills, experience) necessary to operate the ESCo model. However, the Utilities had generally exhibited a surprising ability to accommodate the characteristically distinct ESCo model. Consequently, over the coming years the UK Energy Utilities could sit alongside other rare examples of incumbent organisations that have successfully identified and exploited potentially disruptive innovations prior to being disrupted by others (see Yu and Hang, 2010). This finding indicates that if there is 'buy-in' from senior incumbent personnel, then the transition from unsustainable traditional model to a novel sustainable model may not always be fraught with difficulty.

9.1.2 Sustainable Business Model Literature

We now consider the contribution this research has made to the business model literature, particularly that relating to sustainable business models and Product-Service Systems.

> *Contribution 5:* This thesis provided an empirically grounded, detailed account of a business model that has the potential to fulfil our energy needs in a sustainable fashion

As part of the in-depth and extensive Literature Review undertaken as part of this research (Section 2), we identified only a handful of examples where scholars had undertaken a detailed examination of a specific sustainable business model or Product-Service System (PSS) (see Mont et al., 2006, Wells, 2006, Williams, 2007), outlining not only their core characteristics but how they functioned as a business. Furthermore, the review did not identify any instances where Osterwalder's comprehensive and state-of-the-art 9 building blocks framework had been adopted to populate the core characteristics of a sustainable business model. Consequently, we argue that an important contribution of this research has been to provide a detailed, empirically grounded account of a sustainable business model by populating the ESCo model. In turn, this has provided insight into the types of components that make-up a business capable of creating, delivering and capturing value by satisfying a human need (such as energy services) in a sustainable manner, and importantly how these different components knit together as a coherent system.

By comparing the ESCo to the EUCo model, we were also able to illuminate the differences between a business model that is broadly regarded as having the potential to fulfil our energy needs sustainably (i.e. ESCo model) (Fawkes, 2007, Marino et al., 2011, Vine, 2005, Hansen, 2009) and one that has traditionally fulfilled our energy needs in an unsustainable manner (i.e. EUCo model) (Eyre, 2008, Steinberger et al., 2009, York and Kuschler, 2011). This has contributed to a stronger understanding of not only what a sustainable business 'looks like' but also how an organisation adopting such a business model may characteristically differ from others operating a less sustainable business model.

> *Contribution 6:* This thesis highlights that organisations across private, public and third sectors can drive the development and implementation of sustainable business models

Our research supports the view that private sector organisations are likely to play a leading role in both developing and implementing innovative sustainable business models (Birkin et al., 2009, COWI, 2008, Johnson and Suskewicz, 2009, Osgood, 2009), considering the wealth of technical and financial resources they are capable of drawing upon, as well as the pressure on firms to identify compelling value propositions that can enable them to out-compete their competitors within their respective markets. However, our research also supports the view that sustainable business model innovation can be driven by organisations outside the private sector such as community organisations and charities in the third sector (Steward et al., 2009, Seyfang and Smith, 2007, Seyfang, 2012, Wilson et al., 2009). Furthermore, it also highlights the role public sector organisations could play in sustainable business model innovation, such as Local Authorities. This view is supported by the identification of a number of Community (e.g. MOZES, Ashton Hayes, Kielder District Heating etc) and Local Authority owned and led ESCos (e.g. Thameswey Energy, Aberdeen Heat & Power etc). Therefore, we argue that academics, entrepreneurs and policymakers should be sensitive to the potential for organisations across all sectors to drive forward the development and implementation of novel sustainable business models.

> *Contribution 7:* This thesis examines the factors responsible for enabling and inhibiting sustainable business model innovation

By examining the trials and tribulations ESCos have experienced, as a form of organisation that operates a novel sustainable business models, our research identified a number of drivers and barriers to the uptake of sustainable business models. This has served to build upon existing research in this field (see Charter et al., 2008, Steinberger et al., 2009, Wilson et al., 2009, COWI, 2008, Schaltegger et al., 2011) by corroborating some of the factors previously identified (Section 2.5.3), such as a lack of awareness, risk adversity and the lack of regulatory incentives. It also identified lesser known barriers to sustainable business model innovation (Sections 6.1.4.2 & 6.2) such as the lack of appropriate skills, scarcity of finance and the unpredictability and complexity of the regulatory framework.

Contribution 8: This thesis examines sustainable business model innovation in a heavily regulated industry

Not only has this thesis built upon previous research examining the factors enabling and inhibiting sustainable business model innovation (Contribution 7), it has also examined these factors in the context of a heavily regulated industry. Traditionally, much of the research that has examined how innovative business models have gained traction and disrupted the status quo of traditional markets have focused on case studies of organisations operating in industries with relatively little regulation. For instance, the popular cases of Apple and the music industry (Johnson, 2010), as well as Xerox and the photocopying industry (Chesbrough, 2010) both emerged largely in the absence of a strong regulatory framework (Section 2.4.2). In contrast, some other studies have focused on business model innovation in more heavily regulated industries, such as Southwest Airlines and the airline industry (Teece, 2010), as well as Wal-Mart and the food retail industry (Magretta, 2002). However, we argue these have not explicitly examined how formal institutions and specifically regulation has served to either enable or constrain business model innovation, and particularly the adoption of sustainable business models.

In light of this, we argue our research makes an important contribution to the wider literature by examining the operation of a novel, sustainable business model (i.e. the ESCo model) in a highly regulated industry (i.e. the UK energy system). The research finds that regulation has both served to support *and* inhibit the uptake of an innovative, sustainable business model such as the ESCo model (Section 6.1.4 & 0). The finding that regulation can support the uptake of innovative business models holds with Porter & van der Linde's (1995) view 'that properly designed environmental standards can trigger innovation that may partially or more than fully offset the costs of complying with them' (p.98). This jars with the more traditional, *laissez faire* notion held by some economists that if environmental and financial 'win-win' opportunities do exist, then firms do not require regulation to encourage them to harness these opportunities. Conversely, our findings also supports other research that emphasises how regulation can also pose a significant barrier to the development and uptake of sustainable innovations, such as novel sustainable business models (Charter et al., 2008, COWI, 2008, Steinberger et al., 2009) (Section 2.5.3).

In summary, this research emphasises the potential for novel sustainable business models to gain traction in highly regulated industries such as the energy sector and other highly regulated sectors (e.g. water, transport, waste industries). Importantly, well-designed regulation can play a key role in supporting the development and deployment of such business models, helping to accelerate the uptake of these compared to less regulated environments. However, in contrast, regulations can act as a significant barrier to the proliferation of novel, sustainable business models if there is a poor fitness between the model and the institutional landscape.

9.1.3 ESCo Literature

We now discuss the contribution this research has made to the ESCo literature.

> *Contribution 9:* This thesis provides a detailed account of the core characteristics exhibited by the 4 most common variants of the ESCo model operating in the UK, presenting their characteristics, strengths & weaknesses and drivers & barriers

Very little research to date has examined the characteristics and experiences of the various different forms of ESCo that exist in the UK (see King and Shaw, 2010, Smith, 2007a, Bertoldi et al., 2006a). Although these studies have provided some valuable insight into the types of variants of the ESCo model that exists in the UK, this research has provided a much more detailed, empirically grounded analysis of these variants. For instance, the sector level (Phase 1) (Section 6.1.5) and particularly the case study (Phase 2) (Section 6.2) phases of the empirical investigation served to highlight how although these variants were similar in some respects, they also exhibited a number of characteristic differences, as well as different strengths and weaknesses. Furthermore, the research identified how these variants were also subject to a mixture of similar and differentiated drivers and barriers. The case studies helped to situate these in the context of an ESCo's narrative, helping to relate these to 'real world' examples.

> *Contribution 10:* This thesis provides a detailed account of the 9 building blocks that make-up the ESCo business model

We argue that building a detailed picture of the ESCo business model, using the 9 building blocks framework (Osterwalder and Pigneur, 2010)(Section 6.1.1), represents an important contribution to the ESCo literature. This is because, as outlined in Section 3.1, although some valuable and detailed research already exists that outlines the core characteristics of energy service contracting (see Fawkes, 2007, Marino et al., 2011, Smith, 2007a, Sorrell, 2005, Sorrell, 2007), no detailed accounts previously existed of how the various components and linkages that make-up an ESCo's business model were identified, despite numerous references having been made to the ESCo business model (Hansen, 2009, Sorrell, 2005, Steinberger et al., 2009, Goldman et al., 2005). Consequently, we argue that this research helps to improve our understanding of the ways in which ESCos create, deliver and capture value via the provision of energy services to their customers, thus helping to alleviate some of the confusion surrounding what constitutes an ESCo (Bertoldi et al., 2006a, Hansen, 2011, King and Shaw, 2010, Sorrell, 2005).

> *Contribution 11:* This thesis incorporated an in-depth, up-to-date examination of the strengths and weaknesses of the ESCo business model from the perspective of the customer and potential adopters of the model, as well as the factors enabling and inhibiting ESCo operation in the UK

Little research to date has examined the strengths and weaknesses of the ESCo model from the perspective of both energy consumers and potential ESCo model adopters. In Sections 6.1.1.1 & 6.1.3 we sought to address this. Significantly more research has focused on the factors responsible for enabling and inhibiting their operations (i.e. drivers and barriers), however we argue that a large number of these studies incorporated a limited empirical investigation of UK ESCo activity (see Bertoldi et al., 2007, Marino et al., 2010, Marino et al., 2011, Bertoldi et al., 2006b). Other work, despite providing valuable insight into UK ESCo activity, has incorporated no obvious empirical methodology (see Fawkes, 2007, Smith, 2007a, Boait, 2009). This thesis has helped to corroborate some drivers and barriers to ESCo operation in the UK previously identified by other scholars with additional, in-depth, up-to-date qualitative evidence. Additionally, a number of previously unidentified drivers and barriers to ESCo operation were identified by this research, such as the decline of capital grants and the introduction of financial incentives for low-carbon micro-generation.

> *Contribution 12:* This thesis provides valuable insight into the role that ESCos are likely to play in a transition to a sustainable UK energy system

The only other work we identified as part of the Literature Review, which has also considered the role of ESCos in the transition to a sustainable UK energy system, was undertaken by Sorrell (2005) and Foxon (2012). We discussed in Section 8.3 how our findings compared with the role the three different transition pathways reserve for ESCos. Therefore, we briefly consider how our research findings compared with Sorrel's. Broadly, our findings are closely aligned with Sorrell's, for instance his research also identified that the ESCo market represented a niche market, where application of the ESCo model rather than the EUCo 'tends to be the exception rather than the rule' (p.iv). Furthermore, he also indicated that the ESCo population had exhibited a significant degree of heterogeneity. Looking forward Sorrell explained that ESCos were likely to play some role in the transition to a sustainable UK energy system, however he was sceptical of how important this role would be explaining that a 'wholesale shift from commodity to service supply appears very unlikely' (p.100) largely because 'the transaction cost of contracting will continue to provide a substantial obstacle and many energy services will remain inaccessible to the contracting approach' (p.99-100). Although our research also indicates that the ESCo model is unlikely to entirely displace the EUCo model, it does however envisage a more prominent role for ESCos in this transition than Sorrell, when taking into account both the uptake of the ESCo model by the Energy Utilities in recent years (Sections 6.1.5.3 & 6.2.4) and the positive outlook for the UK ESCo market in the context of emerging developments (Sections 6.1.4.3 & 8).

We argue that although Sorrell's research is both insightful and of an extremely high quality, this research builds upon his work in five key ways to provide a stronger understanding of the role ESCos could play in a transition to a sustainable UK energy system. Firstly, we have applied an analytical framework that situates the ESCo business model within the context of its wider socio-technical system, in an attempt to understand how its broader environment will causally influence the evolution of the ESCo population and how this might influence the role it plays in a transition to a sustainable energy system. Secondly, we identify specific ways in which operation of the ESCo model in the UK has led to changes in the various dimensions of the energy system. Thirdly, our empirical investigation was considerably more in-depth incorporating the undertaking and analysis of 43 interviews and a wealth of primary literature, compared to Sorrell's 13 interviews. Fourthly, our empirical investigation provided a greater focus on the heterogeneity of the ESCo population by incorporating 4 in-depth case studies of the 4 key variants of the ESCo model in the UK. Finally, although still valid and insightful, Sorrell's work was conducted in 2005. Since then a number of important energy related developments have taken place, most notably the introduction of key pieces of low-carbon regulation (Sections 1.3 & 5.4). In contrast, our project provides an up-to-date examination of the ESCo operation in the UK.

9.2 Chapter Summary

This chapter has situated the key findings from the previous chapters in the context of the wider literature. In doing so we have underlined the key contributions this research has made to on-going debates in the socio-technical transitions, business model and ESCo literatures. In the following chapter we briefly summarise the key findings of this research and how these address our research questions, before reflecting upon the key strengths and weaknesses of our research strategy, particularly the application of our integrated analytical framework. Finally, we conclude with a number of suggestions for future research, which we argue would build upon the insights and experience gained from this research.

10 Conclusion

In the previous chapter we outlined the key theoretical and empirical contributions this thesis has made to the broader literature. In this final chapter we begin by drawing upon the insights gained from the previous chapters in order to address our research questions (Section 1.5). Following this we reflect upon the strengths and weaknesses of both the integrated analytical framework and research strategy this thesis has employed. These insights are in turn drawn upon to inform a number of suggestions for future research, which are presented at the end of this chapter.

10.1 Addressing the Research Questions

Based on the empirical findings of the sector level and case study analyses of the UK ESCo population presented in Chapter 6, and the present and future coevolutionary analyses of the relationship between the ESCo population and the UK energy system presented in Chapters 0 and 0, we now summarise how the thesis has addressed the research questions set out in Chapter 0.

1. *What are the core characteristics of the ESCo business model?*

The core characteristics of the ESCo business model are discussed in detail in Section 6.1.1 and a summary of these is provided in Table 6.3, as part of a comparison with the EUCo model. In Table 10.1 we present the core characteristics of the ESCo model characteristics as outlined in Table 6.3 in a more visually accessible manner in order to help the reader identify these more easily. The colour coding corresponds to Osterwalder's four business model pillars, (i.e. *product/value proposition, customer interface, infrastructure management and financial aspects*), which represent categories that each of the 9 building blocks falls into (Section 6.2).

Key Partners

Private Sector

- Financial Institutions & Investors
- Technical, Legal & Financial Consultancies
- Sub-Contractors
- Property Developers
- Energy Utilities

Public Sector

- Local Authorities

(Also a number of less important partnerships as outlined in Section 6.1.1.7)

Key Activities

- Finance, design, build, operate and maintain small to medium scale demand management & low carbon supply energy projects
- **ESCs:** Generation, distribution, supply, metering and billing
- **EPCs:** Preliminary and investment grade auditing, measurement and verification of energy savings

Key Resources

- Project capital
- Experienced personnel with technical, financial and legal expertise to deliver energy service contracts
- **ESCs:** Primary energy conversion and decentralised distribution equipment. Fuel to generate energy from
- **EPCs:** Secondary conversion equipment and building controls

Value Proposition

Fulfil Energy Needs at a Lower Cost and/or with Added Value

- Fulfil energy needs at a similar or lower cost to Energy Utilities
- ESCo assumes most financial and technical risk of fulfilling energy needs
- Bespoke and holistic energy solutions can ensure energy needs are entirely satisfied
- Energy needs met with fewer adverse environmental effects than via EUCo model. Customer can enjoy more sustainable lifestyle, fulfil regulatory and CSR obligations etc
- Societal benefits e.g. alleviation of fuel poverty, climate change mitigation, localization of capital flows

Customer Relationships

- On-going & long term
- Close, cooperative, candid and trusting relationship to enable open and detailed dialogue, in order to develop bespoke & holistic energy solutions that satisfy both its own and its customer's needs
- Customer may also act as investor and/or manager of the ESCo (e.g. Community ESCo)

Channels

- On-line, TV, telephone, postal & door-to-door marketing, purchasing, metering, billing & customer feedback
- Energy supplied via localized and often private distribution networks (e.g. private wire)
- Support via on-going customer interaction & project management

Customer Segments

Core

- Public sector (local authority, government etc)
- Commercial (office, retail etc)

Peripheral

- Residential sector
- Industrial sector
- Agricultural sector

Cost Structure

- Equipment/technology
- Technical, financial and legal consultancy
- Staff
- Marketing and communication
- Operations & Maintenance
- Finance or investment repayments
- Technical, financial and legal consultancy
- **EPCs:** Preliminary Auditing; Measurement & Verification; Compensation for poor performance
- **ESCs:** Fuel and energy; Acquiring rights to supply from gatekeeper organisation (e.g. developer); Metering & Billing

Revenue Streams

- Capital grants
- Customer investment
- Bank finance

ESCs

- Payment for useful energy streams (e.g. heat). Customer covers this in part via the energy savings the ESCo achieves through efficiency gains or utilisation of cheaper primary energy input
- Low-carbon financial incentives for micro-generation (e.g. FiT, RHI)

EPCs

- Payment for predefined quality & quantity of final energy services (e.g. light). Customer covers this via the energy savings the ESCo achieves through efficiency gains

Table 10.1 The core characteristics of the ESCo business model according to Osterwalder & Pigneur's (2010) 9 business model building blocks framework

2. *What are the strengths and weaknesses of the ESCo model?*

This research acknowledges that the extent to which the ESCo model has proliferated in the UK cannot be explained by extrinsic factors alone but also by the strengths and weaknesses associated with the ESCo model from the perspective of both the organisation considering adoption of the model, as well as its customers. Consequently, the research sought to identify the strengths and weaknesses of the ESCo model from the perspective of the ESCo's customers (Section 6.1.1.1) and the organisations operating the ESCo model (Section 6.1.3).

The strengths of the ESCo model from the perspective of the customer are encapsulated in the Value Proposition section of Table 10.1. The key weaknesses of the ESCo model from the customer's perspective include (1) a reduction in operational flexibility over a long-term period, (2) the requirement of the customer to engage heavily in contract design and (3) a financial commitment with the ESCo that resembles financial debt.

From the perspective of the ESCo (or potential ESCo), a key strength of the model was considered to be the provision of bespoke energy service contracts as bespoke contracting is normally capable of creating more value for energy consumers than compared to the standardized contracts associated with the supply of energy units. Firms find compelling value propositions such as this desirable not only because they can normally attract more customers but that customers are often willing to pay more for bespoke services as they constitute a 'value-added' service compared to standardized offerings. Bespoke energy service contracting also opens up a large potential customer base as such offerings are capable of satisfying a more heterogeneous customer base than standardized offers. However, this strong value proposition and flexibility comes at a price because replicating bespoke energy service contracts from customer-to-customer typically proves problematic, meaning many ESCos typically have to design new agreements for each of their customers, reducing their economies of scale and thus subjected them to high transaction costs for each energy service contract they provide.

An important strength of the ESCo model is that it cannot only be applied to satisfy the energy needs of a broad range of customers but that it is accessible to a broad variety of adopters, ranging across the private, public and third sectors. However, these organisations will be required to access a range of key resources (e.g. capital, skills etc) and partners to effectively provide energy service contracts, which are often difficult to secure. Finally, even though long-term energy service contracts provide long-term revenue streams for ESCos, they also constrain their ability to alter their business model because they are committed to contracts that typically last up to 25 years. This limits their ability to react and adapt to changes in their selection environment, which could prove detrimental to the organisation's future prospects.

3. *How have the various key dimensions of the UK energy system causally influenced the evolution of the ESCo population?*
4. *How has the ESCo population causally influenced the evolution of the various key dimensions of the UK energy system?*

The core focus of this thesis was to improve our understanding of how the evolution of the ESCo population has been causally influenced by the five key dimensions of the UK energy system, which include the *ecosystem, institutions, user practices, technology and the incumbent business model* dimensions (question 3). Furthermore, we sought to identify how the ESCo population has influenced the evolution of these different dimensions and has thus characterised change in the UK energy system (question 4). In short a core aim of this thesis was to elucidate our understanding of the co-evolutionary relationship between the ESCo population and the UK energy system.

In response to question 3, we found evidence that supported the view that each of the key dimensions of the UK energy system has had an important causal influence on the *variation, selection* and *retention* of the ESCo population. Although we cannot easily quantify each dimension's influence and thus compare their relative strengths, the research indicated that the *institutional* dimension had the greatest direct influence on the evolution of the ESCo population, whilst the other dimensions had a similarly strong influence compared to one another. We found evidence to support that these dimensions were in part responsible for the heterogeneity of the ESCo population, encouraging the emergence of the four archetypal ESCo variants outlined in Section 6.1.5, which were examined as case studies in Section 6.2. The causal influence of these dimensions had also constrained the scope for *retention* of the ESCo model, although *regulatory* (e.g. standardised contracts) and *user practice* (e.g. growing awareness and understanding of the ESCo model) developments had helped to improve the model's prospects of retention in recent years. Finally, the limited uptake or *selection* of the ESCo model could also be attributed to developments within each these dimensions, the pressures from which formed a broadly hostile environment for the ESCo model, which in contrast was supportive of the EUCo model's operation. However, the research found that in recent years the evolution of each of these dimensions has contributed to a more favourable selection environment for ESCos, thus helping the ESCo model to gain additional traction. Conversely, recent developments were judged to have cultivated a more hostile environment for Energy Utilities, however they continue to remain extremely profitable and dominant in the UK energy system.

In relation to question 4 the research indicates that the ESCo population has causally influenced the evolution of each of different dimensions of the UK energy system to varying degrees. As was expected, the small size of the ESCo population and the number of energy service contracts that have been delivered in the UK to date has meant that ESCos' have not had a major causal influence on the evolution of the UK energy system, however their influence was large enough to be identifiable. The ESCo population's influence was strongest on the *user practice* dimension, where the signing of energy service contracts, particularly EPCs, had required consumers to engage in different consumption behaviours. Furthermore, the uptake of the ESCo model by communities and Local Authorities had the effect of transforming these consumers' traditional role as they had assumed significant control over the organisation responsible for fulfilling their energy needs, i.e. the ESCo. One of the most interesting findings was in relation to the *incumbent business model* dimension where the majority of the Energy Utilities had created separate organisational divisions that were established to deliver energy service contracts. Furthermore, the Utilities had also made efforts to scale up their ESCo operations.

The most compelling evidence to support the existence of a co-evolutionary relationship between business models and the wider socio-technical was the identification of positive feedback mechanisms, considering that they constitute evidence to support the view that the ESCo population's has causally influenced the evolution of the UK energy system (question 3) *and* that the energy system has causally influenced the population's evolution (question 4). These positive feedbacks were observed to have locked-in the EUCo model and locked-out the ESCo model. However, it was also found that positive feedbacks were helping the ESCo model to gain additional traction, such as the feedback involving improved awareness and understanding of the ESCo model and the greater incidence of energy service contracts.

5. *How is the co-evolutionary relationship between the ESCo population and the UK energy system likely to change in the future?*

Having identified the manner in which the ESCo population has co-evolved with the key dimensions of the UK energy system during the past and at present, we turned our attention to the future in order to provide insight into how this dynamic is likely to change over the coming years, during which the UK will seek to move towards a sustainable energy system. In order to do so we drew upon a combination of the insights from our interview, documentary evidence relating to emerging regulatory developments and other research that has provided projections relating to key energy sector related developments (e.g. energy prices, climate change etc).

Over the coming years we expect that emerging developments are likely to mean that the ESCo population will continue to exhibit a similar degree of *variation* to that at present. This is because some emerging developments are expected to increase variation, such as the influx of new entrants and strategic partnerships in the UK ESCo market, although these are expected to be balanced out by factors that will decrease variation, such as the introduction of standardised contracts, learning effects and the disbanding of some ESCos (Section 8.1). Additionally, the sector-level and case study findings indicate that no single ESCo variant is expected to 'win out' over the others and so we envisage that these will continue to operate alongside one another.

The prospects for retention of the ESCo model, i.e. it being 'preserved, duplicated, or otherwise reproduced' (Aldrich and Ruef, 2006 p.17), are set to improve with the introduction of standardised contracts, alongside other emerging developments such as actors' improving understanding of the ESCo model and their growing awareness of exemplary cases of energy service contracting, which could provide a template for other firms to emulate (Section 8.1).

The ESCo model's *selection* environment is expected to improve particularly at the hands of an expected continuation of *ecosystem* related crises, such as climate change and energy insecurity. *Institutional* developments are also expected to help cultivate a more favourable selection environment for ESCos, most notably the imminent introduction of new regulation such as the Green Deal, Green Investment Bank and European Energy Efficiency Directive, alongside the expected continuation of supportive policies such as the CRC Energy Efficiency Scheme, the Feed-in-Tariff and the Renewable Heat Incentive. However, many of the barriers identified in Sections 6.1.4.2 & 6.2 that have traditionally presented significant challenges to ESCo operation in the UK are expected to persist for some time to come, such as the instability and complexity of the regulatory framework and the lack of skills in the UK to deliver energy service contracts. Furthermore, some emerging developments may serve to inhibit ESCo proliferation, such as the imminent Energy Company Obligation, which will continue the tradition of enabling the Energy Utilities to discharge their commitment to reducing their associated GHG emissions without fundamentally altering their business model, thus discouraging the establishment of Energy Utility ESCos. It is also expected that many of the positive feedbacks identified in Section 7 that have served to both lock-in the EUCo model and lock-out the ESCo model are likely to remain, considering the persistence of virtuous cycles.

Despite these potential challenges, emerging UK energy system developments are expected to be broadly supportive of ESCo operation, encouraging the ESCo model to proliferate in the future. Considering that the ESCo population is expected to exhibit a similar degree of variation over the coming years to that at present, we expect the *type* of influence ESCos have on the wider energy system to be broadly similar to that at present. However, considering that their selection environment is expected to continue to improve, we expect the *strength* of their causal influence on the evolution of these dimensions to increase as the ESCo population grows. Consequently, it is envisaged that we will begin to observe more changes and potentially more profound changes to the different aspects of the UK energy system over the coming years, which can be partly or wholly attributable to ESCo activity (Section 8.2). For example, a greater focus on sustainable, decentralised energy generation and demand side management technology as part of the UK's energy technology research and development programme (Section 8.2.3) and/or a shift in public consciousness, where energy consumers realise they have the potential to assume control over how they fulfil their energy needs.

Having addressed these research questions we now turn to our overarching research question:

> *What role could the development and adoption of the Energy Service Company (ESCo) business model play in the transition to a sustainable UK energy system?*

In recent years the ESCos' selection environment has radically improved, helping many existing ESCos to scale-up their activities and serving to encourage new entrants across different sectors to enter the UK ESCo market, most notably the UK energy system's incumbent Energy Utility companies. Looking forward, this pattern is expected to continue, considering that the majority of the emerging developments this research identified are set to support the activities of the various different ESCo variants. Many of these emerging developments can be considered beyond the control of the ESCo population, such as climate change or rising energy prices. However, as the fitness between the ESCo model and its selection environment improves and the model gains traction, the causal influence of the ESCo population on the wider UK energy system is expected to increase, which could in turn help to cultivate a more favourable selection environment for the ESCo model. Positive feedbacks, similar to those that have helped the Energy Utilities to rise to dominance, are expected to play a particularly important role in cultivating a favourable selection environment for ESCos, as illustrated in (Sections 7 & 8). In summary, our research broadly supports the view extended by Sorrell (2005) and Foxon (2012) that the ESCo model is likely to play a prominent role in the transition to a sustainable UK energy system, which raises questions around the lack of attention policymakers have paid to the ESCo model to date as a means of facilitating this transition (Section 7.2.2).

Despite this positive outlook for ESCos, we expect a number of key barriers to ESCo operation to persist in the future, meaning that although the ESCo model may rise in prominence, it is unlikely to replace the EUCo model in near future as the dominant energy business model in the UK. This view is supported by the expectation that many of the enabling factors and positive feedbacks that have helped the EUCo model to dominate the UK energy system will persist (e.g. electricity trading arrangements, energy supply company obligations etc). Therefore, we envisage that the Energy Utilities will continue to operate their traditional EUCo model for many years to come and are unlikely to make the wholesale transition to the ESCo model, even though their energy services divisions are expected to grow. Consequently, the EUCo model will continue to play an influential role in shaping the UK energy system's future.

It is important to note that the different ESCo variants identified in this thesis, such as the Energy Utility Energy Service Provider discussed in the previous paragraph, are likely to enjoy varying levels of uptake under the 3 different *Transition Pathways* envisaged for a low-carbon UK electricity system (Foxon, 2012) (Section 8.3). As illustrated by Section 6.2, these different ESCo variants differ to some extent with regards to the way in which they influence change in the wider energy system. Consequently, a proliferation of one variant over another will have a bearing on the manner in which the ESCo population causally influences the evolution of the UK energy system and thus the role ESCo play in the sustainability transition. Under the *Market Rules* pathway, where a market-led logic continues to characterise the governance of the UK energy system (as it does today), Energy Service Providers and Energy Utility Energy Service Providers are most likely to proliferate due to their private-sector structure and corporate rationale. Whilst, these organisations are also likely to play a key role in the *Thousand Flowers* pathway, where a civil-society led logic is dominant, Community ESCos are likely to proliferate considering that they represent a manifestation of the civil-society logic. Finally, in the *Central Coordination* pathway, where there is significantly greater direct government involvement in the governance of the UK energy system, Local Authority 'Arm's Length' ESCos are likely to enjoy the greatest degree of growth of the ESCo variants considering that they can be controlled by local government.

In conclusion, we foresee that the development and adoption of the ESCo business model will play a key role in the various different envisaged transition pathways to a sustainable UK energy system. However, we broadly agree with Sorrel's (2005) prediction that 'a wholesale shift from commodity to service supply is unlikely' (p.iv) and that the ESCo model will have to work alongside other business models (e.g. EUCo) and sustainable energy solutions, in the transition to a sustainable UK energy system. Importantly, as we emphasised in Section 8.4, the role ESCos play in a UK low-carbon transition will very much depend upon how the regulatory framework develops over the coming years. Consequently, we outlined a number of policy recommendations designed to help the ESCo model achieve wider-scale uptake and thus play a more prominent role in a low-carbon transition. These included amongst others changes to public sector procurement frameworks, the Landlord Tenant Act, the energy company obligations and BETTA, as well as the introduction of standardized energy service contract templates, city-level GHG emissions targets and energy service contracting skills programmes.

10.2 Strengths and Limitations of Analytical Framework and Research Strategy

In this sub-section we briefly consider the strengths and weaknesses of our analytical framework (Section 3) before examining those relating to our research strategy (Section 4).

10.2.1 Analytical Framework

We argue that applying the 9 business model building blocks framework initially developed by Osterwalder (2004) and refined by Osterwalder and Pigneur (2010), provided an effective means of uncovering how an ESCo is able to generate income by satisfying their customers energy needs and importantly, how this contrasted with the EUCo model employed by the incumbent Energy Utilities. Our experience of the framework was that it provided a comprehensive account of the system of different components that constitutes a certain type of business. However, one recommendation we would make to improve the framework would be to incorporate a greater focus on how these various business model components fit together to form a coherent and effective system. We find that Osterwalder's earlier work incorporated flows from one business model dimension to another (Osterwalder, 2004) but more recent iterations have diluted this focus. At present these building blocks are somewhat disconnected and we argue that a greater emphasis on the relationships between these could serve to provide greater insight into how the restructuring of one of these blocks (e.g. key activities) may trigger changes in other business model blocks (e.g. value proposition).

Importantly, the framework enabled us to build a sufficiently clear picture of the ESCo model to appreciate whether it presents a financially viable means of satisfying our energy needs in a sustainable manner by detailing the relationship between the processes of value creation, delivery and capture, and the flows of natural and financial resources. In contrast, it helped us to appreciate how the EUCo model fails to incentivise Energy Utilities to satisfy their customers' energy needs in a sustainable manner. However, we acknowledge that in order to truly appreciate whether a business model is capable of satisfying one or more human needs sustainably, it is important to quantify the value, financial and resource flows associated with the model's operation. Although the business model framework does not exclude quantification of these flows, it does not encourage it. Therefore, we argue that the business model aspect of our analytical framework would benefit from a greater focus on populating the business model using quantitative data (see Section 10.3) to provide deeper insight into the economics of firms' business model (see Sorrell, 2007).

We concur with Foxon (2011) that one of the key strengths of applying a co-evolutionary framework *a la* Norgaard (1994) is that by incorporating a significant degree of analytical separation between the core dimensions of a socio-technical system, one is able to focus attention on the causal influences between the various key dimensions that make-up a socio-technical system (Section 2.3.3.3). Consequently, the framework afforded us the opportunity to examine in detail how a population of organisations practicing a novel business model has causally influenced the evolution of the core dimensions of a socio-technical system and conversely, how these dimensions causally influenced the population practicing this novel business model. In comparison, we find that the MLP does not provide this same degree of analytical separation between the core dimensions of a socio-technical system, instead emphasising the intertwined nature of these dimensions. Importantly, it was felt that the analytical separation of these dimensions was particularly helpful in structuring the empirical investigation, by ensuring that empirical data was collected that corresponded to the ESCo population's relationship with each key dimension.

A key strength of our analytical framework was that it afforded us the opportunity to identify positive feedback mechanisms that were responsible for locking-in and locking-out business models. In contrast, although the ST literature frequently refers to lock-in phenomena, we argue that the MLP is not designed for the identification of the positive feedback mechanisms responsible for lock-in. Furthermore, we found the framework was particularly useful in providing detailed insight into how changes in one dimension may trigger change in another. For instance, how emerging institutional developments, such as the Green Deal, or ecosystem developments, such as climate change, might influence the evolution of the ESCo and Energy Utility populations. Consequently, we support Foxon's view that the framework could generate valuable 'insight into how decisions made by policy-makers or other actors could affect these influences, so as to promote evolution towards more sustainable, low-carbon systems' (p.2262). The framework was also sensitive to how change in one dimension may trigger a series of consecutive changes across others dimensions (i.e. a chain effort), which we argue contributes to socio-technical transitions.

It could be argued that analytically separating the socio-technical system into 5 key differentiated dimensions over-simplifies the complexity of socio-technical systems, considering the multitude of components that make-up a system such as the UK energy system. Furthermore, as emphasised by the socio-technical transitions, Science and Technology Studies (STS) and Social Shaping of Technology (SST) literatures, it is both difficult and inappropriate to divorce ‘the social’ from ‘the technical’ considering that ‘that science and technology are thoroughly social activities’ (Sismondo, 2010 p.11) and vice versa. However, having applied the framework to analyse the evidence from our empirical investigation we found that the central components of the UK energy system were well accommodated by the various dimensions of our analytical framework. In addition, we argue the framework remains committed to the view that social and technical components are intertwined by being sensitive to how the evolution of both social (e.g. institutions, user practices) and technical (e.g. technology) components is shaped by the influence of other social and technical dimensions.

One of the major criticisms levelled at the MLP is the lack of consideration it gives over to the role of political power and agency in shaping socio-technical transitions and consequently, how actors’ decisions and the power imbalances between actors shape evolutionary processes such as selection and variation (Genus and Coles, 2008, Shove and Walker, 2007, Smith et al., 2005). We argue that by distinguishing between populations of incumbent and non-incumbent actors, our analytical framework draws attention to the imbalance of power between two populations that possess varying degrees of political power. This dynamic is important because populations with greater political power and financial might are likely to exert a stronger causal influence on the wider socio-technical system, via such means as political lobbying (Murmann, 2003, Murmann, 2012, Stenzel and Frenzel, 2008). Consequently, we concur with Foxon (2011) that our framework is sensitive to the role of power and importantly the inequalities of power amongst market, government or civil society actors, in shaping socio-technical transitions.

Our analytical framework could be criticised for being too focused on the enabling or inhibiting influence that external factors have had on firms’ operating sustainable business models and not sufficiently focused on internal factors, such as the firm’s organisational culture and structure, as well as their financial resources. However, a number of internal drivers and barriers could be drawn from the key resources and partnerships which are required to successfully operate the ESCo model (Sections 6.1.1.6 & 6.1.1.7). For instance, the technical expertise to provide energy service contracts constitutes a key resource for organisations looking to adopt the ESCo model and the absence of such expertise constitutes an important internal barrier to doing so. Additionally, our empirical investigation highlighted other internal drivers and barriers, particularly as part of the case studies. For example, organisational culture and structure were identified as an internal barrier to Energy Utility X's adoption of the ESCo model (Section 6.2.4.7).

Finally, it is important to acknowledge that the application of an analytical framework based on existing theory can mean the researcher is less sensitive to alternative conceptualizations of the phenomena under investigation (Maxwell, 2005). However, we argue that as the extensive Literature Review in Section 2 illustrates, this research is sensitive to a broad range of approaches capable of explaining socio-technical system change. Consequently, if our co-evolutionary analytical framework was found to be entirely unrepresentative of our empirical evidence then alternative bodies of theory would have been utilised and the analytical framework restructured; a process which is encapsulated by our research strategy (Figure 4.3). In short, the framework was chosen to fit the observed empirical phenomena. On reflection, evidence supported the view that a co-evolutionary relationship existed between the ESCo model and the wider UK energy system, thus validating our choice of framework.

10.2.2 Research Strategy

Moving away from the analytical framework we now consider some of the strengths and weaknesses associated with our research strategy as outlined in our Methodology (Section 4). On reflection employing a Straussian Grounded Theory approach to theoretical development enabled us to strike a balance between an inductive and deductive research strategy, ensuring that the research was informed by existing theory but was also able to advanced existing theory by allowing for new theory theoretical insights to emerge from our empirical investigation. We also found that the sector-level and case study approaches complemented one another well. For example, the sector-level approach provided valuable insight into how the ESCo population was evolving in the UK and the factors responsible for this, whilst the case study approach helped to corroborate a number of these findings by situating them within the context of a particular ESCo's narrative. Furthermore, the case study approach gave us the opportunity to provide additional insight into the key variants of the ESCo population identified in the sector-level investigation. Broadly, the interviewee selection, data collection and data analysis methods were effective in providing the necessary quantity and quality of evidence to address our research questions.

The research strategy did however have some limitations. Firstly, the breadth and depth of the empirical investigation into UK ESCo operation was limited by the modest resources available for this research. Consequently, it is possible that important causal mechanisms responsible for characterising the evolution of the ESCo population and UK energy system were not identified. Secondly, the co-evolutionary causal mechanisms were identified via analysis of qualitative data from energy stakeholder interviews and documentary evidence. In both cases, the data collected constituted a representation of an individual or group's interpretation of past, present and future developments in the UK energy system. Although this provided valuable insight into the different interpretations actors shared for the same phenomena, it is important to note that their accounts may not have been wholly representative of the causal mechanisms at play due to factors such as inaccurate recollections of past events and/or the difficulty of making sense of the complexity inherent in the UK energy. Thirdly, quantitative methods for data collection and analysis could have proved useful in identifying other characteristics of the UK ESCo market, such as the value or size of the market. Therefore, whilst we believe this research has improved our understanding of how novel business models can characterise sustainability transitions, we acknowledge that the research has its limitations. This leads us to our final sub-section, which focuses on potential avenues for future research.

10.3 Potential Avenues for Future Research

Focusing on additional research relating to ESCo operation first, we would recommend that future research incorporates a quantitative analysis of the monetary and resource flows associated with the operation of the ESCo model in different contexts. This would help us to build a more accurate picture of how commercially viable the ESCo model can be and also the environmental impact associated with operating the model (e.g. GHG emissions), thus helping us to draw more accurate conclusions relating to its sustainability credentials. This could incorporate an analysis of how the extent to which the *rebound effect* typically offsets the GHG emissions reductions achieved by the ESCo model, which occurs when their customers choose to invest their cost savings in product and/or services with a high carbon-footprint (Section 2.6.4). Other potential avenues for research include a cross-case comparison of the UK ESCo market with markets in other countries (Section 5.5) to improve our understanding of how and why the ESCo model has enjoyed varying degrees of success in different socio-technical contexts. Finally, we would suggest a more customer-centric analysis of ESCo operation to provide insight into why energy consumers have or have not engaged with the ESCo model and importantly, what changes might be required to increase customer engagement with ESCos.

Moving away from the ESCo model, research may also focus on the co-evolutionary relationship between populations practicing business models that seek to fulfil multiple human needs in a sustainable manner. For example, Multiple Utility Service Companies (MUSCos) constitute a single point of supply for multiple utilities (e.g. energy, water, communications, waste management etc) and like ESCos, they focus on providing these not as commodities but as services (SuRe Infrastructure, 2012). Additional research into the EUCo model may also prove insightful. As emphasised in Section 6.1.2 (Footnote 26), even though the EUCo incorporates a volume sales driver, this does not necessarily translate into the unsustainable fulfilment of consumers' energy needs. This is because Utilities could in theory source their electricity from low-carbon, secure and affordable sources of energy. Consequently, we recommend additional research into the changes to the structure of the EUCo model and the Utilities' wider socio-technical environment that might encourage the Energy Utilities to move towards renewable sources of energy instead of carbon intensive fossil fuels.

The analytical framework developed and applied in this thesis could also be applied to provide insight into the co-evolutionary relationship between other forms of sustainable business models, operating in other types of socio-technical system (e.g. water, waste, transport etc). We suggest that research would be most revealing if the system in question featured an unsustainable business model that represented the dominant means of creating, delivering and capturing value, in a similar fashion to the EUCo model and the UK energy system. For example, the research could focus on the transport sector and examine the reasons why use-oriented (e.g. car leasing, pooling and sharing schemes) and result-oriented (e.g. 'pay-per-km') business models for private transportation occupy a relatively small market share in comparison to the product-oriented 'Fordism' business model employed by the majority of the major vehicle manufacturers (e.g. General Motors, VW, Nissan etc), which predominantly focuses on the sale of vehicles as products, in conjunction with a handful of basic services (e.g. warranty, maintenance packages etc) (Wells, 2006, Williams, 2007).

Finally, turning to additional research in relation to our analytical framework, we would suggest that the other dimensions of the coevolutionary framework (e.g. institutions, technologies etc) are 'opened up' in a similar way to how the business model dimension was opened up as part of this research, by using Osterwalder & Pigneur's (Osterwalder and Pigneur, 2010) framework for business model characterisation. Doing so would provide a more detailed picture of which components make up these system dimensions, allowing for a more accurate analysis of how bi-directional causal mechanisms between dimensions have causally influenced their evolution, specifically the processes of *variation, selection and retention*. For example, with a clearer understanding of the different types of technology that make up the technology dimension in an energy system, we could more accurately identify the emergence of new technological innovations (*variation*), chart how these innovations have fared in the prevailing selection environment (*selection*) and the extent to which the characteristics of these technological innovations have been retained in the design of future technological innovations (*retention*).

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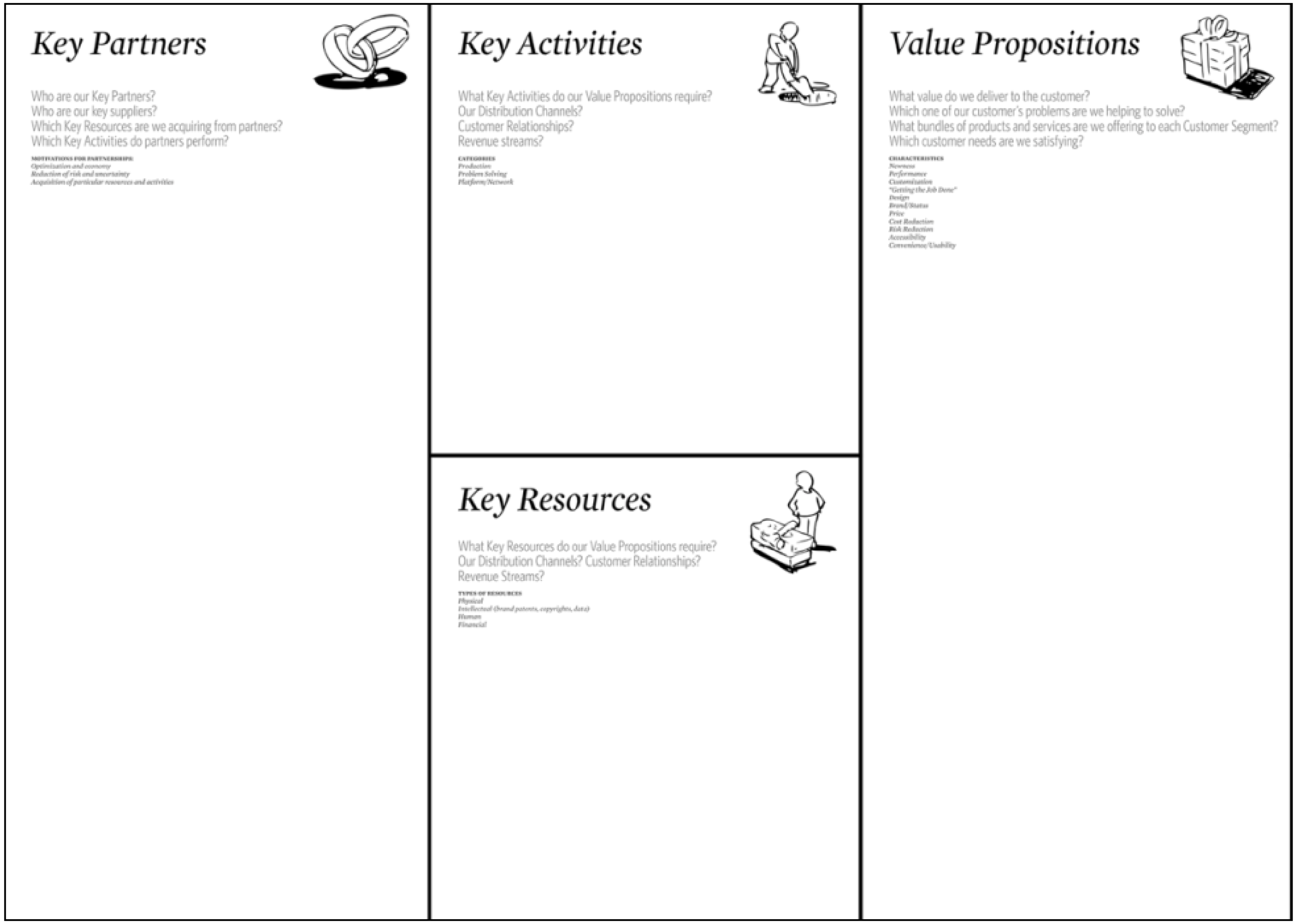
12 Appendices

12.1 Appendix A: A Section of Osterwalder & Pigneur’s Business Model Canvas



12.2 Appendix B: An Extract from a Coded Interview

Extract of Interview (H 2) used in Honeywell Case Study	Coding Categories
M – In terms of the solutions that you offer, is it largely what I would term demand-side, the lighting and the various technologies that convert energy into what the customer really wants.	
J – We do three things mainly. The first is generation, like CHP or tri-gen. We can integrate and provide renewables but we don't specifically sell them as part of our offering.	**Business model characteristics - Key Activities** ➢ Installation and management of primary conversion equipment
We do look at the demand side by putting in efficient kit but then we also go one step further and provide active demand management. So I may have efficient demand management in the building but if it is not active, then I may still be wasting energy because I am not managing the usage of those assets based on the individual requirements of the building from day to day. As the occupancy levels rise and fall I can actually have minute-by-minute or hour-by-hour active demand management that gives me a number of savings over above having kit that uses energy efficiently.	➢ Installation and management of secondary conversion equipment and building controls
We also engage with behavioural management, working with the users of the building and typically by getting them to participate in efficient interaction with the building you can get between 6 and 10% additional savings	➢ Behavioural management
M –Looking to the future, how do you see the market developing considering the various emerging developments?	**Future Drivers & Barriers - Drivers**
J – It is still a mate market and there are still some challenges we face. I can really start to see the market is maturing and we will start to see a greater number of EPCs progressing.	➢ Maturation of ESCo Market **Strengths & Weaknesses of Business Model - Weaknesses**
An EPC will still take between 12-24 months from absolute start to signing the contract. It just takes that long, even in the US where the market is much more mature.	➢ Long Sale & Procurement Process **Business model characteristics - Customer Segments**
We have got a recognition that EPC for the public sector is currently the best way to go. People have different understandings of what an EPC and an ESCo is.	➢ Public sector organisations **Current Drivers & Barriers - Barriers** ➢ Lack of common understanding of ESCo model
Overall we are starting to see a conversion to a common understanding which is required to mature a market.	**Current Drivers & Barriers - Drivers** ➢ Growing common understanding of ESCo model

12.3 Appendix C: Historical Structure of the UK electricity sector

	Nationalised	Privatised	Liberalised
Generation	- Central Electricity - Generating Board - (CEGB) - South of Scotland - Electricity Board (SSEB) - North of Scotland Hydro- - Electric Board (NSHEB) - Northern Ireland - Electricity Board	- National Power - PowerGen - Nuclear Electric (publicly owned until 1996 when privatised as British Energy) - Scottish Hydro-Electric - Scottish Power - Northern Ireland Electricity - (privatised in 1992)	30 major power producers in the UK. The largest of these include: - E.On - Scottish Power - EDF Energy - Scottish & Southern - Centrica - Drax - GDF Suez - RWE Npower
Transmission	- CEGB - SSEB - NSHEB - NIEB	- National Grid Company - Scottish Hydro-Electric - Scottish Power - Northern Ireland Electricity	- National Grid - ScottishPower - Scottish & Southern - Northern Ireland Electricity
Distribution	- 12 Area Boards in England and Wales - SSEB - NSHEB - NIEB	- 12 Regional Electricity Companies in England and Wales - Scottish Hydro-Electric - Scottish Power - Northern Ireland Electricity	Nine companies now run the 14 distribution networks in England, Scotland and Wales: - Scottish Power, - Scottish & Southern - Northern Power Grid - UK Power Networks - Western Power Distribution - Electricity North West - Northern Ireland Electricity - GTC - Inexus
Supply	- 12 Area Boards in - England and Wales - SSEB - NSHEB - NIEB	- 12 Regional Electricity - Companies in England and - Wales - Scottish Hydro-Electric - Scottish Power - Northern Ireland Electricity	Over 70 licensed suppliers but market dominated by six companies: - EDF Energy - Npower - ScottishPower - Scottish & Southern - E.On - Centrica

Table 12.1 Market structure of the UK electricity sector during periods of nationalisation, privatisation and liberalisation (adapted from Pond, 2006)

12.4 Appendix E: Phase 1 – Sector-Level Interviewees

Job Title	Firm Type	ESC or EPC	Sector	Date	Interview Reference
Phase 1a					
CEO	Local Authority 'Arm's Length' ESCo	-	Third	22/7/2010	A1
Head of Environment Unit	Local Authority	-	Public	22/7/2010	A2
Director	Biomass Supplier & ESCo	ESC	Private	9/8/2011	A3
Principal Designer & Energy Engineer	Local Authority	ESC	Public	11/8/2010	A4
Head of New Energy and Power Research	Investment Company	ESC & EPC	Private	17/9/2010	A5
Sustainability Project Manager	Property Developer & ESCo	ESC	Third	17/9/2010	A6
Senior Research Fellow	University	EPC	Public	21/9/2010	A7
Head of Community Energy	Energy Utility	ESC	Private	18/10/2010	A8
Head of Sustainable Development	Local Authority	-	Public	19/10/2010	A9
Head Of Energy Efficiency & Environmental Care	ESCo	EPC	Private	8/12/2010	A10
Associate Director	Low-carbon Energy Consultancy	ESC & EPC	Private	17/1/2011	A11
Phase 1b					
Committee member; Professor	Community ESCo University	-	Third Public	8/7/2011	B12
Partner	Low-carbon Agricultural Think Tank	-	Third	12/7/2011	B13
Partner	Law Firm	ESC	Private	13/7/2011	B14
Energy Solutions Marketing & Strategy Director	Energy Services Provider ESCo	EPC	Private	13/7/2011	B15
Finance Director	Energy Services Provider ESCo	EPC	Private	14/7/2011	B16
Director of Sustainable Energy Finance	Big 5 Bank	EPC	Private	20/7/2011	B17
Director	Energy Services Provider ESCo	EPC & ESC	Private	20/7/2011	B18
Emergent Technology Specialist	Energy Utility Company Owned ESCo	ESC	Private	21/7/2011	B19
Sustainability Director	Energy Services Provider ESCo	EPC	Private	21/7/2011	B20
Associate	District Heat and Electricity Association	ESC	Third	22/7/2011	B21
Manager	Arms Length Local Authority Owned ESCo	ESC	Public	4/8/2011	B22
Chairman; Architect; Professor	Community ESCo Architecture Firm University	ESC	Third	9/8/2011	B23
Partner	Law Firm	ESC & EPC	Private	15/8/2011	B24
Head of Environment & Project Leader of Energy Services Procurement Framework	Regional Development Agency	EPC	Public	15/8/2011	B25
Policy Advisor	Government Department of Energy & Climate Change	-	Public	16/8/2011	B26
Director of Community Energy	ESCo Division of Energy Utility	-	Private	22/9/2011	B27
Product Development and Energy Services Manager	ESCo Division of Energy Utility	EPC	Private	28/9/2011	B28
Chief economist and Head of Fair markets	Consumer Oriented Think Tank	-	Third	10/10/2011	B29
Director	ESCo	ESC & EPC	Private	11/1/2011	B30
Knowledge Transfer Partnership Associate	ESCo & University	ESC & EPC	Private	31/1/2012	B31

12.5 Appendix F: Phase 2 - Case Study Interviewees

Case Study	Type of ESCo Variant	Dates	Interview Number	Job Title
Thameswey	Local Authority Arm's Length ESCo	10/1/2012	T 1	Chief Executive of Woking Borough Council
		10/1/2012	T 2	Thameswey Limited Group Managing Director
Energy Utility X	Energy Utility ESCo Division	22/9/2011	X 1* (B 27 in Phase 1)	Business Development Director of Community Energy Division
		16/1/2012	X 2	Director of Business Development Public Services in Community Energy Division
		19/1/2012	X 3	Head of Energy Solutions
		24/1/2012	X 4	Business Development Manager in Community Energy Division
		1/2/1012	X 5	Senior Business Manager Commercial Energy Division
Meadowside Energy Services Company (MOZES)	Community Owned and Run ESCo	9/8/2011	M 1* (B23 in Phase 1)	Former Chair of MPT & Meadows Resident
		2/2/2012	M 2	Director of MPT & Meadows Resident
		7/2/2012	M 3	MPT Trust Accountant
		9/2/2012	M 4	Chair of Meadows Partnership Trust (MPT) & Meadows Resident
Honeywell	Independent Energy Services Provider	13/7/2011	H 1* (B 15 in Phase 1)	Marketing & Strategy Director
		3/4/2012	H 2	General Manager
		4/5/2012	H 3	Business Development Manager
		22/5/2012	H 4	General Manager

* This denotes interviews conducted in Phase 1 but used as evidence to develop the case studies

12.6 Appendix G – A List of ESCos Operating in the UK

Energy Service Providers			**Local Authority 'Arm's Length' ESCos**	**Community ESCos**
ESCos Offering ESCs - Alpheon Energy - A Shade Greener - BioRegionalQuintain - Carillion Energy - Cofely GDF Suez - Cynergin - Dalkia (Veolia) - Direct Solar Power - Due South Energy - Dulas - EcoCentroGen - Econergy - Ecovision - Energy U Go Green - Engensa - EnerG Switch 2 - Evo Energy - Freesource - Freetricity - Green Dimension - Green Energy Power Solutions - Green Nation - Greenrock	- HI Say Solar - Highland Wood Energy - HOBESCO - Home Sun - Imperative Energy - ISIS Solar - My Energy Station - MyLincolnshire Renewable - Pureglo/Land Energy - PV Solar UK - Reflex Energy - Regeneco (Galiford Try) - Schneider Electric - Solar Capital - Solar Eclipse - Solar Solutions - Solvis Energy Solutions - Scottish & Southern Energy Utility Solutions* - Street Energy - Susenco - Stroma - Thames Energy Ltd - Titanic Mill Energy Services Ltd - Touch Solar - Vital Energy	***ESCos Offering EPCs*** - Anesco - Brookfield Green - DC21 - EDF* - Envido - GSH - Honeywell - RENU - Schneider Electric - Siemens ***ESCos Offering Both ESCs & EPCs*** - British Gas* - E.On UK Energy Services Limited* - Font Energy - Johnson Controls - MITIE - nPower Business Energy Services* - Self Energy	- Aberdeen Heat & Power - Enviroenergy - Thameswey Energy - Birmingham Energy Savers	- MOZES - Kielder Community Enterprises - Woodhope Dome Community Woodfuel - Eskdale ESCo - Chale Community Project
				NOTE: The ESCos listed here were identified as part of the Phase 1 empirical investigation during the interviewee selection process. Information to verify that they met the ESCo Selection Criteria in Section 4.3.2.3 was sourced via the companies' website and/or interviewees. The information is accurate as of 1/12/2011. Companies marked with an * have traditionally operated as Energy Utilities