A Skills Framework for Energy Saving

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Abstract

Energy conservation has been a widespread concern for decades for two main focuses: environmental protection and energy issues. Studies on energy savings have constantly been developing which led to many innovative energy-saving methods covering both technical and psychological aspects. Governments, enterprises and higher education are placing great importance to the understanding of energy saving measures and policies as it contributes positively to environment. Such steps also provide employment opportunities to hundreds of thousands of people. As many industries are now integrating energy-saving policies with organizational culture, there is a steady demand for energy-saving talent and skills associated. Thus, higher education is responsible to cultivate talents and skills with curriculum focusing on energy-saving principles. If specialists and graduates are to engage in the field, one of the keys is their skills and abilities. What skills and abilities are expected in organizational roles related to energy saving? So far, no scholars have specifically analysed or summarized skills on energy conservation. Therefore, this study aims to fill this gap using qualitative analysis. With desk research and detailed literature review on energy saving, this study proposes an energy-saving skills framework. As a part of data collection, a focus group interview is conducted to understand opinions about energy-saving skills among managerial personnel from high energy consumption enterprises. An analysis of energy-saving related job advertisements which shows recruiters' expectation for employees' mastery is also carried out. This step checks the validity of the proposed skills framework. The findings of this study contribute to the growing literature on energy saving and help to understand energy-saving skills in human resource management of enterprises and higher education curriculum design. Gaining a systematic knowledge of energy-saving skills is the way forward for organizations, higher education institutes and individuals to enhance long-term sustainable prospects and eradicate certain environmental energy issues.

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Declaration

I declare that this thesis is a presentation of original work and this thesis is the result of my own investigations, I am the sole author. This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree other than Master by Research of the University of York. All sources are acknowledged as References.

Chapter 1

Introduction

1.1 Research background

With the increasing rise in energy consumption in the world, energy-saving and energy efficient measures have been some of the topics of discussion and research since the 1970s (Petrecca, 1993). In this context, the word ‘saving’ means achieving the purpose of saving energy through relevant behaviour (Oikonomou et al., 2009), while ‘efficiency’ refers to the ability to provide the same or better product or service with less energy (IEEE-USA Board of Directors, 2014). Resource management have now become the major economic and social challenges (De, Verhoef and Nijkamp, 2001) with countries all over the world introducing corresponding policies to support sustainable development. In the UK, there is a prevailing trend in recent years towards green economy in the manufacturing process of traditional industries (Department of Business, Energy & Industrial Strategy, UK, 2017). Prominent market leaders are therefore focusing on paving a route for sustainable energy development and energy saving measures and policies. Businesses such as Ford, General Electric and Royal Dutch Shell regard energy saving as one of their high priority strategic targets. Many industrial sectors are witnessing a gradual shift towards a more energy efficient direction. Some of the key measures to achieving such transformation within an organization involve cultivation of energy saving ethics and behaviour among employees. It also includes recruiting talents who are competent in energy-saving policies and measures.

During the transition phase towards an energy saving culture, an organization can encounter many challenges. For example, one of the challenges the UK government pointed out in its 2017 energy report (Department of Business, Energy & Industrial Strategy, UK, 2017) is whether the market can meet the corporation's demand for skilled workforce who are professionals in energy-saving. As more and more industries now focus on energy efficient areas, such policy and organization culture shift create opportunities for richer and more diverse jobs. But such changes also bring challenges especially in skills shortage (Crouch et al, 2001). An important part of human resource management, recruitment and internal training process is the term "skill" which has always been the focus of attention (Torrington and Taylor, 2004).

In companies, the level of relevant skills is directly associated to the quality of human resources management. So, a comprehensive understanding of relevant skills is very crucial for any company who wants to transition towards energy saving policies and measures as part of their organizational culture.

With such growing changes in the market, many higher education institutes are now developing specific curricula and training programme focused on energy saving and management. Prominent institutes in the UK such as University of Cambridge, University of Oxford and University of Durham among many others are offering different levels of courses on energy-saving skills development at both undergraduate and postgraduate stages. Many companies and training institutions are now understanding the growing need to focus on energy saving skills training and human resources management.

Studies on skills framework is often conducted to provide references and recommendations for skills development and management. According to Perth and Kinross's (2015) definition, a skills framework is a system that integrates the skills, knowledge and attributes needed for people of a specific area and arranges them in a logical structure with specific order. It helps managers to make informed decisions about talent recruitment, retention, and succession strategies. Washer (2007) indicates that a skills framework can be used as an auxiliary tool which can facilitate curriculum design in higher education. There are also studies on higher education, regeneration, planning and health service concerning the exploration of skills framework, yet there is no research on energy-saving skills framework so far.

1.2 Research motivation and research gap

Energy-saving has long been a burning topic in the industry with both governments and businesses actively pursuing sustainable development. As many industries are now focusing on the adoption of energy-saving policies within their organizational culture, there is a steady demand for talent and skills associated with energy-saving. In this context, industries are now seeking talents who understand energy-saving and are competent in areas related to energy sustainability management. One of the responsibilities of higher education now is to cultivate and nurture talents and skills with curricula focused on energy saving principles. As highlighted earlier, many higher education institutes are now showing a focus on skills development in the

field of energy conservation. However, there is a lack of clarity on the skills and competences associated with energy saving roles. If a specialist or a graduate is recruited to work in the field of energy saving or assist in the transition process, what skills and abilities are expected in their organizational roles? So far, no scholars have specifically analyzed and summed up skills associated with energy conservation. The aim of this study is therefore to fill this gap by proposing an energy-saving skills framework. The classification of the energy-saving skills in previous studies have remained rather broad since scholars have paid more attention to specific skills rather than studying them according to their specific natures. Therefore, it is of necessity to establish a systematic framework for the classification of those skills.

A comprehensive energy-saving skills framework will be beneficial to human resource management since it allows recruiters to gain a better knowledge of the up-to-date skills needed (Torrington and Taylor, 2004). On the other hand, it enhances the practicality and comprehensiveness of the curriculum in higher education as the skills collected are the most current in the industry. Therefore, a skills system that reflects the recent needs of the industry is significant to the design of the training courses in companies as well as universities (Ward et al, 2017).

1.3 Research purposes and methods

Using detailed literature review of previous studies on energy saving, along with the focus group interview and job advertisement analysis, this study aims to create an energy-saving skills framework which will contain a comprehensive set of relevant skills related to energy saving. This study will serve as a guideline for academics, and corporate firms in understanding the importance of energy-saving and the role energy-saving skills play in advancing sustainable development of modern industries. Organizations, research institutes, individuals and policy makers can use this proposed energy-saving skills framework to understand energy-saving measures and skills in a comprehensive perspective. The overall objectives of this research study are twofold: theoretical and empirical objectives.

1.3.1 Theoretical objectives

The following are the key theoretical objectives of the thesis:

- Collect, identify, integrate and organize skills related to energy-saving in the existing literature by desk research.
- Propose a skills framework with clear categories which contains a comprehensive set of relevant skills for energy-saving.
- Present an up-to-date literature review on energy-saving and energy-saving skills.
- Enhance the finding of the energy-saving skills framework research by using focus group interview and job advertisements analysis.

1.3.2 Empirical objectives

The following are the key empirical objectives of the thesis:

- Understand opinions about energy-saving skills among managerial personnel from high energy consumption enterprises.
- Identify recruiters' current demands for skills related to energy-saving roles in industries.

The research approach chosen for this study will be justified, along with the overall settings of the research design involving focus group interview and job advertisements analysis. This research methods refers to some previous studies such as Johnson, Veitch and Dewiyanti, 2015; Squiers, et al, 2012; Chien, Brown and McDonald, 2009; Gould, Berridge and Kelly, 2007; Washer, 2007; Turok and Taylor, 2006, they are considered and assimilated into the design of the proposed framework. Data for energy-saving skills are derived from literature such as journal articles, books, government reports and news releases. The framework in this report is proposed following a series of processes which includes skills identification, logical skills analysis and skills classification among others.

As part of data collection, a focus group interview is conducted so as to understand opinions about energy-saving skills among managerial personnel from high energy consumption enterprises. As a representative of high energy consumption industries, papermaking sector is an ideal platform to explore further information to support the aims and objectives of this study. The focus group interview in this study involves four managers primarily related to energy and environment management from different companies within the paper sector.

Another method to support this study is to analyse online energy-saving job advertisements. Ward, Gbadebo and Baruah (2015) have tested and confirmed the value of job advertisements in a study on skills analysis. Building on this approach, an analysis of a sample of online job advertisements is carried out as part of this research study. Job advertisements as part of the recruitment process is one of the key elements of human resource management. It provides reliable and up-to-date information on recruiters' current demands for energy-saving skills. It can also help the researcher check the validity of the proposed energy saving skills framework in this study.

1.4 Contribution of the research

This study explores and classifies the skills related to energy saving in high energy consumption sectors and proposes an energy-saving skills framework. The validation of this framework is done through qualitative data analysis. The skills framework related to energy-saving primarily consists of 3 skills at the top-category followed by 23 skills at the sub-category (as shown in chapter 5). The framework is organised in a hierarchical structure, aimed at making a slick and clear-cut presentation of different energy-saving skills. This pattern of classification makes it possible to involve a wide variety of skills types and present these in a well-organized manner.

The proposed skills framework in the study fills one of the vital gaps in energy-saving field. The results achieved are of value as the theoretical framework can help people improve their understanding of energy-saving skills related to energy consumption, guiding them to gain a systematic knowledge of the classification of energy-saving skills. The methods of focus group interview and job adverts analysis both reflect the industry's attention on energy saving and its demand for people with relevant skills. The results of this study are expected to benefit businesses (such as recruitment process and internal training), higher education (such as curricula and syllabus design) and individuals and employees who desire to adopt energy-saving behaviour. Gaining a systematic knowledge of energy-saving skills is the way forward for organizations, higher education institutes and individuals to enhance long-term sustainable prospects and eradicate some of the environmental energy issues.

1.5 Structure of the thesis

The thesis is structured as follows:

- **Chapter 1** gives a basic understanding of this study, what the research is and why it should be conducted. This chapter presents the key background of the project along with the research gaps. The necessity and rationality of the research are explained here.
- **Chapter 2** provides the necessary background of this subject with a detailed literature review on areas related to this study. It provides an overview of energy-saving and skills framework.
- **Chapter 3** illustrates the research gap based on the reviewed literature and put forward the aims and objectives of this research.
- **Chapter 4** describes the research methodology applied in this research and elaborates on the research design of this study. This chapter discusses the methods used to build the framework and the methods to validate the framework. The rationality of the methods is expounded.
- **Chapter 5** indicates the establishment process of the energy-saving skills framework in detail. The key contribution of this study, the energy-saving skills framework is presented in this chapter.
- **Chapter 6** presents the analysis of the focus group interview. Professionals from the representative of high energy consumption industries, papermaking industry, are interviewed; and the content of focus group interview is analysed in detail. This analysis provides further information for energy saving and related skills in the industry.
- **Chapter 7** presents an analysis of a sample of online job advertisements related to energy saving to further assess the validity of the framework. Detailed analysis processes are described in this chapter and the discussion adds some validity to the proposed framework.
- **Chapter 8** discusses the results of this study and presents the conclusions of this study. Relevant recommendations of the application directions of the research results are illustrated. Also, some of the limitations of the research and the direction for further study are highlighted.

Chapter 2

Literature Review

2.1 Chapter overview

The main purpose of the literature review work is to survey previous studies on the subject, find out what have been achieved and what await further investigation the research field. This chapter provides an overview of background information of energy-saving and skills framework. It introduces the current situation of energy consumption, the importance of energy-saving, energy-saving skills shortage and the role of skills, previous skills framework studies and energy-saving skills training condition in higher education. Background knowledge gives a basic platform for this study and provides direction in the construction of a skills framework. Understand these broad topics is necessary to prove the necessity and rationality of this research. Also, the findings from extant literature helped maintain throughout the study a sense of the topic's perspective.

2.2 Energy consumption and energy-saving condition

Great energy consumption is one of the inevitable outcomes of the development of modern society. The issue of energy efficiency has been a growing public concern of the present century.

2.2.1 Energy consumption and energy efficiency in the world

The exploration to energy-saving has never stopped in the past 50 years (Petrecca, 1993), energy consumption is still alarmingly increasing even though much effort has been put (Abdelaziz, Saidur and Mekhilef, 2011). According to World Energy Outlook (2017), global energy demand will increase continuously by 30% in the next 20 years. Two-thirds of the growth in global energy consumption stems from developing countries, with the rest coming mainly from the Middle East, Africa and Latin America. Meanwhile, the growth of energy consumption in developed countries cannot be neglected as well. In the case of the United Kingdom, the energy consumption increased by 2,167 ktoe (1.6%) in 2016 (Department of Business, Energy and Industrial Strategy, the UK, 2017). Ecological environment quality and

resource management have become the main economic and social challenges (De, Verhoef and Nijkamp, 2001).

Energy is the foundation of economic development, social security and environmental stability. To ensure that we can reliably and securely meet our growing energy needs, the IEEE-USA Board of Directors (2014) indicates that energy and economic resources should be used more efficiently. Also, it is urgent to prepare an engineering and skilled workforce that has the necessary knowledge and skills to design, plan, construct, operate and maintain modern energy consumption systems.

Ideas for energy-saving has been an ongoing discussion since the 1970s (Petrecca, 1993). Energy efficiency refers to the ability to provide the same or better product or service, with less energy (IEEE-USA Board of Directors, 2014). For example, every time someone turns on a light switch, energy is used to light the room. In this context, energy efficiency means cutting down the amount of energy required for lighting so that energy-saving can be achieved, and this involves either technical way or other behavioural approaches. On Spafford's (2009, p.13) opinion, energy is discussed as power over a period of time (is typically reported in kilowatt-hours), if people can cut both the wattage or the duration of use, then the results are classified as "energy-saving".

In general, the key to fulfil energy conservation is the advances in technology (Oikonomou et al., 2009). According to the National Research Council (2010), by 2020 and 2030, 19% and 30% of energy usage reduction are expected to be achieved respectively with the assistance of science and technology. Undoubtedly, the introduction of technical energy-saving skills is the fast pass to energy conservation.

As Payne, Weatherall and Downy (2015) indicated, it is widely recognised that great emphasis on energy efficiency can deliver many different social and economic impacts. They highlighted that energy efficiency can have "multiple benefits", with domestic impacts ranging from growth and employment, to healthier public balance sheets, to greater health and wellbeing amongst residents. For enterprises, the economic benefits of energy savings are enormous. UK business could collectively save over £400 million a year only through improving the efficiency of hot water boilers (Carbon Trust, 2018). Besides, a global survey (2010) conducted by the

Economist Intelligence Unit shows 83% of those surveyed noted significant cost savings from their energy efficiency programs, furthermore 54% suggested that their brand reputations are enhanced owing to their energy-saving measures.

2.2.2 Energy-saving initiatives in countries

With the rapid economic growth, the urgent need for sustainable development of the environment and the effective reduction of greenhouse gases remains a global focus (Carley and Christie, 2017). At the UN's Intergovernmental Panel on Climate Conference of Parties, a new legally binding global climate deal named the "Paris Climate deal" was signed by 195 countries in 2015, which is a global agreement on tackling climate change. Since the energy issue has attracted considerable attention from the international community, many countries have since developed corresponding policies and strategies to ensure energy supply security and improve energy efficiency.

The United States is one of the earliest countries that formulated relevant policies. The policy of "The Energy and Conservation" is acted as early as in 1975. In the EU, energy conservation has focused on the development and application of renewable energy sources. For example, the European Parliament and Council issued directives on promoting the energy using renewable resources (Howes, 2010). Germany is one of the countries with a comprehensive legal framework for energy conservation and emission reduction among European countries and its recent focus is on the implementation of the environmental protection and energy conservation (Klessmann et al., 2011). It aims to reduce carbon dioxide emissions by 40% by 2020. The French government is putting its emphasis on environmental protection technology to develop renewable energy projects (Wallace, 2017). Australia's focus is on improving the quality of the workforce who work in the energy efficiency area since the government believes that it is necessary to set up a standard for selecting staff and to update energy auditing (Australia, Department of Resources, Energy and Tourism, 2010).

In the UK, the Confederation of British Industry (CBI, 2003) encouraged energy efficiency as a priority in the development of industrial sector. The government has come up with new policies to support low-carbon power generation and plans to triple the total power generation by 2020 in a more environment friendly way. What

is more, the government also provides new incentives and funds to motivate the new green products and renewable generation in the UK (Gary, 2017).

For those businesses in a highly competitive market, the pressure from global climate change seems too modest to stimulate their efforts in improving energy efficiency, while the legal requirement and economic interests are likely to be the dominant factors to prompt their implementation of energy-saving process (Jago and Stavins, 1999). In this context, governments have made relative reward and punishment for those high energy-consumption companies (Tanaka, 2011). Furthermore, they will use both hard and soft tactics with the assistance of legislation (McKane et al., 2008). For enterprises which fail to meet the energy conservation goals on time and fail to make reasonable improvement plans, the governments will order rectification promptly and impose fines or penalties within a time limit. As for the rewards, the government mainly uses monetary incentives (Handgraaf, Jeude and Appelt, 2013). For example, the financial incentives adopted by the United States included cash subsidies, tax breaks and low-interest loans.

Moreover, the Organisation for Economic Co-operation and Development has also sought to enhance people's awareness of the importance of sustainable development, particularly in the field of sustainable development and so-called ‘green’ growth (OECD, 2011; OECD, 2012). The United States also encourages education in support of fostering the efficiency of using energy and capital investment in energy-efficient technologies to rebuild the infrastructure and develop different industries with energy-smart products (Siddiqui, 2009).

To sum up, there are five key methods of how governments handled energy issues based on the studies mentioned above:

- Establish and improve laws and regulations related to industrial energy conservation;
- Strengthen energy management and supervision of high energy-consuming enterprises;
- Formulate economic policies that encourage fiscal revenue tax incentives for industrial energy conservation;
- Continuous research and development of new technologies for energy conservation and promotion of energy-saving products;

- Improve the quality and awareness of the workforce in the industrial sector, especially in terms of energy use.

Apart from enacting laws and increasing financial investments, governments have provided considerable encouragement to energy conservation, including supporting technical development of energy efficiency, and raising the energy-saving awareness and quality of the employees. In UK, enterprises contribute to over a half of the domestic energy consumption, which means they are supposed to take responsibility for the consumption (The Telegraph, 2018). Sustainability strategy has already been prioritized by market leaders, such as Ford, General Electric and Royal Dutch Shell (Ford Motor Company, 2018; GE Sustainability, 2018; Royal Dutch Shell, 2018). Energy-saving management has brought these companies a lot of good changes. As such a universal trend grows, companies have started to embrace an energy-saving era, spontaneously or passively.

2.2.3 Drivers and barriers in companies in terms of energy-saving

Governments and enterprises have made a lot of attempts in energy saving which brought factors that can drive energy conservation, but barriers still exist.

2.2.3.1 Drivers in companies in terms of energy-saving

Governmental policies with reference to environmental protection and sustainability creates a positive atmosphere for enterprises to embrace reformations in energy conservation (De, Verhoef and Nijkamp, 2001). Payne, Weatherall and Downy (2015) pointed out that it is high time for companies to follow the course of energy preservation. To achieve that, sustainability has been included into the future developmental plan in most corporations (Loorbach, 2010).

Energy-saving brings considerable benefits. Financial benefits of energy efficiency is the direct driving force of energy conservation reforms in most companies. Effective energy control greatly reduces energy consumption and manufacturing cost by enhancing the performance of energy utilization. For instance, energy accounts for 40% of the running cost over its lifetime in the building trade (E.ON, 2018).

For the majority of companies, the most immediate interest in energy efficiency investments is to generate cost savings (Siddiqui, 2009). The impetus from considerable economic benefits makes corporate management level more committed

to energy-saving investment. Apart from this, the energy efficiency can also contribute to commercial interests and enhance brands' reputations. Besides, energy-saving culture and environment will have a positive impact on promoting the process of sustainable development in a company. According to comprehensive literature review, Sardianou (2008) and Brunke, Johansson and Thollander (2014) identified several key drivers regarding energy-saving which are summed up in Table 2.1.

Table 2.1: Key drivers in companies in terms of energy saving

Drivers	**Factors**
Awareness and information drivers	• Personal commitment of individuals
	• External pressures like the company rules
Decision making drivers	• Long-term energy strategy
	• Commitment by top management
Financial and economic drivers	• Long-term benefits
	• Lack of budget funding
	• Access to capital
Internal drivers	• Threat of rise in energy prices and energy taxes
	• Increasing energy prices
	• Government support like allowances or public financing
Organizational environment	• Green/sustainability company culture

(Sardianou, 2008; Brunke, Johansson and Thollander, 2014)

As mentioned earlier, government policies and financial factors are the leading drivers behind the conservation of energy in industry. Previous studies summarised the factors that promote energy-saving process in companies as Table 2.1 shows. Individual awareness (such as employees' energy-saving awareness) and decision-making drivers (such as managers' commitments of energy-saving exploration) are the contributing factors of the introduction of the energy-saving policy. They also point out the importance of economic drivers in or outside the company (budget storage or energy price changes) and government support. All these factors continually foster a company culture of sustainability and make a difference in the course of energy saving.

2.2.3.2 Barriers in companies in terms of energy-saving

Even though companies are acknowledging the benefits associated with energy efficiency, there are still some barriers that hinder them from implementing enterprise-wide energy-saving measures.

A lot of literature highlighted this topic. Jaffe and Stavins (1994) for instance, pointed out the technical difficulties that still lie in operational, managerial and behavioural level. Thollander et al. (2013) stated that the most crucial barriers to energy efficiency are organisational economic issues. Although productivity can be significantly improved after energy-efficient investment (Worrell et al., 2003), companies may struggle with the initial expensive investment. Therefore, future energy systems will need not only new technologies, but also new policies, governance arrangements, business and finance models (Jackson and Senke, 2011). According to a study by Sardianou (2008) and Brunke et al. (2014), energy-saving barriers can also be grouped into the following four categories.

Table 2.2: Key barriers in companies in terms of energy-saving

Barriers	**Factors**
Technical barriers	• Existing technology has been replaced
	• Skills shortages /lack of technical staff for implementation
	• Availability of appropriate infrastructure
	• Technology not applicable to actual process
	• Technical risks such as the risk of production disruptions
Financial & economic barriers	• Hidden costs
	• Cash flow prevents implementation
	• Absence of economic incentives policies
	• Cost of production disruption/ hassle/inconvenience
	• Bureaucratic procedures to get governmental financial support
Investment barriers	• Cost of obtaining information about purchased equipment
	• Low rates of return & long payback periods
	• Auditors assessment inaccurate
	• Cost of production Disruption/ hassle/inconvenience
	• Measure not profitable
	• High initial capital cost
	• Rules of investment decision making
Awareness & information barriers	• Information issues on energy contracts
	• Inadequate national policies and regulations
	• Poor information for the energy efficiency decisions
	• Lack of time and other investments more important
	• Lack of interest in energy efficiency interventions
	• Lack of support from high-level manager

(Sardianou, 2008; Brunke, Johansson and Thollander, 2014)

In Table 2.2, key barriers regarding energy-saving are summed up. Skills shortage and the lack of high-quality technical staff etc. remain the main barriers. Financial shortage remains severe which bring about uncertainties and hesitations over the decision-making of investments in energy conservation. Besides, factors like cost of production disruption and high initial capital cost etc. are the main barriers in the process of energy saving investment. Awareness and information barriers due to rules of investment decision making, poor information for energy efficiency decisions and lack of time and other investments etc. are also other crucial issues.

Based on the Report for Long-Term Strategy for the Development of Energy Efficiency Assessment Skills Training Needs Analysis (Australia, 2010), insufficient knowledge, skills and experience in industry are major problems. Skills shortages often emerge in specific areas such as energy data collection, analysis, assessment, installation, the use of appropriate monitoring equipment and the development and promotion of energy efficiency business cases to name a few. So the industry has been concerned about these aspects. The detailed discussion on the issue of skills shortages will be presented in the skills section (See section 2.3).

2.2.4 Green economy in the UK

The green economy has been developing in the UK in recent years. It is defined as an economy in which value and growth are maximized across the whole economy to reduce environmental risks. This type of economic development can increase profits and competitiveness, making UK industries stronger and more resilient. As a result, the environmental damage is expected to be reduced, while energy security, resource efficiency and the recovery of the environment from climate change would all be improved (Department for Business, Innovation and Skills. the UK, 2011).

The development of the green economy brought a lot of jobs (Wei, Patadia and Kammen, 2010). For example, The Carbon Trust (2009) noted that the areas which are rich in wind energy resource in the UK could create plentiful jobs by 2020 as the UK has 40% of Europe's wind resource. Accordingly, these employment opportunities from energy efficiency will also increase the demand for skilled engineers and other professionals. To catch up with the developing trend of the low-carbon economy, workforces are required to equip new skills to adapt to the rapid shift of the industry.

Overall, these studies highlight the need for the skilled workforce to fully develop the green economy and make the utmost use of it, and to support the sustainable development. In this context, any business today, should manage to use resources efficiently and sustainably and to hire workers with professional skills and technical qualifications in order to fit for the transition to a green economy (Australia, Department of Resources, Energy and Tourism, 2010).

2.3 Skills in terms of energy-saving

Skills are fundamental to any jobs. And right skills are capable of facilitating the course of industry. To achieve higher energy efficiency, it is necessary for enterprises to harness a combination of different energy-saving skills.

2.3.1 What is skill

In accordance with previous literature, there is no unified definition of skill since it may differ in the context of different fields (European Commission, 2018). Although the term skill is commonly used, it is not easy to define. According to Attewell (1990), "*skill*" can be defined as a synonym with competence which evokes images of expertise, mastery, and excellence. Skills should be defined in line with specific activities which have a wide range of complexity, from "*mopping the floor*" to "*performing heart surgery*". Jessup (1991) believed that skills can only be demonstrated through their detailed performance (doing something). Clarke and Winch (2006) also indicated that workers with 'skill' possess knowledge appropriate to the task at hand, and implied what is essential in the working environment. In addition, Green (2011) put forward three critical features of skill:

- "*Productive*" which means skills produce value,
- "*Expandable*" which means skills are enhanced by training and development,
- "*Social*" which means skills are determined by social needs.

As "*skill*" is one of the keywords in this research, it is essential to determine its specific meaning in the context of this project. Definition can be found in the context of European Qualifications Framework: "*skills are described as cognition (involving the use of logical, intuitive and creative thinking) and practice (involving manual dexterity and the use of methods, materials, tools and instruments)*".

The relationship between the terms "*skill*" and "*competence*" has been frequently discussed by scholars. Green (2011) indicates that skill is usually regarded as social science parlance, like other vocabularies, such as "*ability*", "*competence*", "*knack*", "*aptitude*" and "*talent*". On Attewell's (1990) definition, the core of competence is the ability to do something well. Ahsan and Khan (2013) highlighted the relationship between the competency and behaviour. They state that a competency is a measurable pattern of behaviours which individual needs to perform or approach the tasks of their jobs effectively. Competency enables people to fulfil tasks or become even ultra-productive in their work (Mansfield, 1999), which can be also related to their job efficiency and organizational performance (Brophy and Kiely, 2002). Comparing with the competency, skill is more focused and the hierarchy is more detailed. "Hierarchy" here refers to "*an arrangement or classification of things according to relative importance or inclusiveness*" which is a logical way of grouping (Oxford Dictionaries, 2019, para. 1.3).

In this study, "*skill*" refers to the ability to apply knowledge to complete tasks and solve problems which can be described as "*the ability to do something*", while the "competence" is treated as further work to explore the competence needed or the competence levels. In most condition, "*capabilities*" and "*skills*" can be used interchangeably with regard to ability (Washer, 2007).

Mansfield (1999) claimed that skill is more focused on the work-related concept (such as tasks or functional criteria which managers can refer to) or on the generic potencies qualities (i.e., behavioural competencies). It can be defined as the precise requirements of work. Therefore, skill is regularly used as an important part of a job profile and making it clear about what specific skills are needed. This can help people know whether any training and experience have prepared them well for a specific job.

2.3.2 Why skills are important

In modern society, skills provide competitiveness in a particular area. It provides increased employment opportunities and career development opportunities. As it says:

"*Skills and knowledge together comprise a nation's human capital on which the economy and society depend. For employers, they are critical for productivity and,*

for the individual, a significant determinant of wages and wellbeing."

—— Future of Skills and Lifelong Learning, Foresight Report, 2017, p.6

2.3.2.1 Skills shortages to today's society

In the energy efficiency area, the UK has witnessed a growth of over 6,400 renewable projects in recent years which provides an excellent initiative for increasing employment. Although social development creates richer and more diverse jobs, it brings challenges at the same time, of which skills shortage has been put forward as a vital one (Crouch et al, 2001). As Ward et al. (2017, p.1) described, "*the cry of a skills shortage is regularly heard from engineers to banks in the UK press for Engineering as well as other employment sectors. From engineers to banks struggle to fill skills shortage*". Also, it seems that the skills gap in the industry continues to increase because the UK is leaving the European Union (Richard, 2017).

The situation of the labour market is not optimistic. According to the IET 2015 Skills Survey, 61% of the UK industry found that graduates fail to meet their reasonable expectations, 40% of them suggested universities' training contents cannot keep up with the transformation of the industry and 28% of them pointed out technical degrees of graduates do not meet their needs. In general, Employers expressed their strong dissatisfaction with the quality of the graduates.

At the same time, the demand for skilled workforces is increasing. 51% of businesses are reported to be in need of more engineering and technical staff. However, due to the insufficiency of skills supply in the external market, it is difficult to recruit enough qualified staff. The majority of employers reported that the lack of skills in the external market is attributable to the low quality and insufficient supply of young people who are entering the industry. Thus, it is essential for universities to produce graduates who can fit these gaps.

Apart from the universities, the businesses also have the responsibility to provide staff with professional training to equip them with the right skills and offer them good career paths (IET Skills Survey, 2015). The employers, educators and government must take actions to cultivate more diverse applicants and help young people to prepare for the high demands of working life (Sliva, 2008). As discussed

earlier, skills are associated with the social feature (Green, 2011), all parties need to re-examine whether their skills meet the requirement of this society.

2.3.2.2 The importance of skills

Advances in technology have been rapid and frequent since the Industrial Revolution (The Institution of Engineering and Technology, 2017). Applicants' mastery of professional skills with reference to energy preservation is closely related to whether they are of competence in job applications and career development (Andrews and Higson, 2008). What's more, employees' proficiency in energy-saving skills contributes to the progression of the papermaking industry. For most companies, they prefer to use existing staff to fill vacancies (IET Skills Survey, 2015). In order to catch up with the enterprise's development, employees need to have a clear evaluation of the skills they possess to further enhance their competitiveness.

Having a good understanding of skills is significant for employers. It is common to provide internal training for employees to develop their role-specific skills in companies. According to IET Skills Survey (2015), over the past 12 months 59% of businesses have provided staff with job-specific trainings, among which 31% are initial trainings. A thorough understanding of the skills system helps managers to formulate viable training strategies and recruitment plans (Australia, 2010).

Specifically, in the energy-saving area, technologies will bring a sharp drop in energy consumption (National Research Council, 2010). IEEE-USA Board of Directors (2014) pointed out that the society needs to prepare engineering technicians which master knowledge and skills to design, plan, operate and maintain modern energy systems. Therefore, understanding the relevant skills is crucial for the industry and people who are or are about to enter this field (Siddiqui, 2009). The content of energy-saving skills will be described in detail in chapter 5.

2.3.3 Skills, behaviour and attitude regarding energy-saving

Professional skills play an important role in energy efficiency, these skills can be used to improve the habits of equipment installation and using, intelligent controls, use of renewables, etc. which are technological as opposed to behavioural. However, the actions of energy saving are actually happening in all aspects of people's daily

life and work, from “turning off the lights” to “replace more energy-efficient boiler equipment”.

People always hope to use technology to achieve energy conservation, however, the energy waste caused by irresponsible behaviours and practice may reduce or affect their effectiveness. In fact, the energy waste caused by bad behaviours at workplaces can be very severe. Previous studies (Masoso and Grobler, 2010; Nisiforou, Poullis and Charalambides, 2012) identified that more than 50% of energy is used during non-working hours than during official working hour. These energy wastes are largely due to user's bad behaviour and practice, such as leaving lights and equipment on even after work. U.S. Department of Energy (2018) suggested that the reason behind the waste of behaviour is the lack of basic knowledge of energy conservation.

Behaviours also affect the effectiveness of the use of energy-saving skills. Buchanan et al. (2004) stated, “*behavioural*” is one of the types of skill which partly reflects the personal workforce qualities. When the individual possesses the skills, how they apply the skills is the behavioural issue. Since technology skills are operated by humans, the error of the human may part lead to the failure of the whole task. If the behaviours and attitudes of occupants have not changed, even though they master certain skills, they can hardly accomplish the goal of energy saving. Therefore, it is crucial to raise workers’ awareness of energy conservation so as to improve their behaviours (Masoso and Grobler, 2010).

A positive attitude of energy-saving is the first step to take actions and make it reality. As Eagly and Chaiken (1993) defined, attitude is a mental tendency expressed by assessing a certain entity with some degree of preference and this kind of psychological tendency often contains the corresponding behavioural tendencies. Masoso and Grobler (2010) also pointed out that approaches like hosting campaigns with the theme of energy awareness, designing incentives and punitive measures etc. can improve occupants’ behaviours regarding energy-saving. Hence, having a positive attitude of saving energy will pose a positive influence on the implementation of energy saving behaviour. In the long term, positive attitude can also play a good foundation for learning energy-saving skills (Siddiqui, 2009).

However, it should be noted that for most employees, especially non-technical employees, their understanding of energy conservation still rests on a very basic level and their awareness of energy saving is weak as well (Nisiforou, Poullis and Charalambides, 2012). Every employee is potential energy-saving performer and participant whose attitudes toward the results are crucial.

Apart from the individual's inherent beliefs which influence behaviours (Stern et al., 1999), Turnbull (2001) indicated that corporate values and culture have a strong influence on individuals' behaviours in organizations. Organizations with clear, mandatory norms and rules are more conducive to shaping staff's behaviours (Furnham, 2012). Companies with the values of "*environmental protection*" and "*sustainable development*" will positively influence employees' attitudes towards energy efficiency, and further motivate employees' daily energy-saving behaviours in the company. For example, under the influence of sustainable organizational culture, employees may let the display sleep when leaving the seat and turn off the lights when they leave the workplace, etc.

2.3.4 Skills framework

The skills framework is a common term in the field of human resources and education. It is an organizational category which clearly demonstrates the skills required in a particular field.

2.3.4.1The definition of skills framework

According to Perth and Kinross's (2015) definition, a skills framework is a system that integrates the skills, knowledge and attribute properties needed for people of a specific area, and arrange them in a logical structure with specific order. They also claimed that creating a theoretical skills framework is an effective method to assess, maintain, and monitor the skills, knowledge and attributes of staff in a specific field. The framework allows people to obtain some professional knowledge to measure their current level of skill and to make sure they have the expertise to adapt to the rapid development of industries (Squiers, et al, 2012). Besides, it helps managers to make informed decisions about talent recruitment, retention, and succession strategies. When it is applied in education, Washer (2007) indicated that a skills

framework can be used as an auxiliary tool in higher education context, and it can also facilitate curriculum design.

People can straightforwardly get clear about the specific requirement in a specific field through a list of skills in a skill framework, in addition to the organization, which can make full use of the framework to improve itself in an accurate direction, individuals can also take advantages of it to decide their orientations of their personal development.

2.3.4.2 Previous studies on skills framework

Before designing the framework, previous research about skills framework is reviewed. So far there seems to be no skills framework for energy-saving in the UK. Here are 6 examples of skills framework study presented below in chronological order, and the themes range from education to health science. Although the research areas are different, the characteristics in common such as the general research method of the skills framework and the research boundaries provide valuable inspiration for the framework design of the current study.

Table 2.3: Previous studies on skills framework

Example 1: A skills Framework for Regeneration and Planning (Turok and Taylor, 2006)	
• Study purpose	Aims to present an analytical framework to help structure regeneration skills. In addition, emphasize the importance of the skills framework through evidence of practitioners and community member's survey.
• Building process	It began with a brief review of emerging ideas and understanding. Collect data through interviews, focus groups interview and surveys from regeneration participants and stakeholders as the main information of framework creation.
• Framework type	There are two layers with defined 22 different skills in the framework. Four distinct skills groups are highlighted. Each group identifies a full range of skills, but all of them are general description (e.g. adaptability and flexibility skills under the process skills group). The framework does not cover the whole series of specific technical and professional skills, this is outside the scope of the framework outlined here.
• Framework value	The study defined skills related to regeneration practitioners, also clarified individuals learning needs and skills requirements of employers and investors. The proposed framework provides a good reference for the subsequent skills framework construction in regeneration area.
Example 2: Key Skills Framework for Higher Education (Washer, 2007)	

• Study purpose	Developing a framework to enable graduates to possess skills that meet the expectations of employers, and make the results of higher education can better support students' careers after graduation.
• Building process	Surveying the key skills literature by reviewing previous key skills study in higher education. Followed by proposing a framework for key skills that is adaptable to higher education context. Finally, examines some issues regards to implementation of the framework.
• Framework type	The individual framework is divided into two layers and presented in the form of a chart. The first level is skills categories which have 7 sections in the framework, and the second level is a specific skill description for the corresponding skill category. A total of five frameworks are presented in this study. It shows how the different key skills of undergraduates can be expected to develop over the five stages of the learning process.
• Framework value	This paper proposes a key skills framework which provides inform and structure to innovations in university teaching. Also, it can enhance the quality of content learning by facilitating experiential.
Example 3: the National Health Service Knowledge and Skills Framework (Gould, Berridge and Kelly, 2007)	
• Study purpose	Propose a skills framework to help identify and harmonize career development goals for nurses.
• Building process	The skills framework linked to a process which represents the learning cycle. A series of learning needs are identified by reviewing such a process. Learning needs from staff and managers were also collected. Both of the needs form the cornerstone of the content of the skills framework.
• Framework type	The framework is skill-based and presented in the form of lists. The framework consists of six main core dimensions and an additional 24 specific dimensions. The skills are generic which have been developed in the medical field so they are appropriate for all non-medical staff.
• Framework value	It provides an objective framework to meet both individual and service needs. In addition, it enables managers and staff to determine the key skills necessary for particular clinical roles and to assess whether an individual is able to perform them. Also, it enables managers to identify gaps in knowledge and skills for teams across a service or an entire trust using standard job profiles. In addition, managers and staff should be able to see how the work of a particular individual or service relates to others, thus enhancing team-work.
Example 4: Children's Hand Skills Framework (Chien, Brown and McDonald, 2009)	

• Study purpose	In order to a proposed framework which presents a series of functional hand skills that children may exhibit when performing daily functional tasks.
• Building process	Developed the framework content based on literature review of the existing hand skill models and instruments. Then validate the framework by reviews from experts' evaluation feedback questionnaires.
• Framework type	The framework is divided into 6 distinct categories according to literature review. Each of categories is further broken down into three to seven sub-categories which is recognized by experts. Definition and examples are attached with sub-categories.
• Framework value	Such a framework can be used as a conceptual guide to analyze and describe children's hand skills in the assessment and intervention process. It provides a valuable reference for meeting the different needs of both professionals and non-professionals. This would also assist in providing more evidence-based hand skill assessment and intervention processes.
Example 5: Health Literacy Skills Framework (Squiers, et al, 2012)	
• Study purpose	To create and introduce a framework for conceptualizing health literacy that builds on existing theoretical frameworks to guide the development of interventions to improve the target subject, health literacy.
• Building process	Review and synthesize existing theoretical frameworks in health literacy, and the incorporate the structure from existing frameworks into the proposed framework to develop a new one. Application path and verification method for further work has been discussed in the end.
• Framework type	The framework is organized into 4 primary components according to the elements of theme background, factors affecting the theme, skills required to perform a mission.
• Framework value	Based on previous theoretical frameworks, this framework can provide support for further discussion and advancement in operationalizing a complex construct. It depicts how health literacy functions at the level of the individual. The framework also reflects how factors external to the individual influence the constructs and relations represented in the framework.
Example 6: Murdoch Communication Skills Framework (Johnson, Veitch and Dewiyanti, 2015)	
• Study purpose	In order to develop a systematic campus-wide framework to support staff and students intended to promote communication skills within discipline-based courses at Murdoch University.

• Building process	It began with analysis and exploration of the problem of embedding the teaching, learning and assessment of communication skills in university curricula. Then, a design-based research approach to generate guiding principles for embedding communication skill across the curriculum in higher education. Finally, drawing on existing practices and expertise, generating design principles and interventions, and testing and refining these through further practice.
• Framework type	The framework is based on a multi-layered approach. It is presented in the form of a frame flow chart. The framework includes communication skills rubrics, a set of guiding principles. There is no detailed skill description but mainly shows the factors affecting communication skills training and the channels for providing skills support. The focus is on how to develop abilities, not on the content of the abilities themselves.
• Framework value	The framework established the basis for further work. Also, reflect on the effectiveness of particular aspects and finally to refine both the practical Framework itself. In addition, it clarifies how teaching, learning and assessment of communication skills can be embedded into a university-wide Framework. Finally, the framework provides a reference for the development of communication skills between students and teachers.

Table 2.3 indicates that whether it is for acquiring emerging ideas, understanding background information, or as basic resources for building a framework, reviewing previous research is used by most researchers as a starting point for framework research. The skills framework ought to be built on the basis of the immense data collected so as to ensure it is in accordance with the current situation of the market. For further data collection, methods such as interviews, group interviews, and surveys focused on target field are commonly adopted (Chien, Brown and McDonald, 2009; Gould, Berridge and Kelly, 2007; Turok and Taylor, 2006). These methods can be used to further acquire the data to enrich the skills framework and to some extent verify the assumptions made before. The proposed skills system is usually shown in a form of framework. Besides, most of these skills framework studies have put the work of validation and application in the further work.

The 6 examples shown in Table 2.3 indicate that it is feasible to use the form of the framework as a way to present a skill system because of its integral, intuitive and visible nature. This involves the design boundary of the framework. Though the frameworks above are built for different fields, the thought and rationality embodied in the research method are worth studying.

2.4 Skills in recruitment process within companies

Recruitment is an important channel for companies' human resource development; and understanding the skills requisite to a particular position is crucial in the process.

2.4.1 Recruitment in human resources management

Human resources management regards employees as the most important asset within an organization, believing in their potential and capability to grow and develop through a series management courses or training. As the basis of business operations, basic functions of traditional personnel management cover the following aspects (Tichy, 1981), as shown in Figure 2.1 below.

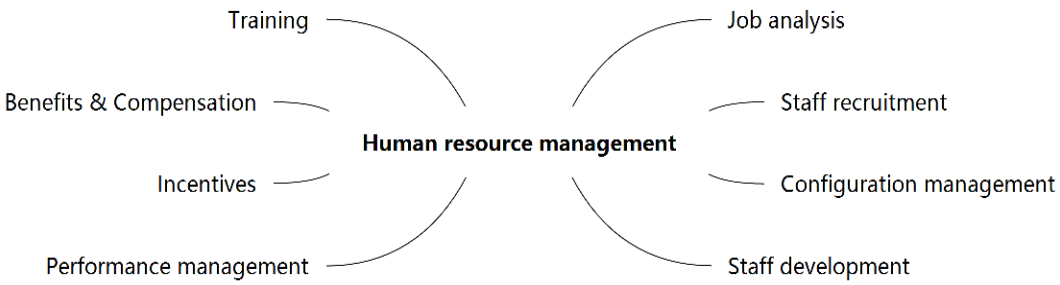

Figure 2.1: The composition of human resource management (Tichy, 1981)

As an important link in human resource management, employee recruitment is a purposeful, planned corporate behavior "*carried out by the organization with the primary purpose of identifying and attracting potential employees*" (Breaugh and Starke, 2000, p. 407). It performs the essential function of drawing an important resource, human capital, into the organization (Barber, 1998).

As economic globalization accelerates continuously, high-quality talents are regarded as the key competitive factor (Wright and McMahon, 1992). Barney (1991) proposed that in the early 1890s human resource is the source of competitive advantage because of its nature of value, scarcity, imitation and irreplaceability. The method to attract and retain competitive talents has been the key that influences the survival and development of enterprises. The value of recruitment is not limited in talent-hunting, its quality affects the efficiency of business operations and even the survival and development of companies. In short, recruitment is extremely strategic (Boxall and Purcell, 2003).

2.4.2 Recruitment method and job advertisement online

As one of the important aspects of human resource management, recruitment has achieved remarkable progress. As modern information technology advances rapidly, the traditional way of recruitment has witnessed great changes. Commencing from the mid-1990s, internet has gradually replaced the publication of job advertisements in newspapers and magazines, or recruitment campaigns on television and radio, large-scale talent recruitment meetings, etc., have become an increasingly influential recruitment process (Boydell, 2002).

Online job advertising is nowadays a widely-used, effective method for talent-hunting. According to Jobvite's (a job recruitment website) 2012 survey of the status of social media recruitment, 82% of the companies used social media recruitment in 2010, and 92% by 2012. E-recruitment has seen substantial growth over a number of years (Torrington and Taylor, 2004). With its broad coverage, huge amount of information, high cost performance, and small time and space restrictions, online recruitment has emerged from the traditional recruitment method and gained considerable popularity among all recruitment methods, becoming the first choice for talent recruitment. The use of online recruitment methods is now widespread among UK organizations (Parry and Tyson, 2008).

Over 3 million people are being recruited by employers per year in the UK (CIPD, 2017). Employers are supposed to create enough jobs and sell them to potential employees. But even then, it is rather difficult to find people who are both willing and able to fill the vacancies. Anyway, recruitment is a costly and difficult process. To improve the quality of recruitment, it is important to place a good job advertisement.

2.4.3 Job advertisement and skills

A competitive global market calls for multi-skilled and flexible workforce. According to IET 2017 Skills Survey (The Institution of Engineering and Technology), almost half of the employers in the UK face difficulties in the availability of applicants in the external labor market with the right skills while recruiting. More and more enterprises recognize the importance of advertisements. The description of skills in the job advertisement is supposed to be more precise so

as to target and select suitable and qualified applicants (Currie, 2006). Generally, a job advertisement contains the following main elements:

- "*Job description*": a list that details the duties, responsibilities, reporting relationships, working conditions of the specific job;
- "*Job specifications*": shows the requirements of the job, that is, the requisite skills, education, personality.

Though there is no standard format for a job description, skills requirement is the indispensable section in most job advertisements. The logic lies in the fact that recruitment is a process involving assessment, interview, and background review, etc., during which the analysis of knowledge, competence and skills is carried out (David, 1973; Torrington and Taylor, 2004).

A measurable skills, knowledge and competencies are also the heart of all enterprises' performance management process (Torrington and Taylor, 2004). Precise description about the requisite skills and competencies of the job role enhances and ensures the efficiency as well as quality of the recruitment (Dessler and Tan, 2006). The most important is that a good job description helps the managers decide who to hire or how to train the recruits. Among numerous recruitment models, the module based on skills frameworks has caused mounting concern. This approach enables organizations to test and assess the target ability of the applicants (Bratton and Gold, 2017).

2.5 Energy-saving skills in the UK Universities

Energy conservation has gradually come into greater focus among higher education institutions. In U.K., domestic universities have introduced and offered relevant curriculum sections and training programs, aiming to train students' energy-saving skills.

2.5.1 Higher Education and skills

Since 1980s, employers looked on higher education as a major provider of highly-skilled talent and thus called on higher education curriculum to be more closely relevant to meet the needs of business (CBI, 2003). In addition to appeals from employers, a supportive government is another driver to increase the focus on skills.

The government seeks to train their graduates in a better way, preparing them for the upcoming work. It is believed that the focus and teaching aim of university courses should keep adjusting according to the latest competitive employment market.

It is important to master subject-related skills for students since university period is the most critical stage for them to acquire skills. In order to attain an ideal career after graduation, students should prepare themselves to demonstrate the skills and meet the expectations of employers. In other words, universities are responsible for identifying and developing skills that graduates need to master so as to achieve a brighter career (Washer, 2007).

The focus on skills has been particularly prominent in UK since the Higher Education Report (1997) is published. According to the report, the skills agenda will be seen as part of the employability agenda to help students develop skills to cope with future careers. In response to this situation, universities and colleges have been developing different syllabuses for various subject areas and developing students' corresponding skills. These various "*skills*" terms, either professional or generic ones, are frequently used in high education in the UK and other countries (Holmes, 2001).

As described earlier, employers expect talents of higher education to acquire considerable technical proficiency in specific professional skills. No matter for external talent employment or internal staff upgrades, companies anticipate universities to provide better skills training services. In the field of energy and energy conservation, employers are searching for graduates who match the requisite energy-related skills, and seeking support for internal staff training from higher education. Thus, it is important to obtain a comprehensive knowledge of how energy-saving related courses are set in universities.

2.5.2 Energy-saving related curriculum in the UK Universities

The field of energy and energy conservation emerged as modern industry developed. Are there any modules in the university involve energy and energy conservation? If so, in what forms do they exist? In order to understand the current situation of skills training in energy and energy-saving in the U.K. universities, this study collected curriculum information through visiting official websites of domestic colleges and universities.

Most engineering departments in the surveyed institutions offer different levels of energy-related courses for undergraduates and postgraduates, to cope with the situation of increasingly insufficient energy resources, and the challenge of transferring the current industry into a more environmental and sustainable mode. In the real market, job vacancy in the field shows healthy expansion and attracts strong competition in future (Target jobs, 2018). Table 2.4 presents the modules and courses related to energy and energy efficiency offered by major universities in the U.K. from 2018 to 2019.

Table 2.4: Energy and energy-saving related syllabus/modules in UK universities

University	Department	Subject	Degree	Syllabus/Modules
Imperial College London	Department of Civil and Environmental Engineering	Energy system	Bachelor	• Energy in modern society • Introduction to energy technologies • Summary debate on future of UK energy policy
		Environmental Engineering	Bachelor	• Waste & resource management
		Environmental Engineering	Master	• Environmental analysis • Environmental management & Decision making • Water and wastewater treatment
		Energy Technologies	Master	• Energy topics • Energy systems and efficiency • Present and future energy systems • Renewable energy • Driving change towards sustainability
University of Cambridge	Department of Engineering	Engineering for Sustainable Development	Master	• Energy and climate change • Fundamentals of environment economics • Renewable electrical power • Sustainable architecture and urban design • Sustainability methods and metrics
University of Durham	Department of Engineering	New and Renewable Energy	Master	• Energy Conversion and Delivery • Low Carbon Technologies

University of Exeter	Renewable Energy Engineering	Renewable Energy	Bachelor	• Energy Management, Sustainable Enterprise • Energy Policy • Energy Policies for a Low Carbon Economy • Energy Storage Technology • Science for Energy Engineering • Sustainable Architecture • The Politics of Climate Change and Energy • Electrical Energy Conversion and Transport
		Renewable Energy Engineering	Bachelor	• Energy Management • Energy Policy, Markets and Law • Renewable Energy Systems • Science for Energy Engineering • Sustainable Architecture
University of Lancaster	Lancaster Environment Centre	Environmental Science	Bachelor	• Energy, Economy and Environment
		Engineering Science	Bachelor	• Renewable Technologies
University of Leeds	Department of Engineering science	Sustainable Cities	Master	• City Systems: Energy • Energy use and low carbon societies • Skills for Urban Sustainability • Sustainable urban mobility planning
University of Loughborough	Department of Architecture, Building and Civil Engineering	Built Environment: Energy Demand Studies	Master	• Building Energy System and Models • Energy demand in Context • Energy Demand: Society Economics and Policy • Energy Theory
		European Master's in Renewable Energy	Master	• Biomass • Solar power • Water power

University of St Andrews	School of Geography and Sustainable Development	Sustainable Development	Bachelor	• Environmental management • Frontiers in Sustainability Research • Governance for Sustainability • Introduction to Environmental Economics • Sustainable technologies • Sustainable economies, social justice • Transitioning to Sustainability
		Sustainable Development and Energy	Master	• Energy Economics • Financial Management of Energy • Interrogating Sustainable Development • Introduction to Global Environmental Change • Legal Regulation of Energy • Master Class in Sustainable Development • Management and Marketing • Strategic Management
University of Oxford	Department of Engineering science	Engineering Science	Bachelor	• Energy system • Engineering • Sustainability and the Environment
		Engineering Science	Master	• Energy

IET 2015 Skills Survey showed the majority of the UK industry found the graduates fail to meet their reasonable expectations and suggested the universities' training contents cannot keep up with the transformation of the industry. As a response, universities provide a series of courses to fill the gap. Also, they show their consideration and intention of offering such courses.

University of St Andrews believes that "*sustainable Development is widely regarded as the most promising framework for addressing environmental and developmental challenges in the twenty-first century*". The courses they offer will "*enable students to understand developmental challenges from multiple perspectives, and to utilise the knowledge to tackle these challenges and realise the opportunities they create*" (University of St Andrews, Sustainable Development, 2018).

Department of Architecture in University of Loughborough (2018) recognizes that there is a serious shortage of skills in the fast-growing energy industry. As they claimed, "*within the rapidly expanding European renewable energy industry, an urgent demand exists for more post-graduate trained staff, specialised in renewable energy technology*". The challenge for practitioners in the industry is to find a powerful way of implementing sustainable development at the practical level, which requires the new generation of engineers possessing a series of skills to face up to all these challenges.

Department of Engineering in University of Cambridge (2018) believes that today's world faces major challenges in meeting current and future needs for sustainable and safe energy supply and use. To cope with this, they launched a program of Energy Technologies for students who are willing to "*help tackle these problems by developing practical engineering solutions, and to learn more about the fundamental science and the technologies involved in energy utilization, electricity generation, energy efficiency, and alternative energy*".

The program of new energy and Renewable energy offered by Department of Engineering in University of Durham is designed to equip graduates with the skills to achieve sustainable energy and environmental sustainability so as to rise to the upcoming strong challenges. Through the course, students can not only solve the problems encountered in traditional engineering, but also gain a comprehensive understanding of the energy system, the relevant technologies as well as their interactions.

Today, the UK government is seeking provision for affordable low-carbon and safe energy which has been a major challenge (University of Lancaster, Lancaster Environment Centre, 2018). In this context, the courses offered by Lancaster Environment Centre provides "*an overview of energy technologies and the energy system within the UK and this will offer the opportunity to think broadly across UK energy provisions and options for the future.*" The module equips the students with a comprehensive understanding of the economic, political, technological, resource and environmental factors that affect energy-related decision-making.

Overall, there are less energy-saving courses at the undergraduate stage. In most cases, the introduction of energy conservation only serves as an auxiliary to enrich

the main subject study. So far, the postgraduate courses mainly seem to focus on certain fields in regard to energy-saving technology.

As the degree and diversity of energy use increases, more and more roles need to be equipped with corresponding energy-saving capabilities. Energy-saving skills as a key training direction have gradually been integrated into higher education curriculum especially in postgraduate training. However, higher education seems to lack energy-saving capacity training at the basic level, such as the cultivation of energy-saving consciousness and concept. As discussed earlier, the level of individuals' motivation to save energy hinges on their energy-saving awareness and their approval of the benefits that energy-saving actions bring about. For example, people leave the room and turn off the light, the energy consumed by lights is therefore saved. The idea behind this behaviour is actually a knowledge skill - people need to know how and when to turn off the light, it includes mastering the knowledge of the type of lights, and the price of electricity (U.S. Department of Energy, 2018).

2.6 Chapter summary

This chapter introduces the world's current situation of energy consumption and energy management condition among companies. Enterprises have been actively exploring energy-saving strategies despite the financial, technical and managerial barriers they are confronted with. Energy-saving policies from different countries are reviewed.

The second part illustrates the importance of skills. The relationship among skills, behaviour and attitude in terms of energy-saving are discussed. Previous studies about skills framework and studies about energy-saving skills are reviewed.

The links between skills and recruitment process as part of human resources management and recruitment methods in companies are discussed. Also, the rationality of acquiring skills through analysing work advertisements is expounded.

Examples of energy-saving related curriculum in UK universities are presented in the section 4. Having an adequate background of the universities' syllabus in the field of energy-saving is helpful to provide implications for the application of Energy-saving skills framework.

Chapter 3

Research Methodology

3.1 Chapter overview

This chapter highlights the research aims and objectives and gives a comprehensive introduction to the methodological approach, research design, methods of data collection and analysis of the study. The detailed processes of the analysis are presented in later chapters. Though there is not yet a study specifically focused on energy-saving skills framework so far, a number of scholars have conducted studies about skills framework, which have been elaborated in the last chapter. Apart from that, there are also studies about energy-saving related skills, such as Ahsan, Ho and Khan (2013), Ward et al. (2016), Baruah et al (2018), providing this study with inspirations for methodological approaches.

3.2 Research aims and objectives

Energy preservation has long been a topic of discussion in the industrial world. In recent years, governments from all over the world are emphasizing on the need to introduce and promote energy-saving policies to create an energy-efficient world so as to cope with energy shortage and overconsumption. In this context, many enterprises especially those involved with high-energy consumptions, are taking actions and measures to achieve a more sustainable approach to address some of the environmental issues in the long term. It is worth noting that energy conservation as a prevailing trend today creates large-scale new employment opportunities. However, organizational roles involving energy saving aspects might require some specific skills which might differ from those involved in traditional roles. For people who are involved in such areas or are about to enter this field, energy-saving skills not only refer to the mastery of the leading-edge energy-saving technologies, but it also involves their acquisition of energy-saving literacy, an understanding of energy management and sustainability and a comprehensive vision of energy saving transition approach and change in behaviour.

Energy conservation is more of an auxiliary subject that serves industrial sectors, especially high consumption sectors such as iron and steel industry, papermaking

industry and so on. This might explain why courses directly related to energy-saving are comparatively less in higher education curricula. In fact, the number of undergraduate courses dedicated to energy saving aspects are particularly low as compared to postgraduate courses.

3.2.1 Research aims

Although previous studies on energy conservation have repeatedly emphasized its importance, many gaps still remain in the literature. In particular, there is a lack of clarity of the skills associated with organizational roles involving energy saving behaviour. What skills and abilities are expected in organizational roles related to energy saving? So far, no scholars have specifically analyzed and summed up skills associated with energy conservation. Therefore, the main research aim is to create a skills framework which will contains a comprehensive set of relevant skills for energy saving.

3.2.2 Research objectives

As discussed in the introduction, the overall objectives of this research study are twofold: theoretical and empirical objectives.

3.2.2.1 Theoretical objectives:

The following are the key theoretical objectives of the thesis (some of which have already been addressed in the literature review chapter):

- Collect, identify, integrate and organize skills related to energy-saving in the existing literature by desk research.
- Propose a skills framework with clear categories which contains a comprehensive set of relevant skills for energy-saving.
- Present an up-to-date literature review on energy-saving and energy-saving skills.
- Enhance the finding of the energy-saving skills framework research by using focus group interview and job advertisements analysis.

3.2.2.2 Empirical objectives

The following are the key empirical objectives of the thesis:

- Uunderstand opinions about energy-saving skills among managerial personnel from high energy consumption enterprises.
- Identify recruiters' current demands for skills about energy-saving in industries.

3.3 Research Design and Research Philosophy

The study aims at developing an energy skills framework to support groups or individuals to achieve better energy management in energy conservation. The achievement of the goal requires a thorough understanding of the complex background and a comprehensive analysis of various phenomena in energy-saving field so as to find a sound approach to build the skills framework.

Based on "*Research Onion*" model (Saunders and Tosey, 2013), the overall design of the study is presented in Figure 3.1.). The outer layers serve as the boundary, giving directions to other layers with regard to specific methods and selections of techniques. The layers are interrelated and linked closely; that is, the settings and understandings of the upper layers directly affect the choices and decision-making in the next layers.

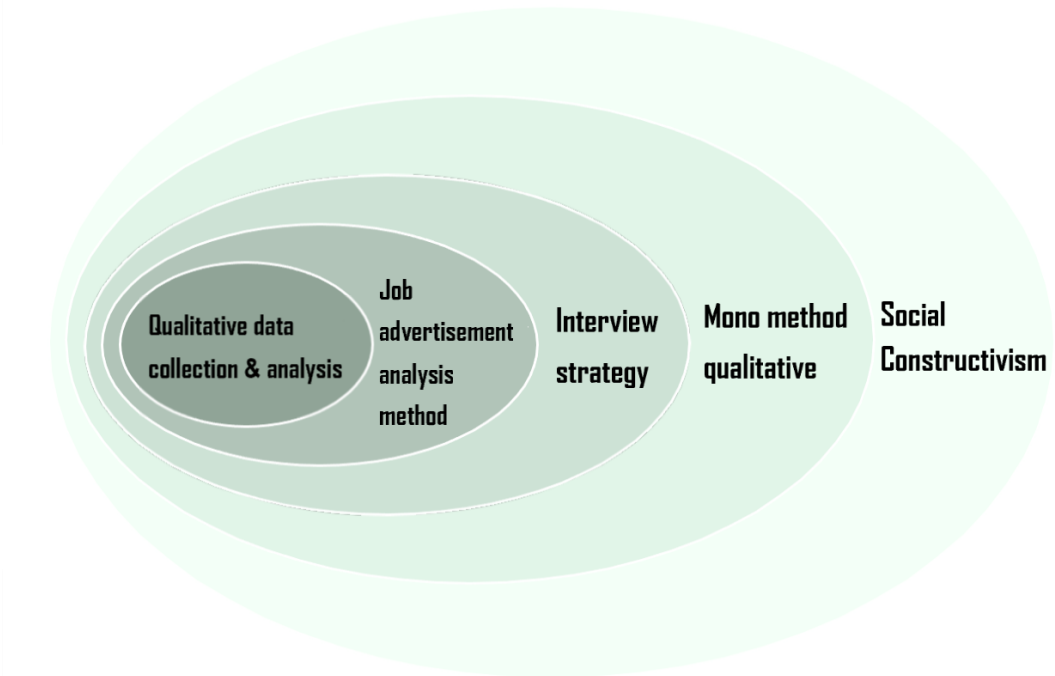

Figure 3.1: The research Onion of this study

The outermost layer of the model is “Research Philosophy”, which refers to “*the set of beliefs concerning the nature of the reality being investigated*” (Saunders et al., 2007, p.2). As Guba (1990) believed, worldview provides researchers “*a basic set of beliefs that guide action*” and explains the nature of the study, revealing how researchers judge the world. It is crucial to identify the philosophical worldview and this belief, as a basis of the research, will lead the researcher to embrace the specific research approach (Corbin, Strauss and Strauss, 2014).

The philosophical worldview proposed in this study is "*Social Constructivism*". Crotty (1998) believed that meanings are constructed by human beings as they engage with the world they are interpreting. According to Creswell and Creswell (2017, pp.5-11), social constructivists hold assumptions that individuals seek understandings of the world from the way they live and work. They are not simply imprinted on individuals but are formed through interaction with others (hence social constructivism) and through historical and cultural norms that operate individuals’ lives.

Taking the social constructivist worldview as the starting point, the study shapes the whole research design. Strategies of inquiry are qualitative, offering explicit directions for the research steps. As Creswell (2002) stated, the philosophy of social constructivism is commonly associated with a qualitative study which offers researchers opportunities to deeply immerse in the problem area through direct interactions, enabling them to understand various situations from their cognition.

Qualitative research is an approach that interprets people’s views, objectively collects and sums up the information that already exists in the field (Creswell, 2002). Silverman (2013) believed that qualitative research inclines to describe problems using textual data rather than numerical data, and that it aims to explore and understand the inherent meanings of the target (individuals or groups) through an inductive view.

The goal of constructivist research is to rely as much as possible on people’s view of the situation being studied (Creswell and Creswell, 2017). The study starts from literature to get the most out of professionals’ views on energy conservation and build a skills framework based on these views. The approach is carried out by collecting the existing knowledge and academic opinions from a constructed

perspective. As the study's key factor exist in a complex operational environment, energy-saving skills requires an in-depth observation and further understanding.

As a common method of qualitative research, focus group interview is employed as the main method to explore problems in detail. Constructivist researchers often address the processes of interaction directed toward certain objects or things (Creswell and Miller, 2000). The researcher's intent is to make sense of (or interpret) the meanings that others have about the world. Rather than start with a theory (as in postpositivism), inquirers generate or inductively develop a theory or pattern of meaning (Creswell and Creswell, 2017). Interviewees are treated as participants in the study. Further data are obtained through researcher's own thinking and cognitive processing of data informed by their interactions with participants (Kivunja and Kuyini, 2017).

Based on previous research, this study employs job advertisements analysis as the other method to get further information. As discussed earlier, job advertisements contain a lot of descriptions of skills which help the researcher to get more data in the field. The information in the job advertisements interpreted by the recruiting companies serves as a key resource to understand the relationships and differences between the proposed skills framework and the skills requirements in the real market.

In general, both interview analysis and job advertisements are useful to obtain the viewpoints of the participants in the industry. The information and conclusions derived from the two methods above supplement with each other, providing more data support and modification comments to the proposed skills framework.

As for the core of the onion model, specific qualitative approaches are selected to carry out data collection and analysis, such as desk research, content analysis and data processing by NVivo software (a qualitative analysis software). All the processes aim to identify, organise and validate the desired skills for energy-saving individuals in the organisational framework, contributing to the literature of energy management.

This chapter illustrates the research design based on social constructivism with an onion model. Social constructivism is often associated with qualitative studies, allowing researchers to interact directly with the research field and deepen their understanding of the area. After extensive desk research, this study has decided to

adopt focus group interview and job advertisement analysis to address the research questions. As for the analysis method, content analysis is applied.

3.4 Research processes and research methods

Based on the research design, specific methods are selected and the analysis process for this study is shown in Figure 3.2 Started with the collection of the basic information needed, the study is to build a skills framework, meanwhile, expand the researcher's understanding of the field and prepare for the subsequent logical analysis. Once the framework is set up, confidence is to be built so as to verify its validity. The stage includes the conduction a focus group interview analysis and a job advertisement analysis.

The focus group interview analysis aims to:

- understand professionals' views on the implementation of energy-saving
- see skills that have come out but not been covered by the skills framework by understanding interviewees' demands of energy-saving skills (detailed analysis process see chapter 5).

The job advertisements analysis aims to:

- get an up-to-date indication of the skills associated with energy-saving within the industry sector.
- test if the skills categories in the proposed framework in accordance with the demands from the market for energy-saving skills (detailed analysis process see chapter 6).

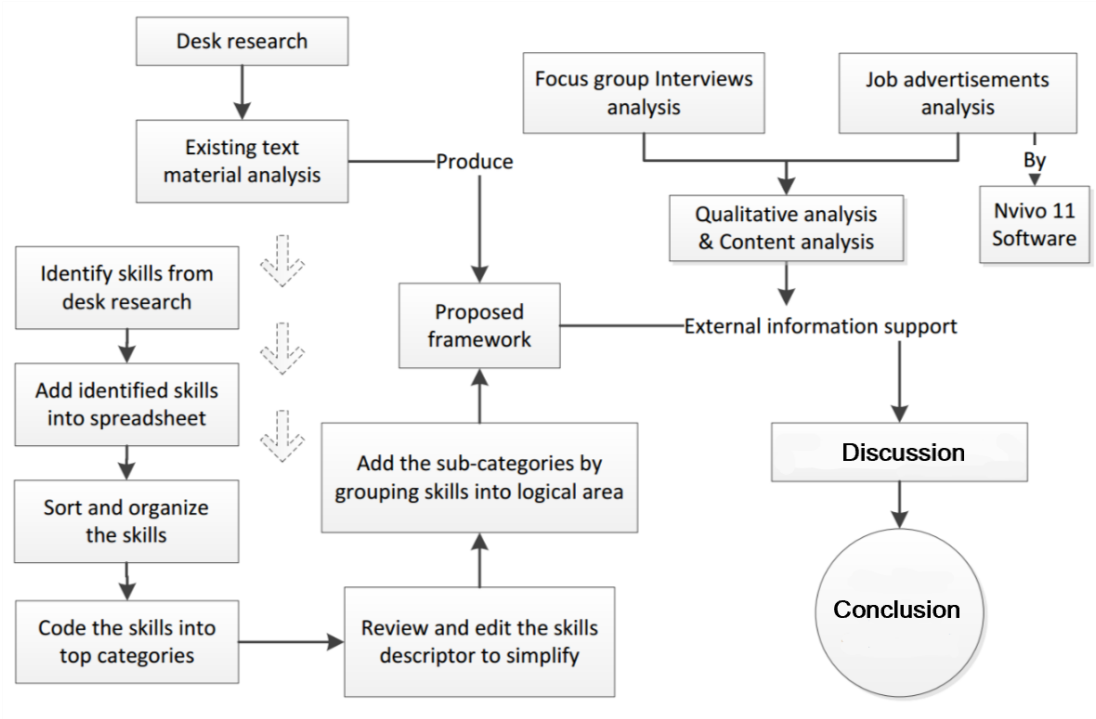

Figure 3.2: The overall of the research process

3.5 Methods of Data Collection

Collecting relevant data is usually the first step in research. Researchers are supposed to decide the approaches of data collection and the range of data information before carrying out the whole process (Ritchie, Spencer and Connor, 2003).

3.5.1 Data collection overview

To collect comparatively rigorous data and address the target problem, the process is expected to be conducted under strictly controlled conditions. It is crucial whether the data sample can explain the real conditions of the research problem (Sargeant, 2012). "*Primary and secondary research are used in a complementary fashion, rather than as substitutes for one another*" (Stewart and Kamins, 1993, p.3). To put it in another way, data collected from both ways is acceptable as long as it is trustworthy and answers the question.

According to the sources, the data collected is can be divided into two types:

- primary data
- secondary data

It involves the following three approaches:

- desk research
- focus group interview
- job advertisement

As shown in Figure 3.3 below, basic empirical data is achieved from secondary information for the purpose of skills framework building, while the primary data is collected to provide external support for the revision of the proposed framework.

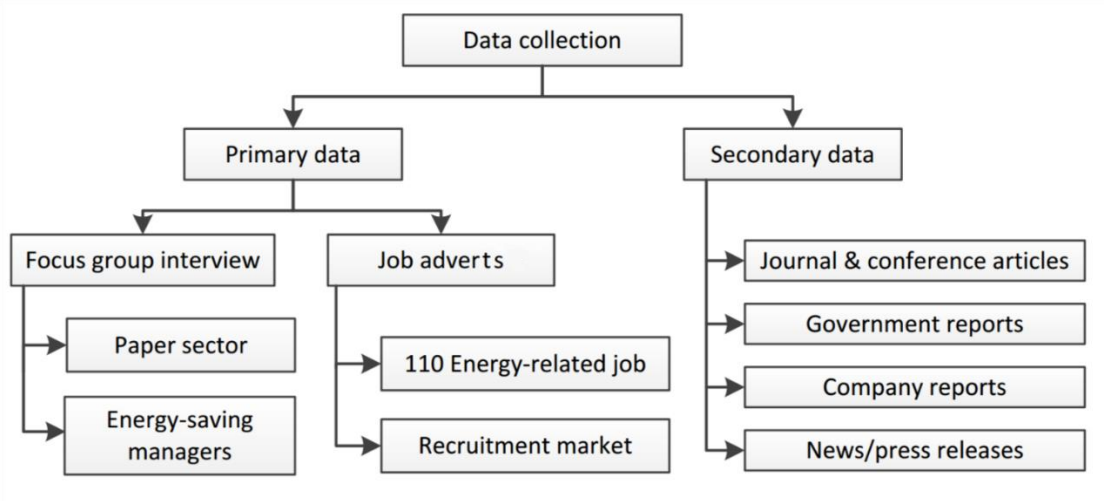

Figure 3.3: The sources of data

3.5.2 Secondary Data Collection

Secondary data refers to the information from the previous results or opinions of other researchers or institutions and achieved in certain forms (Stewart and Kamins, 1993). It involves information sought from existing resources, cross-referencing and data collation. Glass (1976) pointed out that the purpose of conducting secondary analysis is to answer the original research question by re-analysing old data. Secondary information offers relatively quick and inexpensive answers to questions by adopting previous data. The use of published sources therefore is a wise choice.

Reviewing the literature helps researchers see what scholars have worked out in the target field. Desk research is not limited to collecting data, it also helps in reviewing previous research findings and gaining a broad understanding of the field. For most studies, secondary information is always the starting point for research (Stewart and Kamins, 1993), since basic information could be easily extracted from internet and paper materials and used as the benchmark in the research process.

This research is mainly based on the collection of previous research findings and information. As previous studies suggested, reviewing and synthesizing a large amount of literature is usually the first step of data collection for a study related to skill frame analysis (Chien, Brown and McDonald, 2009, Squiers, et al, 2012, Washer, 2007, Turok and Taylor, 2006).

In this study, secondary data is collected from the following key sources:

- Journal & conference articles (1990-2017, mainly from Google Scholar)
- Government reports (2010-2018, mainly from UK, Australia, USA, etc.)
- Company reports (2011-2018, mainly from energy companies)
- News/ press releases (2015-2018, mainly from the Guardian)

The data are mainly extracted from previous study results and statements. It includes information related to energy-saving skills from governments, companies and industries. Relevant information is accessed through secondary research, which further enhances the integrity and reliability of data.

3.5.3 Data Management Method

Given that secondary data collection is a process of collecting large amounts of data, the way to effectively manage and organize data is significant. An effective way of data storage greatly facilitates the research progress. The method of "*Mind mapping*" serves as the primary means of storing secondary data in the study.

Mind map is used to generate, visualize, structure, classify ideas in problem-solving and decision-making processes. Wickramasinghe et al (2011) stated its advantages as the facilitator of active learning, and the retriever of existing thoughts with the graphics presented. As a data storage strategy, mind map can also improve memory for written information (Farrand et al, 2002), assisting researchers to store massive second-hand data for the research.

In this study, Xmind, a mind mapping software, is used to manage data. An example of the mind map in Xmind software is presented in Figure 3.4 to display the managemental mode of the data. In the mind map, the main research topic, "energy-saving skills", is placed at the centre, with sub-topics branching out in a divergent pattern from the beginning of the centre. Sub-topics are usually represented by

different keywords, followed by downstream branches with further details with regard to the subject included in a progressively branching pattern.

Through the process, the collected information is arranged in the hierarchical map in order; the general information is presented in the centre of the map, and further details are presented at the extremes by the various functions of the software. Meanwhile, the associations between different items are marked by the way of arrow connection, and the key parts are highlighted by adding icons or changing styles. As Krueger and Casey (2000) described, for qualitative research, analysis occurs concurrently with data collection. A more detailed and linked framework is constructed by inserting links (to another mind map) in the original frame.

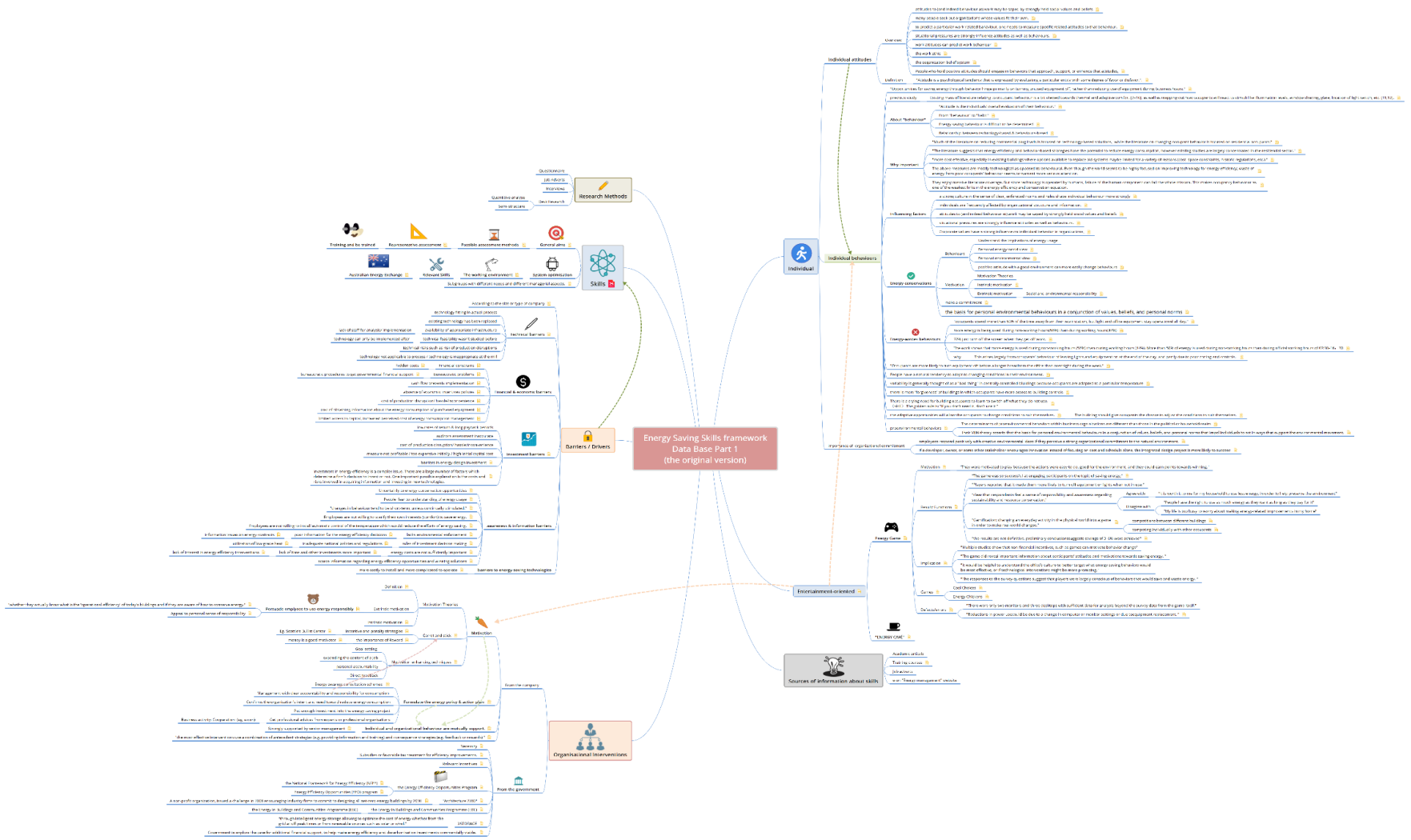

Figure 3.4: Part of the mind map (process by Xmind software)

3.5.4 Primary Data Collection

In the research project, secondary data may not always be sufficient for researchers to examine a specific problem or gap. Data gaps can be filled by the information from primary sources such as interview with managers or leaders. One of the significant approaches to implement a research strategy is the primary data collection based on qualitative research. The reliability of the data is directly related to the validity of the study.

Primary data derives from first-hand sources, therefore it is "*best understood as the data that is being analysed as itself, rather than through the prism of another's analysis*" (Saunders et al., 2007, p.5). Walliman (2017) indicated that research uses data as raw material in order to derive conclusions about some issues, and that it would be difficult to make sense of anything but the simplest phenomenon without such recorded data. Primary data for this study is mainly gathered through focus group interview and energy-saving-related job advertisements.

3.5.4.1 Focus Group Interview

According to Creswell (2007), the application of interview methods is considered to be the most direct and effective way to understand people's experiences and views of the given research areas. While there are various ways of interviews, researchers need to select interview methods according to objective research factors such as the research nature, time span and specific conditions, etc.

As a research method, focus group interview is first proposed by sociologists Robert Merton and Kendal in the 1950s. It is a method of data collection involving a small group of people who are interviewed on a focused given topic of interest to the researcher (Thomas et al. 1995). Usually it is applied as a method for collecting qualitative data (McLafferty, 2004).

Focus group interviews are conducted in an unstructured and natural form to communicate with a group of participants. In scientific research, researchers and participants engage in dialogues based on the professional experience of the participants in a "*collaborative*" interview (Kruger, 1994), and a facilitator is usually responsible for organizing discussions (Richardson and Rabiee, 2001). The main purpose of the group interview is to listen to the interviewees' opinions from the

perspective that the researcher intends to study and obtain an in-depth understanding of certain relevant issues.

Vaughn et al. (1956) analysed the basic application of a focus group interview. They considered people to be valuable sources of information as they can report and explain real materials and clearly express their opinions and feelings. Morton (1956) believed that researchers can find the exact reason why a person accepts a particular idea or behaviour for a particular thing by using this method. Also, focus groups elicit information in a way which allows researchers to find out why an issue is salient, as well as what is salient about it (Morgan, 1988). It often leads to some unexpected discoveries from free group discussions (Green et al., 2003). It is useful to obtain detailed information about personal and group feelings, perceptions and opinions which are comparable. Moreover, it is time-saving as well as money-saving compared to individual interviews, which is suitable for a study with limited time, such as this research case.

The focus group interview as a data collection approach is to conduct a meticulous observation and investigation via asking questions and discussing the problems according to pre-designed semi-structured question list (see Appendix 1). During the interview, the opinions of each participant are shared in the group including the facilitator. The whole process of the interview is recorded after getting a consent from the participants. Comparable opinions from energy-related employees provide the research with more clues. The detailed analysing process of the interview will be presented in chapter 6.

According to what is discussed above, a focus group interview is suitable for this study. However, like all research methods, focus group interview has its limitations. Among them, some disadvantages "*can be overcome by careful planning and moderating, but others are unavoidable*" (Gibbs, A, 1997, chapter 5). By this method, focus group interview is open-ended and hard to be entirely predetermined, which requires researchers to have the ability of on-site control and flexibility. Focus groups can also "*be intimidating at times, especially for inarticulate or shy members*" (Gibbs, A, 1997, chapter 5). The aim of the focus group is to understand how the participants feel about energy-saving and the potential of a framework. Organizing group interviews requires a lot of resources and time which is impractical for a one-year project.

3.5.4.2 The selected participant - the paper sector

The selection of participants is very important in the focus group interview. They should be professionals and experts in the field of specific research. In this context, a focus group interviewing methodology is utilized with managers who play key roles in terms of energy efficiency from different departments in paper sectors of UK.

The paper industry has been a major industry in the industrial sector for nearly 30 years. The world consumes enormous amounts of paper every day as books, newspapers, tissue are all made of paper. Energy consumption in paper industry continues to rise in the overall industrial energy consumption (The NEED Project, 2018). Generally, this sector is representative in the high energy consumption industry especially in the following aspects (Szabó et al., 2009):

- It is a very energy-intensive sector, the energy content of the different paper grades is comparable to that of other energy-intensive products, such as cement or steel, it consuming 5–17 GJ of process heat to produce 1 tonne of paper.
- The most important natural resource for paper-making is biomass, mainly wood and other fibre resources, the use of which is by internationally accepted definitions assumed to be CO2 neutral.

These characteristics bring the paper sector into a focus of attention in the energy consumption field, and therefore, making it an ideal interview target area for the current study.

3.5.4.3 Job Advertisement Collection

To obtain a further understanding of the real market's demands, energy-related job advertisements in recruitment market are selected to be another crucial source of data collection. The analysis on job recruitment advertisements provides an intuitive approach to find out those companies' current requirements and expected skills for their future employees.

Ahsan Ho and Khan (2013) studied the skills of various roles in industry field by using job advertisement analysis. Scholars have tested and confirmed the value of job advertisements in a study on skills analysis (Ward, Gbadebo and Baruah 2015). Also, Baruah et al (2016, p.5) stated that job advertisement analysis is "*argued to be an alternative window into industry needs.*"

When it comes to the selection of the proper job site as the main sources for advertisements, online job boards are fine choices. Compared with advertisements published in newspapers and magazines which are generally limited by layout space, online advertisements are rather detailed and specific. In accordance with the report from Google Analytics (2016) and comScore Analytics (2017), since 2004, INDEED has become one of the largest job sites in the world, with over 200 million unique visitors per month. Served in 28 languages, it receives online visitors from more than 60 countries. Also, it is an important job search website in UK. With the development of the economic globalization nowadays, the recruitment market has become more international.

Job advertisements are directly downloaded from this representative recruitment website (Indeed.com) to avoid ambiguity in terms of job content and statement. To ensure the advertisements in line with expectation and avoid irrelevant information, the keywords "*energy saving*" "*energy efficiency*" "*sustainable*" are utilized as the search character. The job descriptions of each advertisement are attentively reviewed by the researcher. Advertisements is collected during January 2018 as many companies conduct recruitment at the beginning of the year and therefore more job advertisements on the website are collected in this period.

In total, 115 job advertisements are collected from energy-saving job sector. After careful screening of all job advertisements, 5 advertisements are discarded as they contain insufficient and incomplete information. Therefore, the other 110 job adverts, the basic data for this analysis, are copied in the original format from the recruiter website so as to maintain consistency in quality. Every job advertisement is saved into a separate Word file named:

<Job document number> - <job title>

The URL links for each job advertisements are also attached for further reference. (the analysis approach will be discussed in chapter 7)

To sum up, samples of roles from company which can be shown from job adverts help researchers capture and understand the widest range of skills associated with energy-efficient businesses. Such data selection reflects the past and present details of the environment and the target problems, providing good data support for the follow-up research.

3.6 Analytical methods

The basic data of this study is mainly from the complex operational environment which requires in-depth observation and further understanding. Therefore, a qualitative research templet is employed to guide the design of analytical methods.

3.6.1 Analysis for skills framework building

As Krueger and Casey (2000) explained, qualitative analysis occurs concurrently with data collection. In other words, in qualitative research, researchers carry out a preliminary data analysis while collecting data. The building of skills framework relies on large amounts of data relevant to energy-saving skills. In the stage of secondary research, information related to energy-saving skills are collected, while the analysis of the skills-related content occurs concurrently with information collection. Researchers need to identify and then extract the content relevant to energy-saving skills. Thereafter, there is a need for further logical analysis of the skill statements so as to classify them according to their natures.

As mentioned in Chapter 2, scholars have conducted studies relevant to skills framework building such as Turok and Taylor (2006); Washer (2007); Gould, Berridge and Kelly (2007); Chien, Brown and McDonald (2009); Squiers et al. (2012); Johnson, Veitch and Dewiyanti (2015). The current study has drawn on methods and principles in the previous research, including conducting the study using desk research and then using the collected data to build the framework through a constructivism philosophy. The specific building progress of the framework is covered in detail in chapter 4.

3.6.2 Content Analysis

The process of data analysis is not only the process of mining the hidden truth behind the data, but also the process of fully utilizing the correlation between the data (Krippendorff, 2004). The further understanding of the boundaries and characteristics of the target questions requires a detailed analysis process (Bazeley and Jackson, 2013). Data analysis consists of a number of stages so as to address the initial goal of a study.

During the process, logical inferences are made based on textual contents (Holzmann and Spiegler, 2010), and in so doing, target raw materials are converted into meaningful scientific data (Mostyn, 1985). This is particularly useful for analysing mass textual information. Using this approach, patterns or themes can be identified in target information and therefore helps in building pre-defined categories (Holzmann and Spiegler, 2010; Krippendorff, 2004).

3.6.2.1 Focus group interview analysis

This study applies content analysis method to analyse the focus group interview. Authors such as Doody, Slevin and Taggart (2013) showed how transcripts can be analysed by using Microsoft Word file and the possible processing approaches are as follows:

- number each transcript line with specific time point and speaker name;
- make two hard copies of each transcript, one to cut up and one that stays intact;

The basic analysis process for a focus group interview is presented in Figure 3.5. After the focus group interview, audio recording is transcribed into written form. As Burnard (1991) suggested each sentence in text is to be read through meticulously in qualitative content analysis. Thus, the written text is repeatedly read so as to understand the discussed content. After that, the main topics/subjects of the interview can be discovered by identifying the keywords in the text and summarising them.

According to Hsieh and Shannon (2005), categories for the coding system are pre-designed based on literature review in the conventional content analysis. Therefore, the categories of the coding system in this study are referred to the categories of the proposed skills framework which are essentially from the literature.

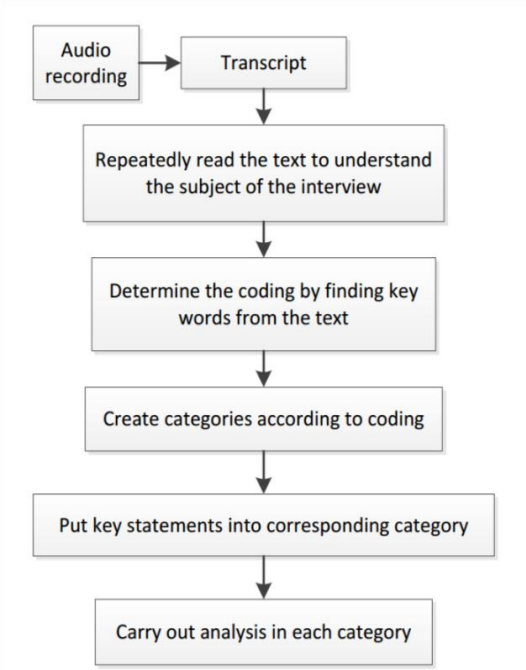

Figure 3.5: Content analysis process (Hsieh and Shannon, 2005)

As what is shown in Figure 3.5, full transcript is made from the audio recording of the focus group interview. The interview transcript is read through repeatedly by the research so as to ensure that the relevant details are fully understood. After that, coding, or the main topics, is determined according to the words that are frequently referred to by the questions and responses in the interview. Then, relevant statements is assigned to the corresponding topics. Finally, analysis is conducted. Details of the analysis is illustrated in Chapter 6.

3.6.2.2 Job advertisements analysis

Content analysis can be applied to job adverts analysis. Nvivo 11, a qualitative analysis software package, is utilized in this study to undertake the analysis of the job advertisements. It can be used for content analysis as it features in functions such as managing data, managing ideas, querying data, visualizing data and reporting findings from the data (Bazeley and Jackson, 2013). Also, NVivo increases the efficiency and effectiveness of data learning and analysis process (Welsh, 2002).

Firstly, job advertisements are documented in textual content, same as the process of focus group interview analysis. This is followed by detailed reading of the skill-related statements in each of the job advertisements. As Burnard (1991) recommended, each sentence should be read thoroughly in any qualitative content

analysis. After understanding and interpreting all the contents, the researcher needs to determine the coding by finding key words from the text and creating categories according to the coding. The current study has adopted the conventional content analysis (Hsieh and Shannon, 2005) and coding system in NVivo. Since the coding system is pre-designed on the basis of literature review, it is in accordance with the categories of proposed skills framework. The skills mentioned in the advertisements are assigned to the matching categories so as to test whether the proposed framework is in accordance with demands from the industry. The detailed analysis process will be described in chapter 6.

3.7 Ethical Issues

There are ethical considerations when carrying out any research (Thorne, 1998). For this study, the ethical issue mainly focuses on the focus-group interview. Ethical considerations for focus groups are typical in most social research methods, such as confidentiality and fidelity (Homan, 1991). As focus-group interviews usually involve more than one participant, the particular ethical issue is the handling and confidentiality of sensitive materials. As the interview discussion is carried out in a group environment, "*participants need to be encouraged to keep confidential what they hear during the meeting and researchers have the responsibility to anonymize data from the group*" (Gibbs, 1997, chapter 4).

The interview session is recorded on an audio recorder as it assists research in analysing participants' responses more accurately. Interviewees' participation is completely optional, and they have the right to withdraw the consent and terminate participation at any time. All the responses are only for this research purpose and the output may be used for conference publications, journal papers and MSc thesis. After being informed necessary information, the interviewees agree to participate in this research voluntarily.

Another ethical area is storage of the data. The researcher is obliged to show the storage location and destroyed way of the data. In my case, the information recorded in the audio recorder is stored in personal laptop with protected password to ensure data security. Generally, the research original data will be destroyed one year after the project is completed.

This research project has been approved by the Physics Science Ethics Committee (PSEC) of the University of York. All points and details are covered by the consent form which is attached in the Appendix 2.

3.8 Chapter summary

This chapter describes the research aims and objectives and shows how the research is designed based on a chosen philosophical worldview by using the research onion model. The detailed approaches of data collection and analysis method are discussed as well. The main sources of data are primary and secondary data. Content analysis is the main method utilized in the study. The research method is predominantly qualitative, involving desk research to build the skills framework, focus group interview and analysis of job advertisements to further explore the effectiveness of the proposed framework. The next chapter is about the creation process of the skills framework.

Chapter 4

The Building of Energy-saving Skills Framework

4.1 Chapter overview

The main purpose of this study is to create a skills framework which contains a comprehensive set of relevant skills for energy saving. To achieve this, a large amount of data relevant to energy-saving skills is required.

As mentioned earlier, secondary information offers relatively quick, inexpensive answers to objective questions. The Literature Review also provides a good understanding of the area related to this thesis. Therefore, the research presented in this stage relies on secondary research to obtain data on energy-saving skills. Furthermore, a great deal of the literature provided the background to the research field, which is helpful for the following logical analysis.

Starting with theoretical research, the researcher collects secondary sources of data related to energy-saving skills in the area mainly from journal articles, books, government reports, websites, etc. Textual extraction is conducted to look for skills from the identified immense number of relevant sources during the Literature Review (see Appendix 4). Those collected skills are then summarised into a skill set (see Appendix 5). Thereafter, for further logical analysis, a classification of these skill statements is made according to their natures. Some energy-saving skill-related categories proposed by previous research are found in the literature, but they are not complete. By combining previous skills classifications with the skills classification summarised in this study, a complete energy-saving skills framework is put forward. This chapter will describe the method of framework building in detail.

4.2 The process of building energy-saving skills framework

This section shows a detailed process of energy-saving skills framework building. It indicates the source of the skills and the way they are interpreted. Also, a conceptual introduction of the proposed skills framework is presented.

4.2.1 Skills identification and extraction

Like most previous studies, this skills framework study obtained basic data for framework building through theoretical research. Energy-saving skill-related statements are identified from the literature:

- Journal and conference articles
- Government reports
- Company reports
- News/ press releases

The information is then screened and extracted. Textual extraction is conducted to look for skills from the identified relevant sources. This comprised a large spreadsheet composed of an unstructured list of 600 potential skills statements (see Appendix 4). Detailed information (such as the skill origin and the context of skills, etc.) about the skills is stored in Xmind mind map, as discussed in Chapter 3.

4.2.2 Skills interpretation

The skills statements extracted from the literature are converted into skills descriptions (for instance, the expression of "Be able to do..."). This aims to translate raw information into formal skills. For example, here is a piece of raw extracted information from the collected data, and the section below is the translation of the extraction. After interpretation, a comparatively formal expression of the requisite skill is achieved.

"*Skill Translation*" example 1

The original extraction: "*Using the voluntary ISO50001 standard as the basis for energy management system.*" (Eex.gov.au, 2018)

The case above could be translated into:

"Be able to use ISO50001 standard as the basis for developing an energy management system for the organization."

"*Skill Translation*" example 2

The original extraction: "*The definition of a good indoor climate is important to the success of a building, not only because it will make its occupants comfortable, but also because it will decide its energy consumption and thus influence its sustainability…understand indoor comfort conditions to help decide on the design and the sizing of heating or cooling systems or passive strategies…and how to define comfort in an outdoor context (availability of shade, wind speed and direction, etc…)*"(Nicol and Humphreys, 2002).

The case above could be broken down and translated into:

"*Familiar with the adaptive approach and be able to design sustainable and energy-friendly building layouts*."

4.2.3 Skills classification

It is important to have a sound and clear classification to cover what is indispensable for a skills framework. When the basic data collection of energy-saving skills is ready, a classification of these skill statements is made according to their nature for the implementation of further logical analysis. Although there are energy-saving skill-related categories proposed in previous research which can be referred to (Australian Energy Exchange, 2017; Cibse, 2018), it is far from enough to support the establishment of a complete energy-saving skills framework.

As Krueger and Casey (2000) explained, for qualitative analysis, analysis occurs concurrently with data collection, in other words, researchers have already begun a preliminary analysis of the data while collecting data. The analysis and interpretation of constructivist research are based on the researchers' personal experience and knowledge background (Creswell and Creswell, 2017). The collected skills will be analysed on the basis of the researchers' understanding of them. According to content analysis, skills with the same content characteristics (for example, with similar keywords or key content) are collected together to make up a specific group.

For example, here are some skills extracted from the literature:

- Selection and application of metering and monitoring equipment (Australia, Department of Resources, Energy and Tourism, 2010)
- Ability to use automated monitoring for continuing to monitor and identify issues (Energydesignresources, 2018)
- Monitor environmental conditions that affect comfort and indoor air quality (Integrated Building Design, 2006)

Based on comprehension of the content and the repeated keyword "monitor", the three skills above all belong to the same category, i.e. "Energy monitor".

A total of 23 categories of energy-saving skills are collected from 600 original skills (see Appendix 5). This result is achieved on the basis of logical organisation and the classifications of energy-saving skills in existing studies (Cibse, 2018; Gandhi and Brager, 2016; Australian Energy Exchange, 2017). According to the nature of the categories and the introduction of skills categories in previous studies (Turok and Taylo, 2006; Washer, 2007; Ward, Baruah and Gbadebo, 2015; Baruah, Ward and Gbadebo, 2018), they could be further sorted into 3 upper-categories. Finally, the general energy-saving skills framework (see Figure 4.1) is completed.

- 600 skills ➡ 23 skill categories
- 23 skill categories ➡ 3 skill upper categories
- 3 skill categories ➡ the overall energy-saving skills framework

Hierarchy as a logical way of grouping, refers to "an arrangement or classification of things according to relative importance or inclusiveness" (Oxford Dictionaries, 2019, para. 1.3). That is to say, if there is a top-level hierarchical label such as "Technical skills", all sub-skills are comparatively specific divisions of technical skills.

Take the skill of "Skill levels in the framework" (see Figure 4.2) as an example for better illustration of the levels within the framework. From the top of the current framework, spot one of the top categories "Technical Skills", through which the sub-division "Energy-related Basic Knowledge" could be traced. The skills beneath this are specific and detailed skills relevant to fundamental knowledge about energy.

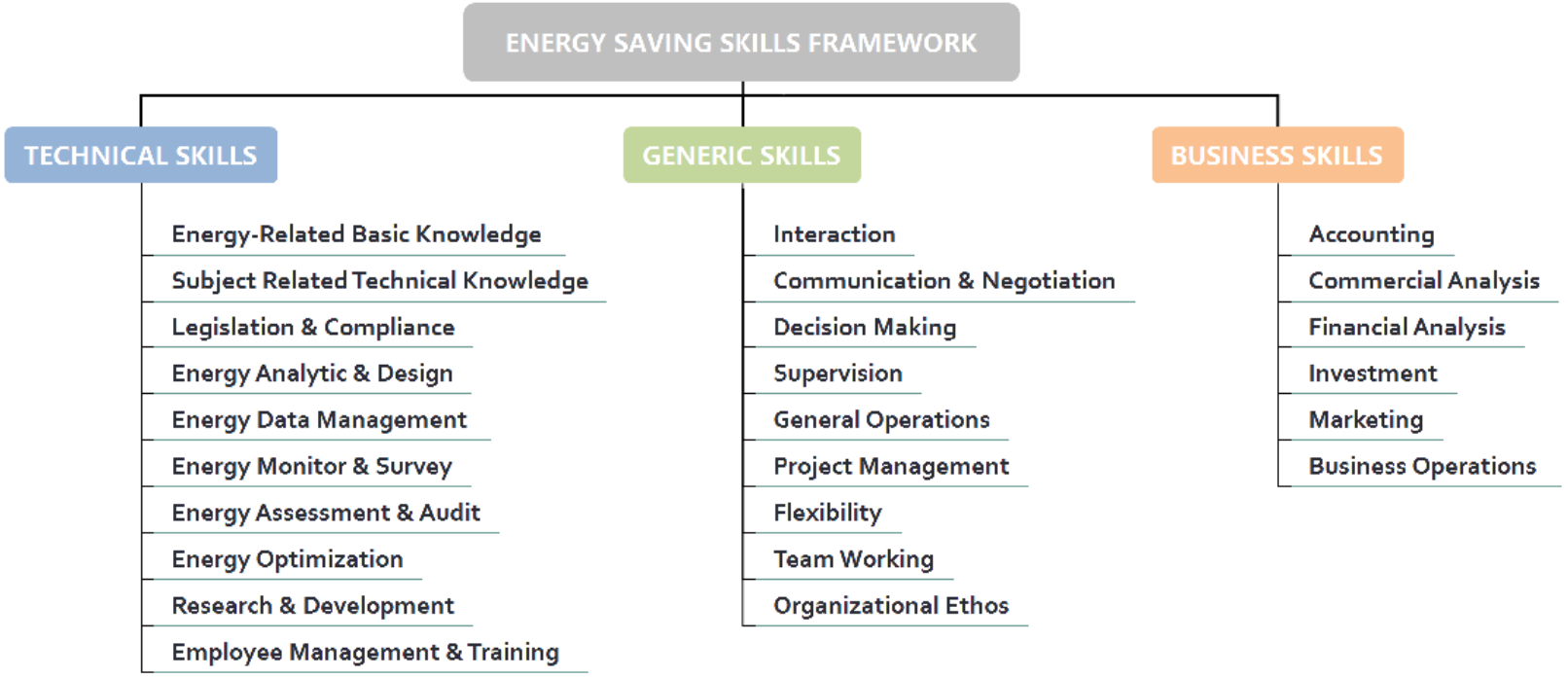

Figure 4.1：The proposed Energy-Saving Skills Framework

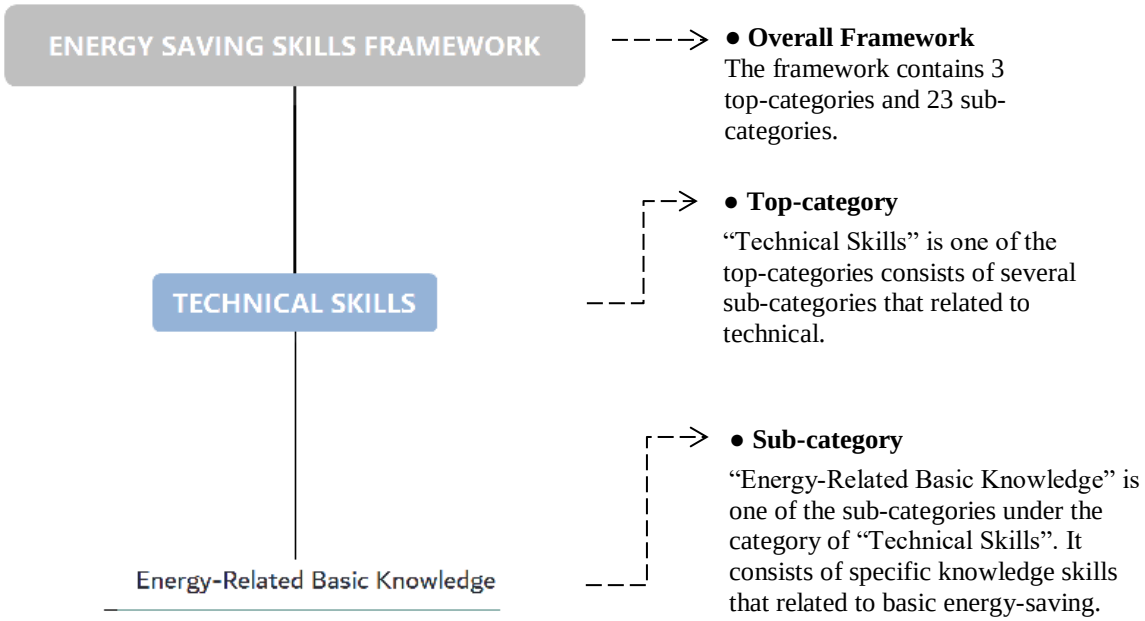

Figure 4.2: Skill levels in the framework

4.2.4 Definitions of categories

To understand and master relevant skills in energy conservation is crucial for the industry as a whole, including people who are in or about to enter the field (Siddiqui, 2009). In practice, it is rather impractical to handle a complex situation solely with a certain skill. Skills are cross-dependent, which means the achievement of a certain capacity requires a broader range of skills (Mansfield, 1996). For example, the majority of industrial companies in Australia require that practitioners in the energy-saving industry show the following capabilities: "Understanding energy"; "Project planning and management"; "Identifying potential opportunities"; and, "Detailed investigation" (Australia, Department of Resources, Energy and Tourism, 2010). The proposal of the skills classification entailed in the framework fully embodies the comprehensiveness of energy-saving skills.

Explanations of skills in previous studies have been a constructive source of reference for the establishment of the definition of skills in the proposed study (Australian Energy Exchange, 2017; Cibse, 2018). However, as mentioned previously, the classification and explanation for skills in those studies is not systematic. To address the situation, the researcher's comprehensive understanding

of various kinds of skills in the Literature Review are incorporated into the proposed definition and classification of the skills framework.

4.2.4.1 Definition of 3 skill top-categories

- Technical skills

The fulfilment of energy saving lies in the advancement of technical skills, which contain Energy-related basic knowledge, Subject-related technical knowledge, Legislation & Complains and Energy analytics & Design, etc. These skill types, under the technical skills category, are closely related to professional knowledge, as well as technical operations in regard to energy conservation. Therefore, it is of great necessity for technicians and staff who are in charge of pioneering advanced energy-efficient techniques or carrying out relevant measures to acquire those significant skills.

- Generic skills.

The progress of general skills is crucial for the promotion of energy conservation. This skill group contains Interaction, Decision making, Supervision and Operational etc. It enhances essential staff qualities, ensures smoother operations, and facilitates coordination between technicians and non-technical staff.

- Business skills

Business skills are the crux that ensures the idea of energy conservation operates smoothly in a business environment. This skill group contains Commercial analysis, Financial analysis, Investment and Marketing etc. A mastery of such skills calls for managers' acquisition of basic commercial knowledge and full comprehension of energy-saving operative patterns in the economic market; so that they are able to work out viable and effective investment priorities with regard to energy conservation.

4.2.4.2 Definition of 23 skill sub-categories

Table 4.1, 4.2 and 4.3 give definitions of each sub-category and incorporate a detailed skill example which presents the skills included. All the detailed skills are specialised skills for either professionals or non-technical staff, reflecting their specific roles and functions in the field.

Hundreds of skills are included in the skills framework and they are fully listed in Appendix 4 (unstructured skills) and Appendix 5 (re-arranged skills). On account of limited time in skills collection and the never-ending renewal of energy-saving techniques, the argument is logical, based on the consent state of the skills found in the result. This skill set encompasses a complete range of skills with scientific classification and hundreds of detailed cases, offering intellectual and managerial support for staff in the energy-saving field.

Turok and Taylor (2006) indicated that there are plenty of distinctive roles and functions with a range of accessible, professional and clear standards in the field, most of which are established occupations or functions that tend to have well-developed education and training systems with recognised qualifications. In this context, the energy-saving skills framework allows people to gain a systematic knowledge of energy-saving skills, guiding them to trace specific as well as corresponding information according to their needs.

Table 4.1: Sub-category - Technical skills

Skills categories	Definition	Examples
Energy-related Basic Knowledge	Basic knowledge in energy saving field.	Understand energy jargon (Cibse, 2018); Know how and when to turn off the lights (U.S. Department of Energy, 2018).
Subject-related Technical Knowledge	Knowledge in specific areas of energy savings or energy-saving processes, such as cogeneration, electrical service and equipment installation and maintain, etc.	Technical understanding of process or sector, including understanding of laws of thermodynamics, heat transfer, energy modelling and their applicability to processes and technologies in different sectors (Australian Energy Exchange, 2017).
Legislation & Compliance	Familiar with the current laws and compliance related to energy and able to ensure that the company is compliant with these laws and regulations when required.	Explain how energy relates to broader sustainability objectives and policies (Brunke, Johansson and Thollander, 2014).
Energy Analytic & Design	Able to analyse the current situation, identify problems and energy-saving opportunities, estimate energy conservation potential, and finally design a workable solution.	Ability to analyse and evaluate the size and type of the business to design energy management system (Eonenergy, 2018).
Energy Data Management	Make dynamically energy consumption effective quantified, able to collect and file energy-related information and apply it to management processes.	Timely and secure access to data information which is key to efficient energy systems operations (IEEE-USA position statement, Energy Efficiency, 2014).
Energy Monitor & Survey	Able to carry out metering related activities to give a clearer picture of energy consumption.	Guarantee availability and provide 24/7 remote operation and maintenance (Eonenergy, 2018).
Energy Assessment & Audit	Able to carry out a systematic assessment and review of current energy consumption situation within a building or industrial site to avoid potential risks.	Ability to use building energy rating simulation methodologies to determine energy use, energy efficiency measures and energy ratings for commercial/office buildings (Australian Energy Exchange, 2017).
Energy Optimisation	Optimise energy saving from all-around including facilities condition, energy-using processes and systems, etc.	Adjust power management savings to reduce energy use during non-working hours (Gandhi and Brager, 2016).
Research & Development	Ability to develop new products and techniques meeting a range of specific requirements for energy saving.	Ability to undertake a technical feasibility study (Brunke, Johansson and Thollander, 2014).
Employee Management & Training	Ability to build energy-saving training system and energy-saving behaviour management system for employees.	Ability to develop accountability of energy management in businesses. (The Telegraph, 2017).

Table 4.2: Sub-category - Generic skills

Skills categories	Definition	Example
Interaction	Able to interact purposefully with individuals or groups, such as internal and external stakeholders, energy suppliers and staff who are related to energy saving in either oral (negotiation and communication) or written (reports) forms	Ability to develop ongoing communication of energy use and the multiple benefits to get energy efficiency opportunities to stakeholders (Australian Energy Exchange, 2017).
Decision Making	Able to identify the priority of energy saving opportunities and make decisions through reasoned process.	Ability to develop long-term energy strategies (Cibse, 2018).
Supervision	Able to supervise employees energy-saving behaviours to support behavioural performance assessment to avoid unnecessary waste.	Create transparency and facilitate communication on the management of energy resources (Cibse, 2018).
Operations	Able to drive the development of energy-saving activities.	Ability to manage the integration of energy efficiency projects and goals into cross-business operational plans, procedures and key performance indicators (Australian Energy Exchange, 2017)
Project Management	Able to implement an energy-related project and meet the criteria at the specified time.	Ability to develop an energy efficiency assessment plan (including timelines, budgets etc.) and manage the project within the organisation (Australian Energy Exchange, 2017).
Flexibility	Ability to flexibly identify energy-saving opportunities in the area.	Reduce energy consumption by discovering adaptive opportunities such as open windows, use a fan or dress code working practices and other factors which influence the interaction between occupant and building to adjust internal temperature (Baker and Standeven, 1995).
Team Working	Achieve energy-saving goals through collaboration between departments.	Able to work in a multi-disciplinary team to maximise outcomes from energy efficiency (Australia, Department of Resources, Energy and Tourism, 2010).
Organisational Ethos	Ability to spread the word about energy-saving and build sustainable organisational culture and values to promote staff energy conservation thinking and behaviour.	Managers should illustrate a strong commitment to ecological sustainability (Starik and Rands, 1995).

Table 4.3: Sub-category - Business Skills

Skills categories	Definition	Example
Commercial Analysis	Use mathematical models and economic research to identify patterns and added value of energy-saving technology to objects	Understanding of economic incentives in energy business (Brunke, Johansson and Thollander, 2014).
Financial Analysis	Able to conduct financial analysis of energy efficiency projects.	Ability to carry out a life-cycle economics analysis (Energy Design Resources: Integrated Building Design, 2006)
Investment	Ability to carry out effective energy saving investment and purchase activities.	Understanding the energy investment return mechanism (California Energy Commission. Title 24, Part 6, of the California Code of Regulations, 2010).
Marketing	Understand energy market, have insight into market changes and trends of discrepancies in financial activity in the energy market.	Understand energy markets, energy pricing and tariffs (Australian Energy Exchange, 2017).
Business Operations	Familiar with the processes to carry out an energy-related business case and able to keep it running.	Ability to provide the feasible equipment procurement program after analysis of company environment (Brunke, Johansson and Thollander, 2014)

4.3 Skill examples

As stated earlier, the skills derive from representative, professional academic papers and government reports, and are accepted as essential for roles in the energy-saving field. Since reasonable data contributes to the reliability of the framework, this section takes some of the skills from the framework as examples to illustrate the data in detail.

4.3.1 Skill example 1

- Category:

  Technical Skills (Top-category)

  Energy-related Basic Knowledge (Sub-category)
- Selected skills:

  Know how and when to turn off the lights (U.S. Department of Energy, 2018).
- Notes:

  As discussed earlier, the level of individual motivation to save energy hinges on their energy-saving awareness and their approval of the benefits that energy-saving actions bring about. If people leave their rooms with the lights off, the energy consumed by lights is therefore saved. The idea behind this is a knowledge skill - people need to know how and when to turn off the light, which requires previous acquaintance with light types and electrical charge. For example, in order to effectively manage CFL lights, they need to know such general rules of thumb (U.S. Department of Energy, 2018).:

  - If you will be out of a room for 15 minutes or less, leave it on.
  - If you will be out of a room for more than 15 minutes, turn it off.

4.3.2 Skill example 2

- Category:

  Technical Skills (Top-category)

Energy Analysis & Design (Sub-category)

- Selected skills:

  Ability to analyse and evaluate the size and type of the business to design an energy management system (Backlund, Thollander and Ottosson, 2012).

- Notes:

  There are many alternative energy-saving approaches, from turning lights off to re-engineering an entire product. The choice of specific options depends on the industry where the business is, the size of the company and type of premises. Means of energy-saving are not universal, which means what works for one might not apply equally in other cases. Therefore, the first step in energy-saving analysis is to identify the type of organisation and then put forward an individualised energy-saving scheme. Here are some examples from Businessjuice (2018) to show how further skills and processes are required after business type is identified as shown in Figure 4.3.

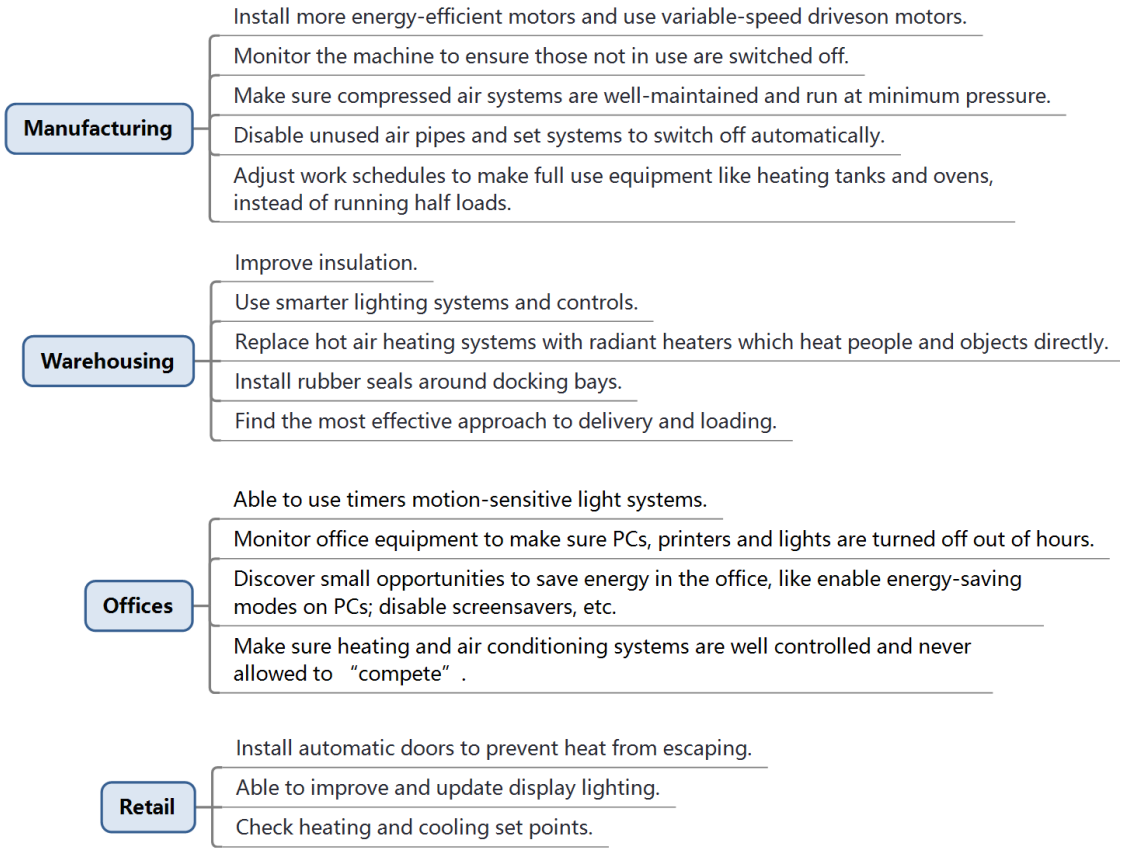

Figure 4.3: Breakdown of energy-saving skills in different industries (Businessjuice, 2018)

4.3.3 Skill example 3

- Category:

  Generic Skills (Top-category)

  Team working (Sub-category)
- Selected skills:

  Able to work in a multi-disciplinary team to maximise the outcomes of energy efficiency (Australia, Department of Resources, Energy and Tourism, 2010).
- Notes:

  The research indicated that effective assessments required human involvement from across the organisation with diverse backgrounds and skill sets, including technicians, untechnical staff and managerial personnel. Multi-disciplinary teams with the right mix of people and skills are able to maximise the outcomes of energy efficiency assessments (Australia, Department of Resources, Energy and Tourism, 2010)

4.3.4 Skill example 4

- Category:

  Business Skills (Top-category)

  Investment Business Skills (Sub-category)
- Selected skills:

  Understanding the energy investment return mechanism (California Energy Commission. Title 24, Part 6, of the California Code of Regulations, 2010).
- Notes:

  Investment in the environmental impact of all products is the key to business. Although greater efficiency in energy use brings multiple benefits (Payne, Weatherall and Downy, 2015), companies are still struggling with energy-saving processes at the moment. Financial barriers are one of the problems which defers energy-saving decisions, as discussed above. The application of ROI (return on investment) or Life-cycle theory which presents the benefits of energy-saving

investments in quantifiable ways helps persuade managers and stakeholders to reach consensus on energy-saving investment.

4.4 Chapter summary

This chapter expounded the establishment of the energy-saving skills framework in detail. It starts with the data collected via theoretical research and is built on the basis of various skills from the whole industry. After the steps of collection, extraction, analysis and classification of the data, and the incorporation of previous achievements with the content analysis method, the energy-saving skills framework is set. In addition, this chapter also provides a clear definition of all sub-categories of skills in the framework with a detailed explanation.

Chapter 5

Analysis of Focus Group Interview

5.1 Chapter overview

An overall skills framework is presented in the previous chapter and in order to further explore the validity of the skills framework, a focus group interview among representatives from the paper industry is carried out. The objective is to explore some of the high energy consumption companies' opinions toward energy-saving skills.

Focus group interview as discussed previously is a qualitative method which is used to obtain detailed information from a group of participants and offers the researcher a good level of flexibility on how the discussion flows during the interview. Essity, a hygiene and health company, hosted an industry liaison meeting at their Prudhoe mill and the researcher is invited to attend this meeting. Four of the participants from this meeting agreed to take part in the focus group interview. The details of the focus group study are as shown below:

- **Date and Time:** 24th May 2018, 14:00-14:30
- **Location:** Prudhoe Mill (a paper mill located in Newcastle, belongs to Essity company)
- **Participants:** Four managers from different companies within the paper sector. Their roles in their organizations related primarily to energy and environment management. As part of the consent form (See Appendix I), all the names of the participants have been anonymized and will be referred as Participant A, Participant B, Participant C and Participant D.
- **Objectives of the Focus Group study:** The focus group study is carried out with the objective of understanding professionals' views on the implementation of energy-saving. Besides, see whether there are any skills

that have come out but not been covered by the skills framework by understanding their demands for energy-saving skills. To achieve this, the focus group interview guide is created with the following four themes:

- Concerns in production process in the factory
- Energy Saving situation and reforms in the company
- Skills requirement and training
- The challenges and the opportunities

5.2 Structure of the focus group interview

The Focus Group interview started with a brief on the research aims and objectives. The full structure of the Focus Group guide is in Appendix II. The first theme in the discussion is the changes in production where participants are asked to reflect on their innovation and technological change in production methods.

The second theme focused on energy-saving situation and the efforts to conserve energy in different companies. This topic encouraged the participants to reflect on their individual experiences from their own companies and discuss a wide range of areas such as the process of energy-saving reform, their employees' views on energy saving, the influence of enterprise culture on energy saving and the supervision mechanism of energy saving.

The third theme is centred on the company's requirement and training in energy-saving skills. It looked at employers' expectations from recent graduates who want to embark on this field as a potential career and whether the company offers any training on energy saving.

The final aspect of the Focus Group discussion prompted the interviewees to review the challenges and opportunities they would usually encounter in the company's initiative to conserve energy and manage energy efficiently.

5.3 Focus Group analysis

The focus group is audio recorded and the researcher made notes during their observation of the group discussion. A full transcript of the focus group is later derived from the audio recording of the discussion. As focus groups are in the form of a group discussion, some topics naturally emerges during the process (Green et al., 2003). Following the analysis of the transcript, four major topics (See Figure 5.1) emerged which will be discussed in the following section.

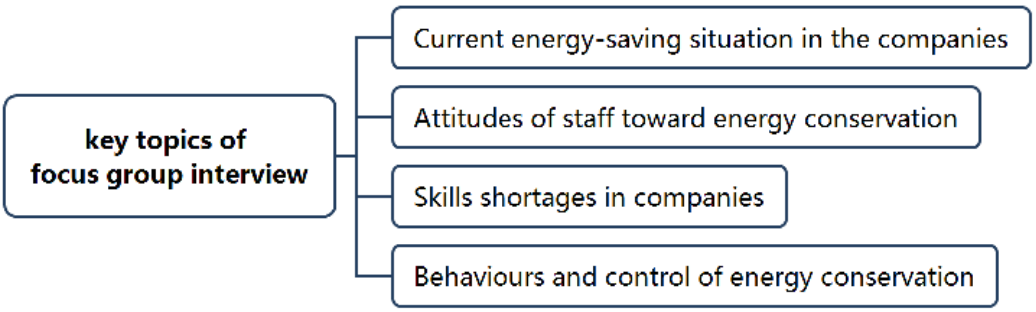

Figure 5.1: Four key areas of the focus group interview

5.3.1 Current energy-saving situation in the companies

One of the core topics emerging from the focus group discussion is the current situation of energy-saving in companies and the barriers in the course of executing energy saving schemes. As discussed in Chapter 2, some of the studies such as Sardianou (2008), Thollander et al., 2013 and Brunke et al. (2014) highlighted barriers and drivers companies face in their execution of energy-saving schemes. This is supported by some of the participants. Some of the crucial issues in the process of energy saving and conservation as reflected in the focus group include: huge initial investment, long payback period, slow approval process and lack of professional skills. As Payne, Weatherall and Downy (2015) stated, although energy efficiency investment can bring multiple benefits, energy-saving activities can still be influenced by several factors. In this context, Participant D notes, *"... it (energy-saving) is important, but then is the cost of expenditure to reduce it… there's a*

company submitting ideas for approval which can take one year, two years to come through. So, there is an attempt of competition, but they still need to be driven to make energy savings, but it becomes harder and harder". Participant B reflected on the challenges of implementing new technologies adding, *"I don't think the technologies have changed out there really...One of the big problems is the amount of time of investment…".* Their opinions seem to suggest that there should be someone who understands the balance between the economic perspective of the change and the technical aspect to help companies to put forward and carry out the strategies successfully. This implies that there might be a lack of such talent in companies who want to drive or push energy saving schemes.

The participants during the focus group also discussed some of their concerns and problems arising during the production process. For instance, one of the participants highlighted how the factory floor is not well addressed at a technical level. Some admitted the lack of technical staff in their companies. This is opinions from participant B who explains that no technicians are there to look after and address the matter when conveyor goes wrong. Participant C reflects, *"…and those big things coming up on the shop floor, isn't necessarily being addressed at the highest level. I still think there's a bit of a gap. We don't have enough competent people that tell us how we get from where we are to where we should be."* This illustrates the importance of addressing skills shortages and behaviours. As discussed earlier, the demand for skilled workforces is increasing, however, such demands are hard to meet. Due to the insufficiency of skills supply in the external market, it is difficult to recruit enough qualified staff (IET 2015 Skills Survey). Considering this situation, companies need to reinforce the internal training system to improve employees' skills, while universities have the responsibility to fill this skills gap.

It is worth mentioning that an effort is made in participant C's company to publicize the notion of energy conservation. However, the participant reported that this kind of approach only had little impact and the energy wastage still continue to exist. According to participant C, *"...we keep talking about it (huge inefficiency) and then*

we have little stickers on lights saying 'switch off the lights as you leave'...I think they're addressing the wrong things sometimes. Sometimes the operation is just left running, because their minds are dealing with another thing. It's quite sad when I see the same thing". This shows that using slogans or banners to influence employees' behaviour may not always lead to having that desired impact. To make employees' behaviour more compliant and understanding towards energy efficiency, the company should influence their awareness from the very beginning (Stern et al., 1999).

In this topic, some of their views can be summarized as follow:

- Barriers exist in energy saving process such as expensive initial investment, long time payback period and slow approval process.
- Complex problems arising from the process of energy consumption are not well solved due to the lack of technical staff.
- Energy-saving propaganda like "*Energy-saving Slogans*" takes little effect in energy conservation inside a company.

5.3.2 Attitudes of staff toward energy conservation

People's awareness to energy conservation will directly affect their practices of energy-saving (Stern et al., 1999). So, it is necessary to understand staff's attitudes in companies towards energy-saving. As participant D pointed out, the process of papermaking usually swallows up tremendous amount of energy and resources which includes consumption of gas, electricity and water. The participant added, *"...because we're getting quite close to- well we have been getting quite close to: energy, water, CO2, everything on that, but we are bringing it all down. Simple things like we changed all the lights to LEDs, we use high-efficiency motors"*. Faced with such huge expenditure, directors have stressed the importance of cutting down unnecessary consumption, trying new efforts to reduce the utilization of all resources as much as possible. As participant B indicates *"If we have two of the filtration units*

going on at once, the director is usually ringing me up and shouting at me to get one of them off if I can, that's about 6 kilowatts a day I think. It's a lot anyway".

The huge utilization of energy leads to the manufacturers' close attention and surveillance over the energy being used. Participant C reckoned energy monitoring as a prerequisite to energy control. *"It is getting an understanding of the right monitoring to be able to make decisions.... If you're not monitoring, you're not managing"* they says. Participant D confirmed the emphasis that enterprises have laid on energy monitoring further noting, *"We also have all-seeing managers who have to cover weekends"*. Regular meetings which encourage communication and feedback of the progress of energy surveillance are requisites for keeping abreast the utilization of energy. Participant B explains *"…you do have two-term management reviews, and even daily meetings, we have 3 times a week production meeting…but a lot of the time you've got a chance to say something".*

Speaking of whether energy usage is monitored at total level or unit level, participant D insisted that surveillance should be measured in unit level. Besides, the interviewee did not express evident satisfaction with the situation of energy surveillance in the company. "*We are going down the route of additional sub-metering to understand where we are using it…So most companies are probably oversized in terms of transformers and the power generation or power supply we were under…S.C.A was never great at monitoring stuff",* participant D says.

However, to those engineers of older generation, energy conservation has never been a matter of great urgency. Participant C indicates, *"Some of the older engineers from our site…they wouldn't have gone to University and they wouldn't have picked out energy efficiency as a primary purpose of them being there."* and added, *"It needs something new to pull that in, to make people see energy saving as a core part of their competence I suppose".* In other words, energy-saving reforms ought to be put into practice in the process of manufacture so as to change staffs' attitude towards energy conservation.

When it comes to who is responsible for the introduction of these energy-saving reforms in the companies, participant D believed that staff from the paper mill should shoulder this responsibility since they were the ones who directly manipulated those machines. participant D explains, "*It should be on paper mill manager, because he's got the usage. He's got two machines using, gas electricity, and steam*." Participant C too agreed that people can really change the condition of energy usage and it should come from the operational line. *"We talk a lot about energy as taking the cost down, but actually the real things that make a difference come from the shop floor up. Those are the guys that really know how to make a difference. Whether it's the operational shop floor, or the engineering shop floor. Those are the changes that make and sound completely difference."* Meanwhile, Participant C pointed out that in order to achieve large-scale energy saving still need strategic arrangement.

From this analysis, the following key points can be summarized:

- Practitioners of paper industry showed an understanding of energy conservation and its importance today as papermaking is a high energy-consuming process.
- Monitoring should be taken seriously and sub-divided into units in operational process since effective energy management demands close monitoring.
- Engineers of the older generation tend to underestimate the significance of energy conservation, thus energy efficiency is not the main purpose of their self-improvement in terms of skills.
- The people who can really change the energy use situation and achieve energy-saving goals should be the technicians from the shop floor.

5.3.3 Skills shortages in companies

Participants have repeatedly mentioned that a large part of the existing problem is caused by a shortage of skills. Specifically, participant C indicates that the monitoring of energy remained a skills gap to be filled. On the other hand, qualified

technicians who acquired energy-saving knowledge are still in increasing demand among companies since they are able to introduce and push through the reform in behavioural and mechanical senses. As participant C says, *"...for those that can actually show energy efficiency saving, whether it's through a behavioural change or whether it's through a mechanical change I would say yes, we still are struggling to find new people to come in."*

Generally speaking, the shortage of skills embodies in all aspects. Because as long as engineering talent is still short, technical problems cannot be settled. As participant C says, *"Generally, we have engineering shortages anyway...I don't really find it so much in engineering. Engineers are completely different breed... I still think there's a bit of a gap. We don't have enough competent people that tell us how we get from where we are to where we should be".* More technicians with professional engineering knowledge and the ability to put theory into practice are needed more than ever in the companies. As participant B indicates, *"You need realistic people".*

Participant C says, "…*even just very recently, I think most of our engineers were actually turned over completely in the last two years. We seem to get a real rapid turnover of engineers and yet operational wise".* In an age when sustainable development has become the global main trend, the industry has witnessed a professional engineering reform, which is urging a faster turnover of personnel. That is to say, a transformation in personnel is required in order to increase the staffs' comprehensive technical capability. Only in this way, can the enterprises follow the varying market trend and achieve long-term progressing development.

However, it is in fact rather difficult for engineers to achieve the transformation in either professional or attitudinal sense. Participant D says, *"They're just used to working with machinery, it might not be a specific set of machinery. So like you say they can swap around. Whenever you're looking at production and stuff, they're trained to use a machine in a particular way, it's not quite so easy to move on, I would say maybe".* Participant C adds, *"Some of the older engineers from our site would have had their skills from apprenticeships at best, they wouldn't have gone to*

University and they wouldn't have picked out energy efficiency as a primary purpose of them being there…and if that's not there, then they're the guys training the next set of apprentices, so it won't be there either". What they have said indicates a less promising prospect for paper industry. Those older engineers who lack keen and conscious awareness of energy conservation are the seniors and instructors to the new engineers, thus the significance of energy-saving notion is likely to be neglected by engineering learners. In the long-run, engineers can neither achieve transformation nor broaden and upgrade their skills in energy-saving regard.

Views are summarized as below in terms of this topic:

- There is a shortage of technical staff with comprehensive knowledge of energy conservation, which brings difficulties to the effective introduction and implementation of relevant reforms.
- The shortage of skills in energy monitoring is one of the pressing issues faced by paper sectors.
- It is rather hard for engineers to expedite transformation of the mode of energy utilization due to attitudinal and technical limitations.
- The old engineers' attitude to energy saving will affect the comprehensive development of the next generation of young engineers.

5.3.4 Behaviours and control of energy conservation

The alteration of people's behaviours makes energy conservation achievable, this is one of the other opinions the participants agree. Participant A suggests it's possible to achieve energy savings by changing the way we act. Compared to investing expensive upgraded machines, it cost less and worked feasibly. Participant A adds, *"There's a relatively small cost to the mill in it (behavioural change)."* The interviewee also mentioned that there are already some companies who areparticipating in an 18-month project to look into people's behaviours psychologically, which to some extent demonstrated their determination in this field.

Participant D considered the alteration in behaviours necessary, for the new generation in particular. Further discussion involved the cultivation of young engineers, such as how the change of behaviours could be achieved via effective introduction and trainings, and that alterations in behaviours are to be monitored so that they are under clear control.

Particularly, these interviewees hold confusions about the cultivation of the energy-saving skills. For example, are there corresponding courses in the higher education that help cultivate engineering students; are there online courses involving the training of energy-saving techniques for staffs, etc. They hardly had idea of the way to find the courses that met their needs, and thus expected government and the Higher Education to offer more detailed instructions.

Participant D advised that the spread and application of the knowledge of energy conservation should be integrated into the education of the engineers-to-be. By doing so, the development of the entire industry would enjoy enormous, long-term benefits environmentally, economically, socially and so on. *"Embedding it to the next generation… I think if you have it as a foundation moving forward. I think you'll get a lot more from it in 10-15 years."*

When referring to the way of managing staffs' behaviours to conserve energies during the process of manufacture, participant B believed that appropriate guidance was effective. *"We instruct them, but I don't think people always do what you want I think that might be similar to what you guys have just said there it's sort of we're trying to really get.. You can tell your employees as much as you want, but if something's going to make their job easier by flicking a switch, they're going to try it on".*

Yet in participant D's views, compulsory regulations were sometimes necessary so as to achieve effective alterations. *"...when you need to affect change it really is difficult sometimes. You don't tell people off and give those warnings, you are just asking and arguing".*

Participant B suggested that directors were supposed to seek a balance way which is neither too compelling nor too loose to regulate the behaviours of the staffs. *"…before I went to the paper mill I worked for quite a large company… and it's not ruling with fear, but there's disciplinary actions, and they're not friends they're work colleagues, and that's how they work. The mill now is the complete polar opposite, maybe it's a little bit too friendly. It's just finding the right balancing act to actually get the behaviour changing".*

Views are summarized as below in terms of this topic:

- Changes in employee behaviour makes energy savings possible.
- Energy-saving related knowledge needs to be embedded in the next generation of engineering talent training program.
- Companies need to find a moderate way which is neither mandatory nor loose to guide the energy-saving behaviour.

5.4 Inspirations for proposed energy-saving skills framework

As the main purpose of the focus group interview is to provide external information support for the framework modification from the opinions of the participants, inspirations from the interview which can support the development of the proposed energy-saving skills framework are summarised as below:

- To encourage the companies' investment in energy conservation, engineers are supposed to acquire comprehensive engineering skills in economic and technical senses.
- The techniques about energy monitoring are urgently needed in industrial business.
- The alteration of staffs' behaviour plays a role in the conservation of energies.
- The creation of an effective behavioural performance assessment is the key to the management of staffs' behaviour.

- Staffs' attitudes toward and behaviours of energy conservation could be changed through effective introduction and trainings.
- The new suggestion like energy-saving awareness is valued. The spread of energy-saving awareness should be integrated with the company's culture in a broad sense.

5.5 Chapter summary

In this chapter, the content of focus group interview is analysed in detail. Through the analysis, four key topics were extracted from the participants' discussion. These four topics include: Current energy-saving situation in the companies; Attitudes of staff toward energy conservation; Skills shortages in companies; Behaviours and control of energy conservation. Overall, respondents' views supported some of the skills reflected in the proposed energy-saving skills framework in chapter 5. Their opinions have shown that these companies attach great importance to skills associated with energy conservation and this includes energy monitoring, human resources management (behaviour management and training included), and the demand for comprehensive energy-saving skills, all of which are embodied in the proposed skills framework. The focus group interview is a cross check against the diversity of the skills in the proposed framework. All the energy-saving skills discussed among the interviewees in the focus group interview are included in the proposed framework. In other words, no skills mentioned in the interview is omitted in the framework.

Chapter 6

Analysis of Skills Using Job Advertisements

6.1 Chapter overview

In the last chapter, opinions collected from managerial personnel in the paper industry on the skills of energy conservation substantiates what is proposed in the current skills framework. To gain a better knowledge of external information about the skills framework and back up the study with reliable numerical data, this chapter analyses energy-saving related job advertisements. Creswell (2002) states that qualitative research is an approach that interprets the views of others and objectively collects and sums up the information that already exists in the field. Job advertisements contain a lot of descriptions of skills and each of them is regarded as an original data source to further explore the research area. Job advertisements are essentially people's objective understanding of related job roles and skills.

The core objective of this research is to build an energy-saving skills framework. In order to make the proposed framework sounder and more reasonable, the job advertisement analysis is conducted with the following aims:

- Get an up-to-date indication of the skills associated with energy-saving within an industry sector.
- Check if the skills modules in the proposed framework are in accordance with employers' requisite skills for future employees in the real market.

Online job advertisements are used as basic data and these are analysed using NVivo software. Based on content analysis, skills categories are derived to support the proposed skills framework.

6.2 Analysis process

This section shows a detailed analysis process that explains how online job advertisements are collected, categorized, and analyzed, ultimately helping to build the skills framework.

6.2.1 Job advertisements collection

Job advertisements related to energy-saving in the recruitment market is another crucial source of data collection to further understand real market demands. The method adopted in this study is based on Ahsan, Ho and Khan (2013), which selected the most widely-used and representative online recruitment database. In this study, the source of data is Indeed.com. As many companies conduct recruitment at the beginning of the year, the data for this study is therefore collected in January 2018. “Energy saving”, “energy efficiency” and “sustainable” are the keywords used to search for the targeted job advertisements. In total, 115 jobs advertisements are downloaded. After careful screening of all job advertisements, 5 advertisements are discarded as they had insufficient or incomplete information. From this sample, each job advert is then saved into a Word document and named using the following naming convention:

<Job document number> - <job title>

The specific URL link for each job advertisement used in this study is added to the Word document for future reference. Following the screening, a total of 110 job advertisements are selected from the energy-saving job sector (for the list of job advertisements see Appendix 5). In the following section, job descriptions of each advertisement will be reviewed.

6.2.2 Building a coding system in NVivo

Job advertisements are analysed by means of *content analysis* in this study. The coding and analysing of these documents are carried out using NVivo 11, which is

popular software used for analysing qualitative data with features that help in coding textual data and deriving any emerging patterns or themes (Baruah et al, 2018). Scholars such as Hsieh and Shannon (2005) suggested that categories for the coding system can be pre-designed based on a literature review in a conventional content analysis in NVivo. According to their theory, categories in the energy-saving skills framework from the results of the Literature Review are used as a reference to build the coding system.

The coding system refers to a node-based data collection system. A node in NVivo is a collection of references about a specific theme (NVivo 10 for Windows Help, 2018). Coding is the process of placing the sorted data into the matching node. One of the essential aspects of the coding process is to establish an analytical construct to guide the review process. During the analysis of sources (documents, datasets, pictures, video or audio), the researcher can code any content related to "subject A" in the *Subject A* node. Accordingly, Node *Subject A* contains all information about subject A.

The nodes in the study refer to skills categories, with each node standing for a skills category. The node-based coding system is shown in Figure 6.1, created on the basis of the skills categories in the proposed energy-saving skills framework.

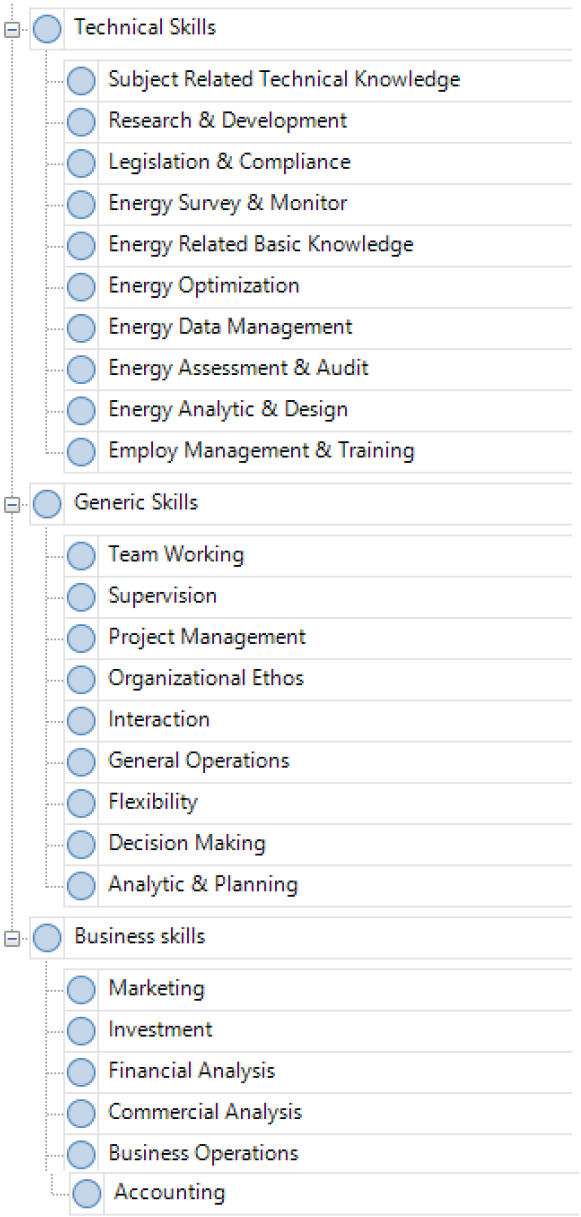

Figure 6.1: The coding system in NVivo

This ensures that the skills required in the advertisements fall into the correct categories. For example, when exploring code skills for energy monitoring in job advertisements, all skills related are coded into the node *Energy Monitor*. In other words, all information involved in the node *Energy Monitor* are skills relevant to it. Moreover, when the node is clicked, all the references of "Energy monitor" can be viewed in one window.

Such a coding system makes the degree of matching of the categories in the proposed skills framework and the skills in the real market viewable and understandable. The

practical significance of the framework can be proved if the skills in the job advertisements are logically assigned to the coding system in NVivo.

6.2.3 Data input and analysis

The online job advertisements and the extracted skill statements are copied in the original format from the recruiter website so as to maintain consistency in quality.

(1) In total, 110 job advertisements are imported as separate Word files as internal data within NVivo so as to build a project database.

(2) Descriptions of the skills in the advertisements are analysed. According to Currie (2006), identification of skills within a job advertisement can be found under the "job/role responsibilities", "job/role specification", "role/role summary" or "experience required" etc. A detailed description of the skills requisite to the job is indispensable in most job advertisements.

(3) The identified skill statements are coded into matching nodes.

As this study follows a constructivism philosophy, the intent is to make sense of (or interpret) the meanings others have about the world (Creswell and Creswell, 2017). Constructivist researchers analyse and make data meaningful through personal life experiences and their cognition and perception of the world (Kivunja and Kuyini, 2017, Punch, 2005). The researcher's understanding in this study developed from the immense theoretical research on this field. In other words, their experience of gathering and reading studies concerning energy-saving skills serves as the cognitive basis for the analysis. The classification of the skills in a job advertisement could be identified according to the researchers' logical analysis and the definitions of skills categories in the proposed framework. Each of the job advertisement is coded separately. An example (Sample 55) from the overall data is shown here to illustrate how a job advertisement is analysed.

55. Environment and Energy Manager

Field：Train operating

Sector：Transportation and storage

About the role:

Reporting to the Head of SQE, the post holder will be required to develop the company environment and energy management systems and establish high standards of environmental performance across the network. They will be responsible for the day to day management of environmental issues, delivering environmental Committed Obligations and driving and influencing change in all aspects of environmental issues.

Main responsibilities:

- Champion all aspects of environmental and energy performance, change and improvements by influencing and engaging employees at all levels of the business, including senior management. This includes supporting staff in implementing environmental standards and initiatives.
- Ensure that Arriva Rail London maintains ISO 14001 Environmental Management System certification and progresses the company towards the latest 2015 version of the standard by September 2018.
- Embed business processes and procedures to progress the business towards the Carbon Trust triple standard accreditations for carbon, waste and water and ISO 50001 Energy Management System certification by November 2018
- Compile KPI's and undertake business reporting as required, including against ARL, Arriva Group and RfL environmental objectives on a periodic basis.
- Develop the business Annual Environment Improvement Plan; Environment Management Plans (Noise & Vibration, Waste and Supply Chain); and the Annual Environment Report.
- Carry out Environmental audits, site inspections across the London Overground network to ensure legal compliance, compliance with internal standards and to mitigate risks and assess opportunities for improvement.
- Actively participate in the Arriva UK Trains Environment Improvement Network.
- Maintain an awareness of all current and future environmental and energy legislation, and ensure the business is compliant.
- Collaborate with internal and external stakeholders to deliver Environmental Objectives

Generic Skills
Organisational Ethos

Technical Skills
Legislation & Compliance

Technical Skills
Legislation & Compliance

Generic Skills
Interaction

Technical Skills
Subject-related Technical Knowledge

Technical Skills
Energy Assessment & Audit

Non-skill description

Technical Skills
Legislation & Compliance

Generic Skills
Team Working

Figure 6.2: Job advertisement No.55

This statement indicates that recruiters expect employees to have infectious enthusiasm in sharing their values of energy conservation so as to arouse other colleagues' passion in saving energy. This ability corresponds with the skills of Organizational Ethos since according to the definitions of the skills categories in the proposed framework, Organizational Ethos (under "Generic Skills") refers to the "*Ability to conduct propaganda and build sustainable organizational culture and values to promote staff's energy conservation thinking and behaviour*".

"ISO 50001", "ISO 14001" and "Carbon Trust triple standard accreditations" mentioned in the advertisements are both energy compliances. The selected content indicates recruiters' clear expectation for candidates to keep abreast of the latest energy-related regulations so as to ensure the company operates legally. This ability corresponds with the skills of Legislation & Compliance, since according to the definitions of the skills categories in the proposed framework, Legislation & Compliance (under the category of Technical Skills) refers to being "familiar with the current laws and compliance related to energy and ensure that the company is compliance to these laws and regulations when required."

The statement here mentions a specific knowledge "Noise & Vibration, Waste and Supply Chain", which corresponds with the skills of Subject-related Technical Knowledge, since according to the definitions of the skills categories in the proposed framework, Subject-related Technical Knowledge (under the category of Technical Skills) refers to the "*knowledge in specific areas of energy savings or energy-saving processes*".

6.3 Job advertisements analysis results

After analysing the 110 online advertisements using the approach discussed earlier, all requisite skills are categorised and then coded into corresponding categories.

6.3.1 Coding results

With the help of NVivo software, the analysis results of the data are obtained. Figure 6.1 shows the overall coding results.

Nodes

Name	Sources	References
Skills	105	610
Technical skills	81	242
Subject Related Technical Knowledge	45	62
Research & Development	10	10
Legislation & Compliance	27	33
Energy Survey & Monitor	23	27
Energy Related Basic Knowledge	6	8
Energy optimization	4	6
Energy Data Management	18	25
Energy Assessment & Audit	19	23
Energy Analytic & Design	20	26
Employ Management & Training	14	15
Generic skills	96	299
Team working	30	34
Supervision	3	4
Project Management	34	42
Organizational ethos	10	10
General Operations	15	17
Interaction	80	123
Flexibility	19	25
Decision making	10	11
Analytic & Planning	25	33
Business skills	40	69
Marketing	15	17
Investment	3	3
Financial Analysis	6	9
Commercial Analysis	21	23
Business Operations	10	12
Accounting	5	5

Figure 6.3: Coding results in NVivo

The item “Sources” in Figure 6.3 refers to the coded source of the file (job advertisement file), and the figures under it refer to the number of advertisement files that had been coded. The item “References” in Figure 6.3 refers to the cited contents in the job advertisement, and the figures under it refer to the number of the skills

being coded, that is, “Citation Frequency”. The figures under “Sources” and “References” are different since several skills in one advertisement might be allocated to the same category.

For example, take the skill category “Interaction” under the “Generic Skills” category (see figure 6.4). This kind of skill refers to the ability to interact purposefully with individuals or groups (such as internal and external stakeholders, energy suppliers and staff who are related to energy saving) in either oral (negotiation and communication) or written (reports) forms.

Figure 6.4: Coding results of Interaction group.

The number “80” under the term “sources” shows that 80 different advertisements mention “interaction”. In the 80 advertisements “interaction” is used 123 times. All the references can be seen if that particular code is opened, as shown in Figure 6.5.

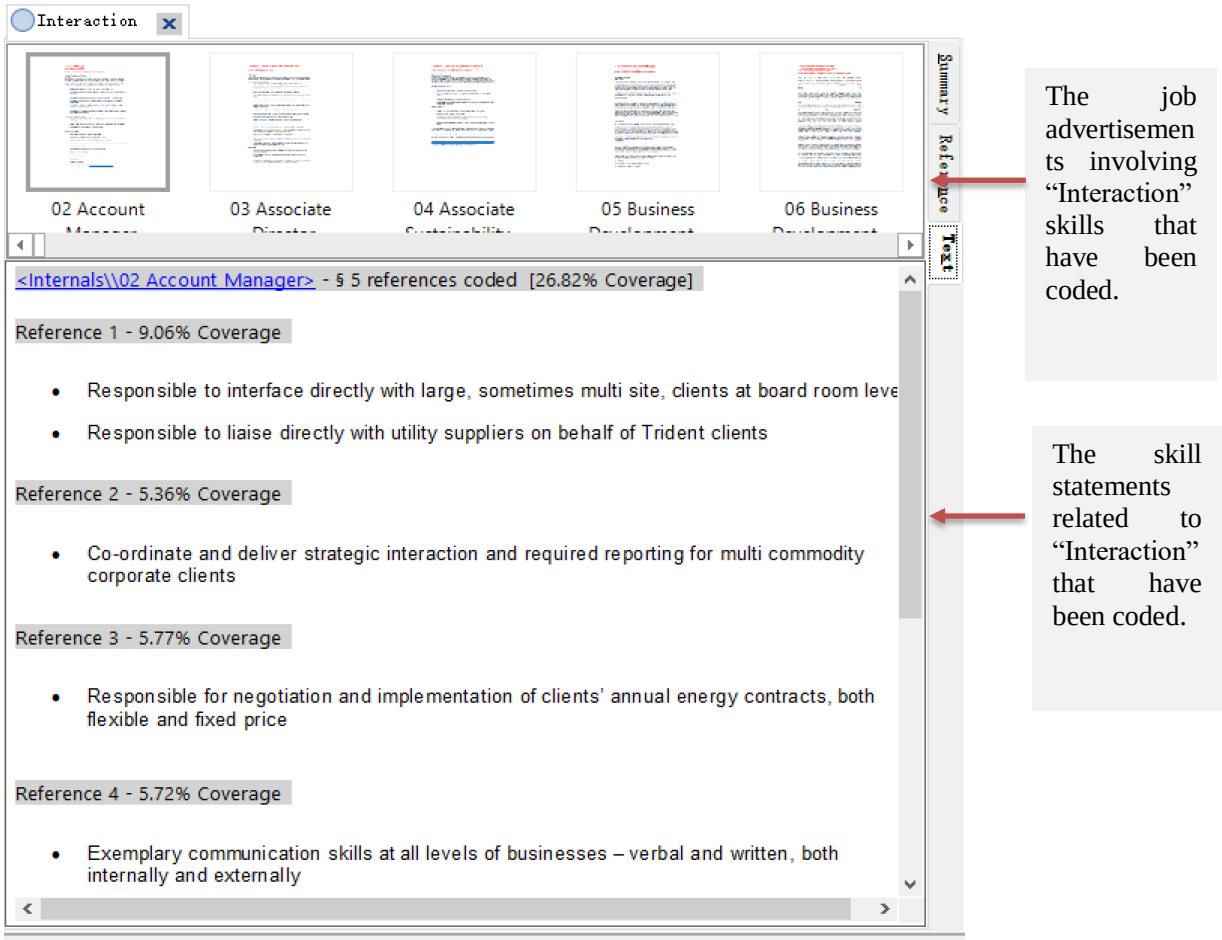

Figure 6.5: References in Interaction group

6.3.2 Analysis of skills expectation in the job market

The citation frequency for each skill that fall under different categories are shown in descending order in Table 6.1. Since each of the skills that appear in the job advertisements can be found and be located to the corresponding group (in the proposed skill categories), the framework keeps in tune with the real situation of the industrial market.

The result also indicates employers' expectations for different skill types. As Table 6.1 shows, the top 3 skill types most frequently cited in the job advertisements are:

- "Interaction"
- "Subject Related Technical Knowledge"
- "Project Management"

Table 6.1: Overall summary of skills citation in job advertisements

Energy-saving skills (all categories)	**Citation Frequency**
Interaction	123
Subject-related Technical Knowledge	62
Project Management	42
Team Working	34
Legislation & Compliance	33
Analytic & Planning	33
Energy Survey & Monitor	27
Energy Analytic & Design	26
Energy Data Management	25
Flexibility	25
Commercial Analysis	23
Energy Assessment & Audit	23
General Operations	17
Marketing	17
Employ Management & Training	15
Business Operations	12
Decision Making	11
Research & Development	10
Organizational Ethos	10
Financial Analysis	9
Energy Related Basic Knowledge	8

Energy optimization	6
Accounting	5
Supervision	4
Investment	3

The most highly emphasised skill is the ability to interact and communicate. "Interaction" in the energy-saving skills framework refers to the ability to interact purposefully with others in either verbal (negotiation and communication) or written (report) forms, such as internal and external stakeholders, energy suppliers and staff who are related to energy saving. This is a high-level skill with a hierarchy of sub-skills below it. Related skills are covered under this skill category such as "*ability to report, document and present key findings from energy data analysis in a meaningful manner*". As a generic skill, communication skills have always been the focus of attention in all industries, and the energy industry is no exception. Project management is another generic skill which appears more frequently in the industry field. Energy service providers consider the skill of project management as one of the most regularly found lacking in University or Vocational Education and Training (TAFE) graduates (Australian Government, Department of Resources, Energy and Tourism, 2009). Project management skills are common in the industrial sector. In an energy-related project, it is crucial to undertake and manage a project that involves project identification, appraisal, design and implementation around energy compliance, meeting deadlines and client requirements etc.

As discussed earlier, technology is the key point to help to achieve energy savings and this is why the demand for skills in "subject-related technical knowledge" is high. The reference codes in NVivo illustrate employers' claims in this regard, such as "Knowledge of SAP, RdSAP and building energy efficiency highly advantageous" (advertisement No.25 - Energy and Environmental Compliance Manager) and "Have technical experience in key technologies e.g. lighting, heating, A/C and BEMS" (advertisement No.39 - Energy Improvement Manager). Managers who participated in the focus group interview also substantially mentioned it. Interviewees indicated that it is difficult to effectively introduce or reform if there is a lack of specific technical skills. This is a kind of knowledge skill that refers to understanding of the knowledge in specific areas of energy saving or energy-saving processes. The specific skills under "subject-related technical knowledge" are listed in the skills in

Appendix 4, such as Power system data acquisition and control, Load and energy management, End-user distribution systems and Cogeneration etc, all of which are key techniques in the energy-saving field.

Business skills such as “investment”, “accounting” and “financial” appear relatively less frequently than other technical skills in job advertisements. This may be because only a small number of specific occupations require business competence in this field, but it is in reality an existing requirement from employers. As illustrated earlier, financial, economic and investment problems are some of the barriers in company’s energy-saving reform process. Business skills are therefore indispensable for promoting the energy-saving process in a company.

The proposed skills framework gives the definition of energy-saving related business skills: it is the crux that ensures the idea of energy conservation operates smoothly in the business environment. Gaining a full knowledge of the energy-saving working pattern helps people draw up a strategic investment plan. For example, understanding the theory of return and payback periods on energy investment can help technical manager make better energy-saving decisions in investment.

Specifically, in the technical related skills group as shown in Table 6.2, the top 3 skill which are most frequently cited in job advertisements are:

- “Subject-related Technical Knowledge”
- “Legislation & Compliance”
- “Energy Survey & Monitor”

Table 6.2: Technical skill categories in descending order by “References”

Energy-saving Technical Skills	**Citation Frequency**
Subject Related Technical Knowledge	62
Legislation & Compliance	33
Energy Survey & Monitor	27
Energy Analytic & Design	26
Energy Data Management	25
Energy Assessment & Audit	23
Employ Management & Training	15
Research & Development	10
Energy Related Basic Knowledge	8

Energy Optimization	6

The second significant skill "Legislation & Compliance" reveals recruiters' wish to ensure the operational process meet energy-saving regulations. This corresponds to earlier discussions; countries around the world attach great importance to energy efficiency and have enacted a variety of legal norms to limit the large-scale use of energy and optimise energy use processes. In order to respond to government policies, companies have been trying to ensure full compliance with the law. This increases the need for talent which can master "Legislation & Compliance" capabilities, it refers to being familiar with current laws and compliance related to energy and ensures that the company is compliant with laws and regulations wherever required.

"Energy Survey & Monitor" ranks 3rd. Participants in the focus group also showed its significance, stating that talent with such skills is urgently needed in industrial businesses. One of the interviewees said that monitoring of energy remained a skills gap to be filled. As he indicated, most companies are probably oversized in terms of transformers and the power generation or power supply, but few are great at monitoring.

As Table 6.3 shows, the top 3 skill types related to business energy-saving skills most frequently cited in the job advertisements are:

- "Commercial Analysis"
- "Marketing"
- "Business Operations"

Table 6.3: Business skill categories in descending order by "References"

Energy-saving Business Skills	**Citation Frequency**
Commercial Analysis	23
Marketing	17
Business Operations	12
Financial Analysis	9
Accounting	5
Investment	3

Though the frequency of the "Business skills" being cited is less than that of the "technical skills", the former is still an existing demand of employers. Integrating different skills according to the situation of the company effectively is of assistance to investments and financial management during the course of energy conservation. Reference codes in NVivo illustrate employer requirements in terms of this type of skill. "Set the commercial strategy in line with long and mid-term vision and business strategy" (advertisement No.12 - Business Unit Manager - Environment); "Extensive energy market knowledge gained or exposure to trading commodities, especially electricity and gas" (advertisement No. 24 - Energy Analyst); "Astute candidate with good commercial knowledge and ability to develop new business opportunities" (advertisement No.26 - Energy and Sustainability Consultant); "Developing business cases for energy investments and infrastructure refurbishments" (advertisement No.90 - Senior Energy Consultant).

As Table 6.4 shows, the top 3 skill types related to business energy-saving skills most frequently cited in the job advertisements are:

- "Interaction"
- "Project Management"
- "Team Working"

Table 6.4: Generic skill categories in descending order by "References"

Energy-saving Generic Skills	Citation Frequency
Interaction	123
Project Management	42
Team Working	34
Analytic & Planning	33
Flexibility	25
Operations (general)	17
Decision making	11
Organizational ethos	10
Supervision	4

The most popular generic skills in Table 6.4, as expected, are "Interaction", "Project Management" and "Team Working", which also turn out to be top in other studies, such as Ahsan, Ho and Khan (2013), Ward et al. (2016), Baruah et al (2018).

It is worth noting the emphasis placed on "team working" skills in many energy-related jobs. For instance, for a "Business Development Manager" (energy management solutions oriented) in advertisement No.09, the expected team working skills are to "proactively establish and maintain effective working relationships with internal teams". Moreover, when recruiting for the position of "Sustainable Energy Use Team Lead", the employer expects the candidate to be an "Effective team player, both internally and externally, in collaborating on strategic initiatives and opportunities to drive business growth" (advertisement No.104)

The results of theoretical research show that energy saving is a complex process. In order to achieve energy saving the right mix of people and skills are always needed, including the implementation of technology, the promotion of investment and the awakening of employees' awareness of energy conservation (Australian Government, 2009). Specifically, previous research indicated that effective assessments require the involvement of people from across the organisation, with diverse backgrounds and skill sets (Australian Energy Exchange, 2017).

The abundant variety of professional skills requisite in the energy industry precisely reflects the necessity of building a complete energy-saving skills framework. This helps employers describe their skill needs clearly and completely when designing a job advertisement. In addition, it avoids ambiguity and repetition of skills due to a lack of understanding of energy-saving skills, ensuring the quality of skills statements in the job advertisement.

6.4 Chapter summary

This chapter presents the procedure of the job advertisements analysis. The analysis begin with 110 job advertisements, then analysis is performed using NVivo software. The coding system in this analysis is built on the categories in the proposed energy-saving skills framework; while the process of coding skills is founded on content analysis and constructivist logical analysis. After the analyses, all skill items identified from job advertisements could be properly assigned to matching categories in the proposed framework. This indicates that no omitted skills have been found so far. To put it in another way, the energy-saving skills categories established in the proposed framework included the common energy-saving skills in the industrial market. Furthermore, the degree of demand from the market for different skills is

also discussed. “Interaction”, “Subject Related Technical Knowledge” and “Project Management” are the top 3 skills wanted most by enterprises in the recruitment market. Specifically, for technical related skills, the top 3 skills most frequently cited in job advertisements are “Subject-related Technical Knowledge”, “Legislation & Compliance” and “Energy Survey & Monitor”. The top 3 skill types related to business energy-saving skills are “Commercial Analysis”, “Marketing” and “Business Operations”, while “Interaction”, “Project Management” and “Team Working” are the top 3 skill types in the business energy-saving skills group.

Chapter 7

Conclusions and Further Work

7.1 Discussion and conclusion

There is no doubt that energy conservation is of cardinal significance to the current world. For the sustainability of our planet, it is important to adopt environment-friendly and energy efficient policies and strategies. This will help ease the growing energy shortage. For a nation, it creates employment and stimulates the economic development (Gary, 2017). For different enterprises particularly the high energy consumption companies, saving energy enhances their sustainable prospects (CBI, 2003). Nowadays, many companies regard energy saving as one of their high priority strategic targets. The key to achieve such a transformation is the cultivation and recruitment of talents with energy-saving skills.

So far there is no complete knowledge system of energy-saving skills to be used as references in the industrial field, this study therefore aimed to build a framework of energy-saving skills. Started from desk research, this study explored the skills related to energy saving in high energy consumption sectors and created an energy-saving skills framework on the basis of literature review. This skills framework related to energy-saving consist of 3 skills at the top-category followed by 23 skills at the sub-category.

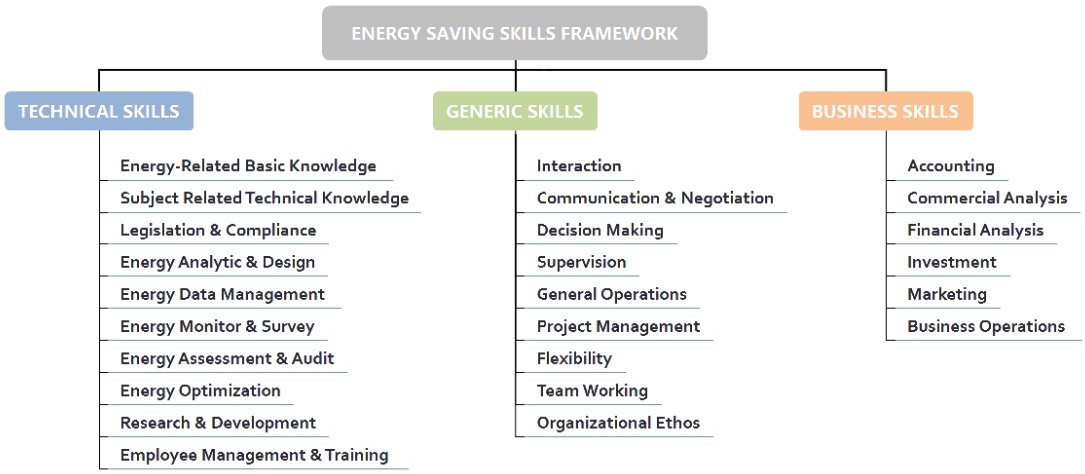

Figure 7.1: Skills framework for energy-saving

The framework is organised in a hierarchical structure, aimed at making a clear-cut presentation of different energy-saving skills. Laterally, the skills are divided into 3 top categories to show the skills characteristics; while longitudinally, every group is expanded and subdivided into more detailed skills categories. Such a pattern of classification makes it possible to involve a wide variety of skills types and present these in a well-organized manner. Further information is obtained through the analyses of the focus group interview and the online job advertisements to further validate the findings of the study and the proposed framework.

Papermaking sector is an ideal representative of the high energy consumption industries and this study utilized a detailed focus group interview with four managers from this sector who are actively involved with energy management. Using this method, the researcher explored four key aspects related to energy-saving:

- the current energy-saving situation in high energy consumption companies,
- attitudes of staff toward energy conservation and management,
- skills shortages in companies focusing on the transition to energy saving policies and
- behaviours and control of energy conservation and management.

The analysis from the focus group interview shows that these companies have a great demand for energy conservation. As said before, global energy demand will increase continuously by 30% in 20 years, especially in high energy consumption sectors (World Energy Outlook, 2017). Given paper industry being highly energy-consuming, interviewees placed a lot of emphasis on energy conservation. However, as shown in the interview, energy conservation management is filled with challenges. Apart from the difficulties mentioned previously (Sardianou, 2008; Brunke, Johansson and Thollander, 2014), new obstacles arose in the interview. The lack of technicians with fine mastery of energy-saving skills is one of the main obstacles for addressing the current energy management situation in industries. Some of the participants in the interview urged the need for a comprehensive understanding of energy-saving skills, especially energy monitoring and energy-saving culture propaganda. This supports some of the aspects in the proposed framework such as the importance of skills for energy monitoring and organizational ethos. The managers in the interview also showed concern over higher education and their lack

of focused curricula related to energy-saving and sustainability management. Many noted the lack of expected skills on these areas among recent graduates. In this context, they indicated that energy-saving knowledge needs to be embedded in the next generation of engineering talent training program and university curricula. The literature review also showed that courses related to energy conservation have been set up. Domestic higher education institutions such as University of St Andrews, Sustainable Development (2018) and Department of Engineering in University of Cambridge (2018), have started to take actions in energy-saving talent cultivation. Whether these higher education courses meet the expectations and demands of the employers in the real market still needs further investigation.

Information about enterprises' expectation on employees' professional skills can be extracted from job advertisements (David, 1973; Torrington and Taylor, 2004). An analysis of a sample of 110 online job advertisements related to energy-saving is carried out in this study. This is done to cross-check and further validate the skills structure in the proposed skills framework. Job advertisement is one of the key elements of human resource management and it contains information about the required skills for specific roles that are being actively sought after by recruiters/employers. Such information gives a real indication of the current needs of the market. The online job advertisements analysis further proves the validity of the proposed framework, as it indicates that the skills categories covered in the proposed energy-saving skills framework are in accordance with employers' expectations for skills in the energy industrial market.

Apart from that, the analysis presents recruiters' attitudes toward different energy-saving skills. "Subject-related Technical Knowledge"，"Legislation & Compliance" and "Energy Survey & Monitor" are the top 3 technical related skills that employers desired most. Energy-saving plays an important role in determining its buoyant demands for "subject-related Technical Knowledge". Constant governmental concern over new laws and regulations for energy conservation brings about companies' growing attention on "Legislation & Compliance". The popularity of "Energy Survey & Monitor" is also evident in the analysis of the focus group interview. Demands for the skills of "Commercial Analysis", "Marketing" and "Business Operations" are relatively less but it still shows their importance in certain aspects. Financial and economic problems are some of the main barriers towards the

energy-saving process as confirmed by some of the previous studies. The understanding of some of the basic financial theories like return and payback periods on energy investment can help people in such areas make better energy-saving decisions in businesses. As for generic skills related to energy-saving, like most other field, “Interaction”, “Project Management” and “Team Working”, are rated as the most highly sought-after skills as expected. These are the skills that use the most frequency which are also highlighted in previous studies.

The analyses of focus group interview and online job advertisements show that the proposed energy-saving skills framework based on desk research is in accordance with the market and employers’ needs.

The skills framework proposed in the study fills one of the significant gaps in energy-saving field. The theoretical framework can help people advance their understanding of energy-saving skills related to energy consumption and management, guide them and help gain a systematic knowledge of the classification of energy-saving skills. The interview and job adverts both reflect the industry’s attention on energy saving and its demand for technicians and other personnel with relevant skills. Therefore, the potential users of this skills framework are:

- Employers, such as recruiters, human resources managers and sector bodies.
- Policy makers,
- Individuals such as employees and graduates.
- Higher education institutes and other training institutes.

The proposed framework gives a thorough introduction of the energy-saving skills with detailed description and examples, assisting the potential users to gain a comprehensive and systematic understanding of energy-saving skills.

Companies who wants to pursue energy saving policies and conservation measures can use this framework as a complete energy-saving skills knowledge system and basic reference to improve human resources management process, such as recruitment and internal training etc. As Squiers, et al (2012) indicated, a skills framework can be used as a beneficial tool for human resources management. The framework creates a win-win situation for both employers and employees in the labour market of energy-saving related industry. Employers are able to accurately describe the skills needed, meanwhile candidates can adjust and improve their

personal skills according to the detailed descriptions in the proposed skills framework. Besides, for sector bodies, the skills framework can be used, to some extent, as a reference to facilitate discussions among companies in the industry on issues related to human resources management.

As for higher education, Washer (2007) indicated that a skills framework can be used as an auxiliary tool. It will help institutes to design more realistic syllabus or curricula using this skills framework since it reflects the real needs of the market. The results of the focus group interview also demonstrate the willingness of employers to further integrate energy-saving capabilities into the university training system, hoping to influence the next generation of engineers through changes in energy conservation awareness. The analysis result of online job advertisement indicates the employer's preference for skills in energy-saving related sector which brings the enlightenment of curriculum arrangement.

7.2 Further work

The thesis explored the skills of energy saving in high energy consumption sectors and puts forward a complete and comprehensive energy-saving skills framework. The content within the proposed framework accords with both the opinions of the managerial personnel in the papermaking industry and employers' expectations of skills associated with energy-saving. There are, however, several possible directions for future research based on what is presented in the current study:

- **Explore the effectiveness of the framework in company's practical applications**

  Conduct case studies to observe the actual situation if the skills framework is applied in the company human resources management. During the process, the application pattern and actual performance of the proposed framework can be further studied in terms of recruitment, performance assessment and employee training, etc.

- **Further analysis of job advertisements to explore the application direction of the skills framework**

  Generally speaking, job advertisements released by the companies reflect their requirements of professional skills for employees. The data obtained in this

study can be also used in further research. It can be used to further understand the interconnection between the job position or the field it belongs to and their demands for various energy-saving skills.

- **Explore the practical application of the skills framework in higher education curriculum design.**

  Higher education seeks a better training model to deliver quality courses and programmes for developing graduates to work in industries. The proposed skills framework reflects the real needs of the market and provides a requirement of what skills employers are seeking. In this context, the framework can help universities to improve their training design to match the market, but the application direction needs further exploration.

- **Explore whether there is a gap in the way energy-saving skills is specified between the supply and demand sides of the employment process.**

  Now a complete skills framework is put forward in the sector, there might still be a lack of recognition and consensus of this skills framework. It is pivotal to explore what the barriers and drivers are for the whole industry to reach such an agreement. As there is a lack of standards or consensus of required skills in a specific sector, it can potentially hinder people from understanding what it is that employers really want and what it is that Higher Education are being asked to supply. Otherwise, the complexities surrounding these terms based on different standards may potentially cause a differing interpretation of the skill and affect the inefficiency of higher education, enterprises, individuals (students, job seekers) in the process of supply and demand of talents.

7.3 Closing remarks

Today, with the growing concerns over environmental impacts and energy resource depletion, the world needs to prioritize more and more sustainable energy management policies and ethics. There is a need to push favourable attitudes towards energy saving among employees across different industries. They need to understand the importance of such policies and measures and the impact of their contribution. Such sustainable policies and energy management approaches is the way forward for our world. High energy consumption related industries must adopt mandatory

strategies to transition into energy saving and sustainable compliances. They also need to pay attention in recruiting employees with relevant energy management skills and competences. Higher education institutes too can make a prominent contribution in addressing some of the world issues on energy crisis and management. They can introduce and develop more focused courses on energy-saving related areas into their curriculum. There should be courses at both undergraduate as well as postgraduate levels. Energy enterprises should also adopt efficient training approaches to provide advanced internal mentoring, training and improve their overall human resource management such as recruitment. All these will collaboratively make a positive impact in sustaining our precious environment and the planet we call our home.

7.4 Reflective Review

As Stephen Hawking said, “It is the joy of discovering something no one knew before” encourages research efforts. Academic research is creative, and the belief that I was creating something is my powerful source of energy.

Yet it is clear to me that passion is far from enough for a research master programme. Challenges were tough and unavoidable at the very beginning. I hardly had any academic research experience; meanwhile, strictly speaking, I was not a proficient English learner. For my research, the focus is on integrating existing resources and coming up with something new. Therefore, gaining a comprehensive knowledge of the whole energy-saving sector was necessary. In the early stage of the study, I devoted most of my time doing literature reading in the campus library where a large amount of information on energy-saving was available. Extensive literature review brought professional understanding of the research field and improvements in English proficiency. Moreover, it also developed abilities of self-study and concentration.

In the next phase, another problem emerged. How to control the process of a research project and clarify its boundaries? To answer the question, it requires researcher’s deep understanding of the project. A right research is a right process for a right purpose. The study got stuck for my lack understanding of the construction aim and verification procedure of the energy-saving skills framework. Something must have gone wrong and I was disorientated searching for the answer. I almost felt like the whole project was about to spin out of control and fall apart. After re-analyzing the

detailed research plan, feasibility and relevance of each steps, with the help of my supervisors and colleagues, I was back on track. If one does not know something, then go for the right people who do. Obviously, they do. This gave me an insight on how to respond quickly to the changing situation, how to get along with negative moods, and how to communicate effectively. As the research drew to an end, I discovered the true meaning of the study: why a study is worth doing and valuable to researchers themselves. Besides, I found that my mode of thinking has been broadened and deepened; and research theories and practice have been brought together. I am well aware of the imperfections of the study and it was them who remind me of what to work on in the future.

This research alerts me the profound influence energy conservation has upon the current world, transforming me from a non-energy-preserver into a staunch energy-saving advocate. In everyday life, I often introduce the methods and significance of saving energy. In work, I often come up with and propose effective suggestions for companies and organizations. I sincerely hope that through sharing my research gaining, the idea of energy conservation will be welcomed and put into action by more people.

No matter whether I stick to doing academic studies, I am absolutely sure that this scientific research experience brings profound benefits to my entire life. Stay curious, keep exploring, remain sincere. When you reach the final destination and look back on the track, you might even surprise yourself. Life is always about meeting and fighting off challenges. Doing a research master's degree, so far, is the most challenging and the rightest thing that I have done in life.

Appendix 1 Focus Group Interview Guidance

Briefly introduce the researcher (myself) and the research project, and sign consent form before proceeding to focus group interview with the interviewees.

Opening remarks: Energy skills as a skill set as a way of managing development to people getting it done, this is what I am really interested in. My research is about energy saving skills and better energy saving management. I already have a massive skills framework that have gleaned through primary research desk research and job advertisements analysis. So I have a massive sets which I don't want to launch on this condition because it's too big. But I try to get the feeling in this meeting is…

Topic 1: Manufacturing processes and energy efficiency technology applications

As we all know, industry is changing, there has been a change on technical engineering or professional engineering (in respect of skills requirement). So that might has quite an impact on when we talk about energy saving skills, I would like to know…

- *Which is kind of relatively new on your production process (such as on a new boiled block)?*
- *How you and your stable situation dealing with these kinks of new energy efficiency technology?*

Topic 2: Energy saving status and changes in the company

In order to promote the transformation of energy efficiency within organization, financial and human resources investment are essential…

- *What is your company current condition on energy efficiency reforms?*
- *Who would drive that change through within the organization?*

Topic 3: Energy saving atmosphere within company

I'd like to understand your company's energy saving organizational atmosphere…

- *What is your employees' opinion on energy saving? How to assess staff performance?*
- *What kind of organizational culture can benefit for or encourage energy saving behaviour?*

Topic 4: Energy saving atmosphere in the U.K.

In your opinion, how is the overall energy-saving atmosphere in U.K. industry…

- *Should energy use to be monitored at the total level or the Union level?*
- *What is cooperation's deeper motivation to drive energy efficiency?*

Topic 5: Skills requirement and training

As for skills requirement and training in your company…

- *What is your expectation on graduates (in terms of energy saving ability)?*
- *What training did/will you give new graduates on energy saving, what skills you expect them to acquire?*
- *Within an organization specifically do you see any shortage of skills on the energy saving side?*

Topic 6: Challenges and opportunities

There are still many challenges in industry, but how to respond them…

- *What challenges or problems did you face while facilitating energy saving schemes and how did you tackle them?*
- *What challenges are you going to face in future in terms of energy saving?*
- *Any suggestions you want to provide to the organization in terms of energy saving?*

Appendix 2 Research Consent Form

Research Project Title: Analysis of skills framework for energy saving

Researcher: Ziyue Liao (Research student from University of York)

I would like to thank you for taking the time to participate in my research study. My name is Ziyue Liao, my research aims develop an energy skills framework to support groups or individuals to understand and achieve a better energy management. I am interested in learning about your experiences as a member of staff related to energy-saving in your organization.

This interview should approximately take about an hour. I will be recording this interview session on an audio recorder as it will assist me in analysing your responses more accurately. Your participation is completely optional and you have the right to withdraw your consent and terminate participation at any time. All your responses will be used only for this research purpose and the output maybe used for conference publications, journal papers and MSc thesis. We will never discuss or publish your answers such that they can be attributed to you or your company personally unless you give us approval to do so in the signature section below.

By continuing, you agree to participate voluntarily in this research. You understand the research purpose of the interview and the protection that will be given to any information you provide. You also understand that by participating in this study you are not waiving any of your legal rights. If you have any queries about this research, you can contact me using the following details:

- *Ziyue Liao, email: zl1359@york.ac.uk*
- *Engineering Management Research Group, Department of Electronic Engineering, University of York, Heslington, York, YO10 5DD.*

Please complete the following to indicate your consent. I, the participant, confirm that:

I have been briefed about this research project and its purpose and agree to participate □

I have discussed any requirements for anonymity or confidentiality with the researcher □

I have been briefed about how the interview data will be stored during the research □

I agree to this interview to be audio-taped □

Participant's name and signature: ----------

Researcher's name and signature: ----------

Date:

Appendix 3 Focus Group Interview Transcript

Date and Time: 24th/May/2018 (30 mins)

Location: Prudhoe Mill (a paper mill, belongs to Essity company)

Occasion: A paper industry regular liaison meeting

Number of interviewees: 4

Facilitator: We are really interested in really is kind of discussing...energy skills as a skill set, as a way of managing development of people getting it done, and where you currently are ...we kind of have a massive skills framework that we have gleaned through primary research, desk research, analysing job adverts ... that kind of stuff, so we have massive super set, which we don't want to launch on you because it's too big, but we want to do is trying[/try] to get the feeling of in this meeting is "where energy saving sits in your priority list, how it's set into strategic cooperate objective level, how that's propagated down, how you fill posts in that area and what the problems are from your point of view", so where do we want to start.

A: There's three very different companies representing you.

Facilitator: Ok…

A: You got Ian from S.C.A who's seen as a huge tissue, a multinational tissue young company, Sharon from De La Rue specialist paper…very special paper.

Facilitator: Bank notes, used to be stamps and notes I know, so.

A: Then we got ours from Union Papertech Tech in Greater Manchester filtration papers. They're part of the small group; two mills roughly the same size with...the parent that isn't involved in the paper making so.

D: Yeah, I don't think they've got any other paper making things, In-Buys have they?

B: No it's just filtration.

A: Yeah, so it's three multinational very specialists, and kind of, I don't you can't... but it is almost impossible to meet the same person in the same time. So that's my problem. I think he's saying the company is too big to recognize everyone because of staff turnovers.

D: We're on the completely other end of the scale to you. We're very old school, 115 employees: grandads, dads, and sons, so turnover wise: it is usually when somebody hits the grave (when they die) or retires. People don't leave, it's quite… industries will pay for internship, once you get into it, that's it

Industry prepares you

C: Oh yes, it's in your veins

D: We are the same, we've got families that worked here: brothers, cousins, uncles nephews, sons, daughters, grandsons granddaughters.

C: it is also said that the number of groups is the same with us, absolutely the same with us. You've got family names that come up time and time again, four generations have been our limit, our maximize I've ever known on the site. Absolutely so. But more so I find in operations these days, I don't really find it so much in engineering. Engineers are completely different breed, so I, honestly think these last- even just very recently, I think most of our engineers were actually turned over completely in the last two years. We seem to get real rapid turnover of engineers and yet operational wise, you stay there, and you stay there for life

B: Yeah, I think I agree with you there, our side engineering-wise…I think in the next 5-10 years, it's going to be a lot of new faces.

D: … indistinguishable mumbles.

D: I think part of it for us is the fact that because it's not huge, We're the big employer for quite some distance… the only other big employer is, I don't know how big De La Rue is

C: So that our site used to be in a village, so we're like a small mill, but we're a big fish in a very small pond. We were THE major, although we're not so much now, but we're still [big] yeah.

D: If you go to Stubbins, it's in a tiny village outside Ramsbottom, but if you go to Manchester it's in the middle of industrial estate. So you've still got families but it's by the M60 (motorway) whereas you've got, you know, you're 10 miles away from Newcastle (I think he meant Manchester), Stubbins is 10-15 miles outside of Manchester?

B: I've gotten Ilkley to Leeds from that mill, in 1914

D: Ilkley is the same, it's a tiny village in the North West

C: There's a degree of sort of movement of staff that may have an influence of how staff will make the decision about whether they come or go, you know with how easy it is to go into the next role, the next town, or the next part of the industrial estate up, isn't it?

Facilitator: I think it's interesting because in the technical engineering, professional engine side, there's been a change in- certainly in my life, I started in 1975 with one

company, and stayed with them for 11 years, and it was that easy for us for engineering, but more and more it's become faster and faster turnover of people, and people who are just moving on. So I guess that has quite an impact when we talk about energy saving skills, which is kind of relatively new, a new boy on the block (idiom). So how are you in your stable situation dealing with that?

B: Energy saving, we have our managing director- the general manager, he's very keen on energy, because he is a Scottish I think.

Facilitator: That's a good start....

B: (just unimportant jokes I think: "it keeps the birds from being in love with him")

C: Is the target really the cost then?

05:20 D: Yes, there's the cost and there's the

B: Obviously there's the cost and he's got the added bonus of- it helps your relationship with the likes of the EEA? (X) guys who spend money over on the affluent band who spend money trying to lower emissions.

E: We've got Europe as well, and the emissions there on that, because we're getting quite close to- well we have been getting quite close to: energy, water, CO2, everything on that, but we are bringing it all down. Simple things like we changed all the lights to LEDs, we use high-efficiency motors.

C: How much has ESOS driven that though?

B: I think they have, to be honest, driven it quite a lot- water reduction and energy

C: So you know that benefit from it?

D: I would tell you that ESOS hasn't given anything- just tick-box exercises.

C: I'm afraid our team would say as well "we could have told you that", so we got nothing good out of that, and that kind of gives me an indication of what our engineers and energy specialists think about somebody else coming in and telling them about efficiency.

D: Engineers important for us, it's the third biggest cost. 18 million pung a year

Facilitator: How much, sorry?

D: 18 million. And I count its 8 gas or 8 electricity because the other one is 10 steams? Something in those ballpark figures

D: ... So, it is important, but then is the cost of expenditure to reduce it. So there's a there's a X (trocode?) company of them -40 mills across Europe from (a place: Witherty park in Runwick?) Submitting ideas for approval which can take one year, two years to come through. So there is an attempt of competition, but there's still

then be driven to make energy savings, but it comes harder and harder

C: It's easy to begin with isn't it?

Facilitator: Yeah, it's typical diminishing returns. Who within the organization would drive that change through?

D: It should be on papermill manger, because he's got the usage. He's got two a machine using, gas electricity, and steam

Facilitator: And is energy usage being monitored at the total level or the unit level?

D: It should be the measure in unit level.

Facilitator: Should be…

D: I'm not close enough to know what is being measured, and what isn't being measured, because I don't go to their meetings, I'm not involved in the process perspective. So I know what we have at the management view. At a management view yesterday [we see it as a] a slide of energy in terms of our performance this year, last year the costings etc, but it's all a kind of higher level Every year they should be getting driven down, but we are going down the route of additional submetering to understand where we are using it. The other issue we have had is we're having lots of blackouts because our transformers weren't picking up, so we were underpowered. Machinery kept tripping out. So most companies are probably oversized in terms of transformers and the power generation or power supply we were under. We were having problems. It's been addressed. And then from that, I think they are trying to go down submetering, because how do we know who's using what? S.C.A was never great at monitoring stuff.

C: Do you think that is part of the skill gap we have though? Is getting an understanding of the right monitoring to be able to make decisions. If you're not monitoring, you're not managing. I think we have that problem as well. Very similar I think. What I've understood from the site has been relatively [confusing?]. We're driving things by pounds instead of kilowatt hours. We talk a lot about energy as taking the cost down, but actually the real things that make a difference come from the shop floor up. Those are the guys that really know how to make a difference. Whether it's the operational shop floor, or the engineering shop floor. Those are the changes that make and sound completely difference. But the big savings are really more strategic than that. In our situation it's things like the efficiency of the CHB. It's whether we are going to be able to comply with the meaning and the compassion part for when it arrives about alternate efficiency. And those big things coming up on

the shop floor, isn't necessarily being addressed at the highest level. I still think there's a bit of a gap. We don't have enough competent people that tell us how we get from where we are to where we should be.

Facilitator: I think you are right, there is two voices looking at it, there's the top level view which is where is the big energy consumption and that's an initial focal point until you got that efficiency as it can be then you move down…down the chain but then there's massive savings to be had from people doing the nitty-gritty daily operations actually spotting opportunities because cumulatively they build up.

C: Yes, absolutely.

10:13 B: But I think it's getting them to do it like compressed air links. We had a survey two years ago which found 150 compressed air links I would bet my mortgage that half of these still exist of a mortgage after they still exist.

D: It's one of the biggest any users, our compressors

B: People aren't addressing the matter. You see conveyers going round, the conveyer lights, and there's no current on it

B: Really?

C: yes, it happens

D: The problem for us is, the conveyer belt uses 5-10% of energy, so it's not seen as the driver to fix. That is a 90 percentage.

C: What's the point in having huge CHB, huge inefficiency, bags of snakes as we keep talking about it and then we have little stickers on lights saying "switch of the lights as you leave. I think they're addressing the wrong things sometimes and that we have the same situation. Sometime operation is just left running, because their minds are sometimes just dealing with another thing. It's quite sad when I see the same thing

B: People aren't always switched on, though are they? I think some people as well do it in their house, I know do, but this is work, it's different at work. I walk around work switching lights off when I notice people aren't knocking around so

C: It annoys me when people do it when they're actually still in the room, that happens with me (joke)

B: I've not done that yet. Every place we have- the director tends to come in and rattle cages (inspect) we do have a lot of screen readouts so he gets all that on his computer, so I think he just has 3 screens set up and through the day if he sees something he'll.

D: the all-seeing managers have a lot of access to you don't know what

A: Is that because you're smaller, and can have greater control? 400 people on site

B: That's probably part of it, yes. I don't even know how they've got all of these things rigged up. But it's a case you can go on computer 1 and look at the different draws, and the different wattages on different things. I look after the affluent plant as well so if there's anything in particular… If we have two of the filtration units going on at once, the director is usually ringing me up and shouting at me to get one of them off if I can- that's about 6 kilowatts a day I think. It's a lot anyway.

D: We also have all-seeing managers have to cover weekends which is why for every 5 weeks I'M off Saturday, Sunday. And they know they're going to come in and first thing you see he's like "Two of those [units] better not be running" So you can keep the pressure on for a longer time.

A: Yeah, you talk to crews here, nightshifts and weekends are the best.

C: Everywhere is the same.

B: They always love that, yeah, because you see them on the weekends. You see they're not monitored usually so they'll stick stuff on that make the job easier. That's the stuff that rounds all the energy up. I mean he focuses on different bits, the director, and that's his particular concern at the moment. I mean you're talking about different areas. We don't focus on everything at once, but that's where he's focusing on at the moment that's why I'm getting a chew in for it all the time (being ordered what to do). Yeah, I think that's the thing isn't it? Finding different areas, because we've done the lights, done the compressors, transformers

Facilitator: So he's just working his way round what he knows of the business

B: yeah, always looking for something new

Facilitator: And he's doing that based on his in-depth knowledge of the business?

B: Himself and also the head engineer as well, I think both of them sort of talk about these things a lot of the time cause the head engineer is always checking it out as well

D: So the biggest cost are the gas and electricity, because we are using that much water. We're using 40-fold mega water, compared to these in our products and we're going to take that water out so we go through it and dry all the time. Afterwards taking all that water out, I mean we've got thermoplastics and curings and heaters to the paper.

B: Yeah, the heat exchange is putting on the taps.

D: Similar sort of things the economizer and in principal, using the hot stuff you've already got to heat up the cold stuff

Facilitator: Is anybody asking the dumb questions in your company? Is there another way into you?

B: I mean, how we're producing the product itself? I don't think the technologies have changed out there really. You have yankees, that are less efficient air dryers, you have spooner-ovens as well. One of the big problems is the amount of times you find a kit -let's say it's 10% more efficient, when you actually look at it and realize you've got to take the whole mill down for 2 weeks to put it in you're probably going to look at 15 years before you get a payback and that risk isn't worth it.

We've got 16 steam cylinders, 2 air dryers, all the converters-

Facilitator: Thank you very much, Ian.

B: He is always a scope for stopping by yeah yeah

Facilitator: I think that balance between the economic perspective of the change and the technical aspect, aspect, you need someone who is capable in both of those to know what to put forward and not to put forward.

B: You need realistic people.

Facilitator: You do. Yeah.

B: I mean luckily whilst the director does ultimately rule everything in our mill, you do have two-term management reviews, and even daily meetings, we have 3 times a week production meetings where you can put stuff forward, so if there's anything happening, sometimes stuff happens without you knowing, but a lot of the time you've got a chance to say something.

D: We also have certain customers that were that tied-into that if we were to make any changes like that we'd have to fly out stateside and go talking to them to say what we're planning on doing, because the knock-on effect is phenomenal for what we're actually selling.

Facilitator: So within an organization specifically do you see any shortage of skills on the energy saving side? Where would they be if there was?

B: We instruct them, but I don't think people always do what you want I think that might be similar to what you guys have just said there it's sort of we're trying to really get. You can tell your employees as much as you want, but if something's going to make their job easier by flicking a switch, they're going to try it on

B: They always do, I've said both sides of this, before I went to the papermill I

worked for quite a large company called (X) for nine years and it's not ruling with fear, but there's disciplinary actions, and they're not friends they're work colleagues, and that's how they work. The mill now is the complete polar opposite, maybe it's a little bit too friendly. It's just finding the right balancing act to actually get the behaviour changing.

D: It's all good when things are going well and you're all mates, but when you need to affect change it really is difficult sometimes. You don't tell people off and give them warnings, you just asking and arguing, and it doesn't happen sometimes.

Facilitator: Well, change changes is everything doesn't it? The informal power balances, the social networks, it changes everything. You can understand that

B,D: Yeah…

Facilitator: How about you, Sharon? Skill shortages?

C: Yeah I think we do, in terms of specific I think engineering with energy know-how. Yes, we definitely need our skills operated. Generally, we have engineering shortages anyway, but for those that can actually show energy efficiency saving, whether it's through a behavioural change or whether it's through a mechanical change I would say yes we are still are struggling to find people new people to come in.

D: It depends where you are as well … as well they had all sorts of things since Jaguar and Land Rover, they're expanding so much that they suck all the engineers from West-Midlands if you speak to our Gill in Stonenbury Aberdeen? Their ability to recruit and keep engineers depends on how the offshore industry does so in Mold everyone wants a job there, but when they boil all the gas they struggle to get new ones.

(This basically talks about the difficulty recruiting engineers in different places)

C: X suck all ours out completely, they're huge obviously I know they have to make they're a weapons establishment just up the road

D: Greater Manchester you kind of get a large enough pool to draw on

B: We don't really lose them for that at our place. I don't think we've ever had in my time.

C: They are paid very well though

Facilitator: We touched on that when you were out the room. Within the professional engineering, the technical engineering side these days there is more of a turnover of people. The engineers churning their jobs quicker than they used to. So I think that

aspect of the environment that we're working with is different anyway

D: I suppose you've got a different skill set with engineers haven't you. They're just used to working with machinery, it might not be a specific set of machinery so like you say they can swap around. Whenever you're looking at production and stuff, they're trained to use a machine in a particular way it's not quite so easy to move on I would say maybe .

C: Is it not what you said before, the last company was the same, the engineers wouldn't stick around because if they were good, within 5 miles you had Rolls Royce, X, and BEA systems, if they work there sold, they'd be gone in nine months. They'd get pinched. (Working for a bigger company) You basically have your old dinosaurs who've been there 30 years and they just keep them and the other ones move up. The turnover is phenomenal. They just steal a lot of [staff], in fact just before I left, a lot of them went to go work for Amazon in the big warehouse that's in Manchester.

Facilitator: So I guess what do you think the answer. The medium- long term answer here, is it to embed energy saving into undergraduate programs, so engineers come out with it? Is it to provide an online training program that you can put your people through? What do you think?

D: Embedding it to the next generation. You're going to get more from that, I mean 10-15% will be able to online. I think if you have it as a foundation moving forward. I think you'll get a lot more from it in 10-15 years

A: But is that in the mill town…? Notes?

Facilitator: I suppose the honest answer is probably not, I don't know of any program asking for it. See whether you can find a program. To be honest I think if you put energy saving engineering into the UCAS which is the undergraduate preference. You probably wouldn't find any, and they probably wouldn't go for it. They wouldn't understand what it was.

A: Yeah, for long term future industry, yes

Facilitator: But there is the students coming out of A levels, total different mindset position than people who have graduated University. People graduate from university, I remember a number of years ago, we introduced in music technology undergraduate program, it was very technical music technology and we found what we needed to do is offer music technology to undergraduates to prospective undergraduates because they wanted to do music, but they wanted their technology

bit. We offered the same program exactly the same program titled “engineering with music technology”, and we found everybody migrated to engineering with music technology as the title of they wanted to graduate with-in about year two years through. They recognize importance of engineering but not at A level. So we might need to be thinking about how we how we can package up energy saving into kind of second and third year modules, may be fourth year for MEng (Masters Engineering) modules.

C: Is something changed then about where the engineers have got their skills in the first place? Some of the older engineers from our site would have had their skills from apprenticeships at best, they wouldn’t have gone to University and they wouldn’t have picked out energy efficiency as a primary purpose of them being there. And if that’s no there then they’re the guys training the next set of apprentices, so it won’t be there either. It needs something new to pull that in, to make people see it as a core part of their competence I suppose.

Facilitator: Yeah and you are right, there may be case here for actually to recommending to the apprenticeship schemes here, that there is an elements in energy saving built into that.

C: I can’t see because sustainability-wise it’s-

D: we did a have a training

Facilitator: With energy saving?

D: I don’t know, because I’m not involved in it I can find the details and check

Facilitator: Okay we're now moving into the notion of professional apprenticeships, as well as we see more senior people getting them opportunities, we will need to do same thing with that actually. Take a broad brush in the education pipeline in its broadest sense and see where we can intervene with it beneficially. Then we’d need to work out what the learning outcomes of that would be, so we can actually guide the people that generated that material. And that will be level-specific as well. Ok, that is very interesting package of work there.

A: Hope that is helpful.

Facilitator: That was very helpful. Yes, thank you very much, any questions for us?

C: What is your timeline then were you thinking of- What are you thinking of following this up with?

Facilitator: Ah, this is interesting, because I don't have a specific timeline for energy saving, it's something that fits in with my overall research interest area, which is

skills in general. This is a one-year master's program looking at this and has created the framework and now may be looking for the educational side of that to look at where that could be put in. When I come to the end I am in this respect resource-less, so I may need to be having a conversation around to see actually what we can get the maximum out of, at the minimum resource unless we can hook into a project.

A: Assuming we can get this Empower project underway. Tony is interested in being involved in that, at least the evaluation of that. We worked on a project 18 months ago with Empower to look at the psychology- the people's behaviour, before you guys get involved…. We've got, in principal, three mills to take part in it, so if you're interested in that at all- some expert in the way people behave, and you picked on that, it's easy for them if they've got it running to look at that behaviour and see if there's opportunities to improve it. There's a relatively small cost to the mill in it, but if you're interested I can let you have a go and see if we can twist Alice's arm if she's interested.

Facilitator: You're absolutely right, its' behaviour changes we needed here and training has got to be able to be fed through to behavioural change range and that change then needs to be monitored and managed and checked up on

D: This is the same with a lot of things isn't it? Its human nature if it's easier, you're probably going to do it especially for the young, it's the vested interest not to do so.

Facilitator: The management's job is finding out how they can push the vested interest down to that level. Which is why this needs wholistic view it's right from very top.

B: We've got our affluent band is run JMA it shuts down at night, but the guys get called in saying we have to look at the big picture. If you've got an extra man you get within security at night and run it 24/7. Because of lot of these guys, they're running the system that hard during the day, and then during the night it tends to lose flow, and they have to come in again, whereas if you're running it continuously. You're not going to get that, you're not going to the get cal- ins, you're not going to get overtime people being tired. You going to step away from all that, so then you will get that behaviour change. It's just trying to get that understanding through that actually it will cost £120,000, but actually look at what happened in the past with daytime stretch.

D: I don't think it will be with that mentality

Facilitator: OK, thank you very much, it is very interesting job, thank you.

Appendix 4 The Initial 600 Items of Skill (unstructured)

	The skills that extracted from desk research (Journal article, Website, Book, etc.)
1	Oversee the development and implementation of an energy management system
2	Ability to evaluate the size and type of the company for the sake of define the energy management
3	Ability conduct energy management into business, not just 'tacked on' to existing systems
4	Ability to design an energy management system to ensure a sustainable mindest to improve energy efficiency, a clear goal is needed as well
5	Using simple, no cost tools to carry out effective day to day energy management with the least effort
6	Basic understanding of Energy Management
7	Energy Saving Knowledge and Skills Gap Analysis
8	Facilitate and manage energy-efficiency opportunities identification process
9	Manage energy efficiency opportunity implementation
10	Familiar with the relevant standard / regulations and be able to apply into the Energy management
11	Ability to fully familiar with international energy management system/ criterion and demonstrating the company's energy management system compliance with
12	Provide organizations with a recognized framework for integrating energy performance into their management practices.
13	Using the voluntary ISO50001 standard as the basis for energy management system
14	Contract types, development and management
15	Mechanical and electrical engineering principles
16	Energy saving Industry Guidelines
17	ISO50001 (ESOS Compliant)
18	Taxes (e.g. energy CO2)
19	National Calculation Method (NCM)
20	Energy Savings Opportunity Scheme (ESOS)
21	Energy in Buildings and Communities Program (EBC)
22	Ability to periodically updated the energy policy like any business policy
23	Built norms for behaviour within the corporation
24	Have sufficient understanding to discuss the direction of future regulations and planning policy and the implications for projects
25	Sufficient understanding of the policy, regulations and drivers for, like reducing CO2 emissions, to be able to assess the implications of these for specific projects
26	Understanding the relationship between planning, regulations and other local authority activities
27	Project planning and management
28	Understanding energy
29	Identifying potential opportunities
30	Detailed investigation

31	Advise clients on how to avoid condensation and how to take remedial action where condensation dampness exists
32	Advise clients on how to record gas and electricity consumption and work out costs
33	Inform clients of ways of paying for gas and electricity
34	Understand the role of different position
35	Precisely find the job vacancies in the company, and develop recruitment adverts accordingly
36	Right mix of people and skills
37	Forming an energy team involving staff from across the organization to ensure all areas of the business are considered in energy efficiency improvements
38	Establish a program to further increase awareness of energy efficiency by creating a new role of an Energy Technology/Techniques Expert
39	To keep up with the latest sector developments in industrial energy efficiency
40	Recruitment for energy efficiency skills (created a new position or adapted/expanded an existing position)
41	Ability to identify, plan and implement change，include practical systems and procedures to reach the energy goals
42	identify and deliver sector innovation including demonstration projects
43	Data logging
44	Energy and other data collection skills, and setting analysis boundaries
45	Develop and implement data management, tracking & reporting systems
46	How to use your data within your business
47	Information management principles
48	Interpreting forecasts
49	Scoping data requirements
50	Sources of data, types of data analysis and performance indicators
51	Statistical analysis, including regression analysis
52	What is data commonly used for, what else could it be used for
53	Energy and other data collection skills required to determine, collect and manage the most appropriate energy and process related data, including setting appropriate boundaries for analysis.
54	Energy data analysis skills to apply a range of methods to explore relationship between energy use and a range of variables that may influence it
55	Statistical analysis skills for energy and production data, including regression analysis
56	Ability to develop and implement effective data management, tracking and reporting systems
57	Rewarding system - Reward the most effort
58	Ability to establishment of a fee structure that rewards the team (or individual) for the extra effort and risks of taking the energy efficiency approach, based on its achieving the desired results
59	Set up a criteria of "how to win the energy champion"
60	Make the employees to realize the importance/contribution of their personal energy-saving activities to the organization

61	Ability to increase the satisfaction level of employees in terms of working environment
62	Disseminate these values to employees throughout the organization
63	Visual Presentation to Technical and/or Lay audiences
64	Written: Report Writing, documents, emails, letters
65	Communicate to influence
66	Develop & implement communications & engagement plan
67	Develop & manage engagement and ongoing communication with stakeholders
68	Interpersonal skills
69	Explain how energy relates to broader sustainability objectives and policies
70	Get commitment with the high-level manager
71	Win the senior management buy-in
72	Ability to determine the roles of internal and external project stakeholders in the assessment, and develop and implement an effective communications and engagement
73	Facilitation and negotiation skills required to acquire necessary human, financial and physical resources and support
74	Ability to combine stakeholders to champion the energy-efficient/energy-saving concept
75	Ability to negotiate with the external energy organization to achieving the most effective strategic cooperation
76	Negotiate with your energy supplier
77	Write energy budget into management regulations, with overage penalty
78	Employee energy saving target setting and how to link these into performance review processes
79	Ability to monitor the energy-saving activities of employees
80	Ability to evaluate the performance of employee's regard to energy saving
81	Personal accountability
82	make sure PCs, printers and lights are turned off out of hours
83	enable energy-saving modes on PCs
84	Use timers motion-sensitive light systems
85	Make sure heating and air conditioning systems are well controlled and never allowed to 'compete'
86	Ability to oversee the process of assessments
87	Ability to show steps that can be taken in each phase of the project to ensure that the integrity of the design is maintained
88	Workshop facilitation and project management skills such as scope, schedule and budget determinations
89	Undertaking an on-site Energy Project
90	Facilitation and negotiation skills required to acquire necessary human, financial and physical resources and support
91	Ability to develop an energy efficiency assessment plan (including timelines, budgets etc.) and manage the project within the organization

92	Ability to project manage energy efficiency opportunity implementation, including design, procurement, construction, installation and maintenance
93	Understanding of key energy efficiency program requirements and ability to identify required human, financial and physical resources
94	Culture and behavioural change management skills to drive ongoing energy efficiency, particularly around employee engagement and communication, project planning and business decisions
95	Ability to develop or participate in multi-disciplinary teams with complementary skills and perspectives
96	Ability to determine the roles of internal and external project stakeholders in the assessment, and develop and implement an effective communications and engagement plan to get their buy-in
97	Ability to report, document and present key energy and financial data and findings from energy data analysis in a meaningful manner, and report and document the energy efficiency assessment process
98	Ability to facilitate and manage the energy efficiency opportunities identification process
99	Ability to develop and manage ongoing communication of energy use data and the multiple benefits of energy efficiency opportunities to stakeholders
100	Collaborative and cultural change skills to facilitate long-term organizational behavioural change throughout the energy efficiency assessment.
101	Be able to provide alarms when systems are not performing as expected
102	Reducing risks associated with climate change
103	Ability to set up a long-term energy strategy
104	Adopt energy-saving strategies and sets difficult but attainable goals
105	Be able to quantitative efficiency goals
106	Set time-specific targets (e.g. a reduction in the amount of energy used per unit of production by a given date)
107	Ability to adopt environmental strategies of energy saving/ sustainability/ New Ecological Paradigm
108	Creating an energy management policy & plan
109	Develop energy intensity indicators and benchmark
110	Energy Awareness - Aligning Energy Management to Business Objectives
111	Global view of energy consumption and its impact
112	Managing integration of energy-efficiency projects and goals into cross-business operational plans, procedures, and KPIs
113	Policy interventions to promote renewable energy value chains
114	Assessing organizational barriers
115	Industry scorecards and dashboards
116	Allows consumers to receive financial compensation for temporarily reducing or rescheduling power use upon request

117	Ability to undertake whole of system and services thinking
118	Ability to identify innovative 'out of- the-box' solutions including contractual, behavioural and cultural solutions
119	Understanding and analysis of process, site or sector, including dynamic factors and transient behaviour of systems
120	Understanding and analysis of design, procurement, commissioning, operational and maintenance practices
121	Ability to identify factors influencing energy use or waste, including procedural, contractual, legal, organisational structure, job descriptions, key performance indicators and behaviour
122	Awareness and understanding of new and existing technologies, their feasibility and cost-effectiveness, as well as other research and development occurring within the sector and overseas.
123	Ability to conduct light energy-saving design
124	Developing and implementing energy efficiency assessment plan
125	Energy planning Energy review and analysis
126	Local waste management operations
127	Manage integration of energy-efficiency projects and goals into cross-business operational plans, procedures, and KPIs.
128	Managing energy demand
129	Practical and professional practice of energy management.
130	Understanding key energy efficiency program requirements
131	Waste Management
132	Water management best practices
133	Promote energy management best practices and reinforce good energy management behaviours
134	Organise network events between relevant companies, equipment suppliers and research institutions
135	Behavioural Changes
136	Collaborative change
137	Organizing improvement activities
138	Building Energy Modelling
139	Provide a framework for promoting energy efficiency throughout the supply chain
140	Energy Awareness in the Workplace and Home
141	Opportunities for saving energy through behaviour hinge primarily on turning unused equipment off, rather than reducing use of equipment during business hours
142	Time management, adapt to change, interpersonal skills to get traction
143	knowledge and understanding of spreadsheet and project management and reporting tools. (e.g. MS excel, MS project)
144	Ability to use adaptive opportunity, involve dress code working practices open a window, use a fan etc.
145	Develop operational excellence in energy management, with the use of ISO50001 as a possible

	enabler
146	Ability to think laterally, see and relate to big picture and communicate and plan
147	Understanding reporting mechanisms
148	Reporting energy waste they notice such as equipment left on unnecessarily
149	Contributing and gathering ideas for improving the way things are done
150	Ability to demonstrate to management the benefits accrued from equipment change, maintenance or better operational practices
151	Personal motivation / staff motivation (to save energy)
152	Understand energy jargon
153	Ability to collect invaluable feedback from occupancy to improve the quality and performance
154	To know how satisfied the occupants are with their spaces
155	Professional discussion - Ability to explain complex professional problems to an non-professional
156	Ability to explain complex professional problems to an non-professional
157	Reporting energy waste they notice such as equipment left on unnecessarily
158	Be able to prepare a compliant energy strategy report
159	Basic technical management and report writing skills
160	Technical report writing and documentation writing
161	Information presentation skills (presentations/communique etc.)
162	Progress is tracked, evaluated and reported
163	Report findings to different levels of staff and management
164	Testing and implementing new processes
165	Create transparency and facilitate communication on the management of energy resources
166	Advertising the value of energy efficiency to employees on a regular basis
167	Ability to build a organizational climate /culture/belief of energy-saving/Sustainability/green-development
168	Illustrate a strong commitment to ecological sustainability
169	Promote values of environmental protection and sustainable organizational performance using a variety of methods
170	Ability to design vivid energy-saving signs and impressive energy-saving banners
171	Advertising the value of energy efficiency to employees on a regular basis information for the energy efficiency decisions
172	Raising its prioritization and awareness within the organization
173	Strengthen publicity towards energy-saving & sustainability value in the organization
174	Staff development and training
175	Awareness of energy usage
176	Ability to make a commitment with the relevant parties in the energy saving strategy
177	(for high-level manager) Ability to make a clear commitment to encourage the energy-efficient designer/team to try their best
178	knowledge test

179	Energy awareness consultation schemes
180	Ability to carry out questionnaires.
181	Provide a competition policy briefing note clarifying what information can be shared to improve energy efficiency
182	Ability of information searching
183	Communicating good practice and being an ambassador for change
184	How to motivate occupant behaviour change through non-financial incentives
185	Actively disseminate information and encourage their members to take an active role in any future innovation-type activity.
186	Have a walk round and survey your premises to spot immediate money and energy-saving opportunities.
187	Corporate social responsibility
188	Ensuring equipment and machinery are well-maintained and working efficiently;
189	Popularizing and advocating the knowledge of energy efficiency (but generalize it)
190	Training and promoting energy efficiency within non-professional staff on a regular basis
191	Ability to teach non-professional staff to distinguish the false or right knowledge
192	Ability to let non-professional staff get rid of fear to understanding of energy usage
193	Ability to let non-professional staff learn to switch off what they do not used
194	Educating and train staff to use new devices and to reduce energy use
195	Raise awareness of state-of-the-art energy efficiency technology and improve related skills through training support
196	Designing appropriate energy saving training and staff development programmes
197	Select a broad team representing all interested parties and all phases of the project. (Including a variety of players on the team means that a wide range of ideas can be examined.)
198	Developing multi-disciplinary teams
199	Ability to considerate different motivations from different parties for following the approach and promote cooperation.
200	Ability to consider differing perspectives (building developer versus a real estate management company, for instance)
201	Ability to consider the effects of an energy-efficiency measure on occupant productivity
202	Workshop and meeting facilitation
203	Team assembly and personnel linkage
204	Allow integration with other organizational management systems such as environmental, and health and safety.
205	Set up a mechanism to share knowledge amongst relevant sectors.
206	Improve knowledge sharing and disseminate best practice for maintenance, behaviour and overall technical competence.
207	For an energy design team, the roles needed ->architects
208	lighting consultant

209	interior gardens designer
210	landscape architect
211	structural engineer
212	construction contractor
213	environmental consultant
214	Seek support and negotiate with consulting company
215	Interpersonal skills
216	Support mature energy efficiency technologies and decarbonisation investments through developing an engagement strategy with the finance sector and other funders
217	Ability to calculate energy savings using simple payback methods, and/or other relevant financial analysis for identified opportunities.
218	Engagement in potential funding opportunities to assess the feasibility of the proposed project/strategy.
219	Ability to undertake non-conventional financial and whole of business cost benefit analysis including evaluation of environmental and social benefits
220	Understanding of financial decision-making processes, key performance indicators and hurdle rates required by the business.
221	Understanding new trading mechanisms
222	Non-conventional financial analysis - whole of business cost benefits analysis
223	Ability to recognize the business implications of energy efficiency and how they integrate into business plans.
224	understanding economic incentives
225	Understanding of simple theory applied to design calculations
226	Ability to understand the financial implications of business decisions
227	Cost implications of wasting energy
228	Economic regulation of utilities
229	What third party intermediaries do and how they get paid
230	Ability to consider analyse the full range of a building's expenses must be considered over the lifetime of the building.
231	Including the costs of construction; financing; energy; operations and maintenance; periodic replacements; even disposal of the building; equipment, or system.
232	(6 basic steps in a life-cycle analysis)
233	1.Gathering basic financial data
234	2.Estimating annual energy costs
235	3.Estimating first costs
236	4.EstimatingCalculating life-cycle costs ongoing costs
237	5.Calculating life-cycle costs
238	6.Comparing life-cycle costs
239	Simplifies life-cycle cost calculations -> salary costs,

240	productivity improvement rates,
241	time on-market capitalization rate,
242	average lease rate,
243	and average occupancy
244	a year-by-year cash-flow analysis.
245	Understand and be able to apply methodologies for sizing, costing and assessing the environmental and financial benefits of different systems
246	Evaluating achievements
247	Cost-benefit analysis including evaluation of environmental and social benefits
248	Economic analysis techniques
249	Financing options, alternative financing
250	Implementation costs
251	Understanding financial decision-making processes
252	Using financial structuring tools to attract investors
253	Performing financial analyses, including payback, rate-of-return, life cycle cost, and cost-benefit analyses that include environmental and social considerations
254	Ability to calculate the payback time of investments in energy saving management.
255	ability to calculate the return and payback period on the investment regards energy-efficiency
256	Taking the lifecycle economics approach, energy-efficiency investments may be attractive to investors
257	Ability to understanding project financial investment appraisal
258	Considering investments in energy saving with a payback time of more than three years as an important prerequisite to improve energy efficiency
259	Financial analysis (e.g. payback period, IRR, NPV etc)
260	Ability to conduct a project of finance for energy efficiency technology
261	Get beneficial loans for energy efficiency investments / third-party financing
262	Ability to identify suitable projects and to provide a basis for bankable finance
263	Facilitate greater access to finance for energy efficiency and decarbonisation-related investments.
264	Construct profit loss account
265	Support and seek out partners for innovation projects to submit bids to access the above funding streams.
266	Ability to build a business case to implement opportunities
267	Business case development skills
268	Business decision-making fundamentals
269	Ability to develop and present a business case for energy efficiency projects to senior management
270	Drive the development of business cases and engage
271	Enable greater deployment of established or near commercial energy efficient technology, so improving the sector’s productivity and competitiveness through energy cost reduction,

272	Ability to develop and present a business case for energy efficiency projects that is meaningful to all relevant levels and areas of management, including senior management"
273	Understanding of energy markets, energy pricing and tariffs
274	Carbon markets, carbon finance, and carbon project development process
275	Understanding electricity markets
276	What are the basic drivers of energy prices in the UK
277	What makes up delivered energy tariffs
278	Understanding of energy markets, pricing, and tariffs
279	Understanding the capital financial market, understanding how to raise money for new projects
280	Ability to develop and present a business case for energy efficiency projects
281	Ability to realize financial, operational, and environmental benefits by changing energy use patterns in response to market signals
282	Ability to manage integration of energy efficiency projects and goals into cross-business operational plans, procedures and key performance indicators, and develop systems that lead to ongoing energy efficiency assessment and implementation
283	Set up the training programmes to meet specific needs such as finance for energy efficiency technology
284	Understanding and analysis of design, procurement, commissioning, operational & maintenance practices
285	Understanding and analysis of process, site, or sector
286	Investment options / decision-making skills - whether the company need to seek the external support
287	Business improvement skills
288	Change management
289	Commissioning principles
290	How to create behavioural change in factories
291	Identify “out-of-box” solutions
292	Utility contracts, rate structures, tariffs
293	Energy efficiency tax incentives
294	Fundamental multi-discipline engineering skills (thermodynamics, electricity, chemistry,) plus industry experience
295	Ability to identify the potential and the most effective solutions
296	The installation of appropriate system controls
297	Understand the principles behind good energy efficient design
298	What do you really need: Displays / Dashboards/ Reports/Alerts
299	Energy Saving in relation to Technical and Operational activities
300	Ability to master and mix any number of these strategies to conduct the energy saving activities
301	Connecting to existing schemes
302	Ability to integrate energy efficiency findings into cross business operational plans and practices.

	(high level)
303	Ability to recognize the business impact of technical decisions and to be able to communicate that in the way that meaningful of both sides
304	Ability to manage integration of energy efficiency projects and goals into cross-business operational plans, procedures and key performance indicators, and develop systems that lead to ongoing energy efficiency assessment and implementation
305	Ability to appreciate the implications in different methods of segmenting the analysing energy use
306	Discuss the direction of future regulations and planning policy and the implications for projects
307	Ability to analyse the benefit implications of each design decision
308	Ability to bring in information on appropriate new technologies
309	Ability to manage communications within the design team
310	Be well-versed in all facets of building design, including non-energy- as well as energy related issues
311	Ability to identify the design sequence (design, build and install)
312	Ability to identify the important energy end uses before design strategies
313	Ability to use “downstream” thinking, design team should start at the space to be conditioned and work back upstream through the distribution system (ducts, pipes, fans, and pumps) to the primary systems (chillers and boilers)
314	Opportunity identification
315	Resources identification
316	Ability to identify and adopt lower energy consumption alternatives
317	Maximised energy savings through occupancy controls and daylight harvesting
318	(Useful rules of thumb and sources that can be referenced)
319	California’s Title 24 energy code
320	The LEED (Leadership in Energy and Environmental Design) rating system --- U.S. Green Building Council (USGBC),
321	U.S. Environmental Protection Agency’s Energy Star program
322	A Source Book on Daylighting Systems and Components.
323	Building Technologies Department of Lawrence Berkeley National Laboratory (LBNL)
324	the Solar Heating and Cooling Programme of the International Energy Agency (IEA)
325	The Building Life Cycle Cost program from the National Institute for Standards and Technology
326	emphasizing the full lifetime value of proposed building improvements
327	allow for an attractive return on investment
328	Ability to account the return that could be yielded from the improvements
329	Describes and evaluates new and innovative technologies for using daylight in buildings
330	Ability to address the energy-related interactions between building shell, lighting, daylighting, HVAC systems, and utility services.
331	Detailed hour-by-hour simulation programs perform heating and cooling load calculations take into account interactions between the building shell, lighting and other internal loads, and

	building thermal mass.
332	Daylighting, VAC controls, Thermal mass, Efficient lighting, Passive solar heating, High-efficiency HVAC systems, Air-leakage control
333	Ability to design a simplified hour-by-hour program for the analysis of residential and light commercial buildings
334	Need to know building type, location, floor area, number of floors, cooling system type, and heating system type
335	Tools intend to be used during the conceptual design phase to identify and rank energy-efficiency strategies.
336	Integrated building design
337	Preliminary design ->
338	1. Assess site for daylighting, solar, and natural ventilation opportunities
339	2. Define energy problems and opportunities, as well identify possible solutions.
340	3. Perform preliminary economic analysis
341	4. Perform detailed lighting and daylighting studies
342	Design development Integrate ->
343	1. load-reduction measures into mechanical design
344	2. Coordinate architectural, lighting, and interior designs
345	3. Simulate energy performance
346	4. Refine economic analysis
347	5. Prepare commissioning plan
348	Construction documents ->
349	1. Review building plans and specifications
350	2. Review equipment selections
351	3. Review construction details
352	4. Finalize performance and economic analyses
353	Construction ->
354	1.Review change orders and product substitutions to maintain…
355	2. integrity of the design
356	3. Inspect quality of materials and correctness of installations
357	Commissioning & occupancy ->
358	1. Develop commissioning plan and involve commissioning agent early in the process
359	2. Verify energy savings and solicit feedback from occupants
360	3. Continue to monitor and tune performance throughout the life of the building
361	Familiar with Thermal Comfort Standards (TCS)
362	Indoor comfort conditions to help decide on the design and the sizing of heating or cooling systems or passive strategies.
363	Outdoors--how to define comfort in an outdoor context (availability of shade, wind speed and

	direction, etc)
364	Familiar with adaptive approach and be able to use the standard to design buildings and their services
365	Identify your potential for energy savings
366	Determining the carbon footprint for a large corporation
367	Conducting data analysis to model trends and relationships
368	Ability to provide the feasible equipment procurement program after analyses the company environment
369	Engineering understanding and process analysis
370	Data collection and analysis – statistical analysis (including representative sampling), benchmarking, energy/mass balance, metering);
371	Identify and prioritising solutions
372	Find the energy-efficiency way through the analysis of consumption peak times and the other times
373	The analysis begins with site considerations that enable effective use of daylighting and natural ventilation
374	Treats a building as a series of interacting systems so as to cutting operating and capital costs by taking advantage of this compounding effect of downstream energy savings
375	System Analysis (optimisation) -> Increased energy efficiency
376	Increased output
377	Less downtime and reduce energy costs
378	Reduced emission
379	Improved product quality or lower emissions.
380	Energy consumption and prices vary with time
381	Dynamic and complex processing environment
382	Dynamic and complex processing environment
383	System Analysis - > Calculating Green House Gas emissions and carbon footprints
384	Developing energy mass balance diagrams and models
385	Whole system analysis
386	Energy data analysis
387	Evaluating energy usage
388	Framework to set up an energy baselines and how it can be used to vary energy performance
389	Identifying factors influencing energy use or waste
390	Identifying inefficiencies in building systems
391	Identifying significant energy use
392	Interpret domestic fuel cost data using reference materials
393	Performance improvement
394	Understanding of energy optimization and energy economics by non-technical professionals; e.g. accounting, procurement professionals

395	Ability to develop meaningful energy intensity indicators and benchmark energy and production data against historical performance, best practice and theoretical limits.
396	Undertaking an energy study and understand the appropriate calculation methodologies, benchmarks and assumptions to apply
397	Ability to develop energy mass balance diagrams and models, both averaged and dynamic.
398	Identify and deliver opportunities to use energy storage and demand side management in combination with increased renewable deployment – either embedded on-site, via private wire or via the network.
399	Ability to monitor environmental conditions that would affect comfort and indoor air quality
400	Provide feedback displays showing real-time energy use.
401	Ability to identify and minimizing unwanted heat gains to reduce cooling loads.
402	Manage the equipment respectively according to the unoccupied periods and occupied periods, figure out the peak of energy consumption via monitoring, and make a reminder with occupants during this period.
403	selection and be able to use of metering and monitoring equipment
404	Guarantee availability and provide 24/7 remote operation and maintenance
405	Ability to know how much electricity, ventilation, air conditioning and light is consumed across the target buildings.
406	Ability to use automated monitoring for continuing to monitor and identify issues
407	Take regular meter readings to get an accurate picture of how much energy business is using and where the biggest savings could be made.
408	Ability to use the simple spreadsheets and associated graphing tools to provide an analytical approach and summary output.
409	Ability to decode utility bill
410	Ability to use energy data to identify inefficiency
411	Ability to use simple spread sheets to carry out detailed analysis of energy usage history
412	Ability to compare energy data to its application
413	Ability to estimate / budget for future consumption
414	Ability to monitor short term and long term pattern
415	Ability to easily identify when Best Practice is starting to wane
416	Energy Managers, Consultants, Site Engineers, Facilities Management
417	Practical calculations methods
418	Ability to understand the issues of data collection, conversion of energy units and calculation of energy savings;
419	Initiative to identify and overcome problems such as energy data quality and integrity issues
420	Energy billing and monitoring
421	Solution development (Based on risk analysis)
422	Set up basic Monitoring and targeting to enable benchmarking
423	Assess an organisation's management approach to energy usage

424	Discuss the relationship between energy and management standards
425	Develop a calculation methodology for predicting likely energy waste and recovery
426	Identification of energy saving opportunities from audits or other source
427	Ability to conduct a detailed energy audit and monitoring
428	Allocate energy cost at sub level and a thorough initial energy audit
429	Ability to identify benefits gained by carefully matching thermal and electrical loads relative to on-site power generation.
430	Ability to reach the baseline for minimum energy efficiency
431	Ability to plan and assembled intelligent measuring/ smart metering systems.
432	frequency: annually-quarterly, monthly-weekly, daily
433	Audit data analysis and interpretation
434	Technical appraisal of actual energy saving from changes
435	the applicability for different building types
436	key considerations: design implications, technical issues, environmental benefits, financial benefits and cost.
437	Ability to decide whether an RA would be appropriate for your company's circumstances;
438	Ability to determine which energy use processes could use an RA approach;
439	Ability to know what kinds of data, and the level of skills, a company will need to undertake an RA;
440	Ability to understand the variations in energy use between and within energy use processes;
441	Ability to sample a population of energy use processes, and the merits of different sampling methods;
442	Ability to undertake a regression analysis and/or non-statistical modelling to examine the factors that have a greater or lesser influence on energy use;
443	Ability to use an energy use model to identify and quantify cost-effective energy efficiency opportunities;
444	Ability to progressively improve an assessment;
445	Ability to build a business case to implement opportunities;
446	Ability to select the best type of population (for example; sites, technologies, vehicle types, or transport tasks) that to be representatively assessed
447	Ability to identify the difference between seemingly identical EUPs
448	Ability to identify the degree of similarity between EUPs and their energy usage,
449	Ability to quantify and correct for the effect of any differences will influence how the RA is conducted
450	Ability to analyse energy consumption in a facility and prioritise effort
451	Basic principles and analytical techniques of energy consumption and energy efficiency
452	Occupancy sensors and controls can be used to switch off lighting fixtures and HVAC services when a space is unoccupied. - To adopt equipment's to switch off unoccupied devices.
453	Heat exchangers can be used to recover waste heat from air-conditioning systems and use it to

	supply hot water.
454	Herma energy storage systems that contain ice or chilled water may help reduce chiller demand during on-peak periods.
455	Treat the tech as a whole system instead of several individual step or approach.
456	Awareness and understanding of new and existing technologies, overview of technologies (sizing, technical requirements, costs) and Combining technologies
457	Technical understanding of process or sector, including understanding of relevant laws (of thermodynamics, heat transfer, energy modelling) and their applicability to processes and technologies in different sectors.
458	Ability to undertake and apply specific techniques such as Pinch analysis, development of models and other engineering focussed process optimisation techniques.
459	Understand how energy is used within production processes
460	Ability to collect energy and allocate it to different venues, to power everything
461	Ability to designing air distribution systems and cooling plants to meet those reduced cooling loads (offer savings in both capital and operating costs).
462	Ability to use IT tools to promote energy-saving campaign
463	Ability to carry out a great deal of input data to meet extremely detailed programs so that provide users with a lot of flexibility to examine different design options.
464	Ability to launch and maintain a web portal that facilitates greater industry collaboration by enabling companies to share information on products & services (R&D), best practice, knowledge and access to funding and finance opportunities.
465	A simplified spreadsheet program developed for evaluating the daylighting performance of skylights.
466	Building type, occupancy, building and skylight geometry, and skylight optical properties.
467	Calculates the average illuminance over the space on an hourly basis for each month of the year.
468	Help designers determine the trade-offs between lighting and HVAC loads, lighting simulation tools that calculate illuminance levels on a point-by-point level.
469	skills for Improving the efficiency of system components.
470	Energy saving in relation to Transport
471	Energy saving in relation to Water
472	Installation and use of monitoring Equipment.
473	Be able to assess the applicability of different technologies
474	Awareness of substation layout of equipment
475	Appreciate the electrical plant and equipment used in main, sub-main and final distribution and circuits
476	Understand the need for initial and periodic inspection and testing and PAT testing for continuing safety of electrical systems
477	Ability to critically evaluate the entire drive power system, and also combining good engineering with efficient components (such as premium-efficiency motors and variable-speed drives)

478	Ability to explore the potential for additional technologies and make an Energy Technology List (ETL) to encourage wider investment opportunities
479	Ability to understand how state-of-the-art technology can work in different settings within the sector
480	Commissioning, retro-commissioning, re-commissioning, and automated monitoring and fault detection
481	Renewable energy fundamentals
482	Utilize premium efficiency equipment
483	(Energy reduction efforts come in widely scattered forms:)
484	energy efficient lighting and equipment
485	ballasts
486	chillers
487	fans
488	pumps
489	drive power system: motors, its controls, the connection between the motor and the equipment it drives
490	circulator pumps
491	air-conditioner and ventilation system
492	a chiller plant
493	industrial boilers
494	heat, steam, cooling, refrigeration, compressed air or electricity.
495	Technique -> Cogeneration systems
496	On-site generation (sustainably reduces energy consumption and operating costs)
497	fuel cells
498	photovoltaics
499	combined heat and power
500	combined cycle gas turbine
501	heat recovery boiler
502	heat recovery steam generator
503	absorption cooler
504	Organic Response smart lighting control sensors
505	cooling towers
506	Intelligent measuring systems
507	high efficiency motors (HEMs)
508	variable speed
509	air-side economizer
510	Demand-controlled ventilation (a control strategy)
511	premium-efficiency motors
512	variable-speed drives

513	building automation systems (BAS)
514	efficient industrial refrigeration systems
515	insulation
516	passive architecture
517	night-time ventilation
518	intelligent controls
519	adaptive comfort
520	load shifting
521	smart glazing
522	skills for using renewable energy systems - PV panels produce electricity during sunny periods, which generally coincide with peak demand.
523	Carbon footprints, GHG accounting
524	Indoor air quality control
525	Compressed air systems
526	Electrical -> Drives
527	Electric motors 10
528	Electrical and power systems analysis
529	Electrical systems evaluation
530	Load/Power factors
531	Industrial equipment operation and optimization
532	Operation of energy-using equipment & systems operation
533	Combined heat & power systems
534	Heating & Cooling -> Boilers
535	Fan systems
536	The efficiency and appropriate use of heating and hot water systems and the functions of the controls
537	HVAC and indoor air quality standards (ASHRAE and others)
538	Lighting
539	Understanding of M&V and other standards and models
540	Plumbing systems and codes
541	Pump systems
542	Steam systems
543	Thermal energy storage systems
544	Thermodynamics and heat transfer
545	Domestic water systems
546	Basic electrical principles
547	High voltage distribution and switchgear
548	Low voltage distribution and switchgear
549	Alternative and standby power supplies (generators and UPS)

550	Dangers of electricity and physiological effects of electric shock
551	Explanation of short circuits and fault currents
552	Protective systems using fuses and circuit breakers
553	Lighting & lamps with simple design calculations
554	Wiring systems and final circuits, differences between the ring and radial final circuits
555	Examples of cable sizing calculations
556	Commissioning, continuous commissioning, measurement and verification, and post-occupancy evaluations.
557	To know what preventive actions are needed to ensure proper operation of building systems in the future.
558	Ability to use building energy rating, simulation, and simulation methodologies to determine energy use, energy efficiency measures and energy ratings for commercial/office buildings.
559	measuring how "green" or sustainable a building is in terms of its design, materials, equipment, and modelled energy performance, involved Materials & Resources, Sustainable Sites, Indoor, Water Efficiency, Environmental Quality, Energy & Atmosphere, Innovation & Design Process
560	Be able to provide advice on the requirements and/or potential benefits of incorporating energy efficiency measures and technologies into new or existing buildings
561	Building construction techniques
562	Building energy rating, simulation, and simulation methodologies
563	Building functions, operations & systems, interoperability
564	Building operation, interoperability and optimization (HVAC, lighting, boilers, steam & hot water systems)
565	Building trades
566	Efficient use of energy in buildings
567	Facility planning
568	Green building standards and programs
569	To create a green office (recycling, cleaning, energy efficiency, supplies, transport and commuting)
570	Understanding of facility and industrial processes
571	Understand daily, weekly, and monthly plug load patterns related to further reductions in energy consumption
572	Wire plug loads on same circuit and turn off at night to reduce vampire loads
573	Control plug loads remotely
574	Ability to design energy models to simulate power consumption of plug load devices and peak loads.
575	Adjusting power management settings, setting equipment timers, and utilizing smart power strips that control energy use are ways to cut down on energy consumption when equipment is not in use.
576	Periodic inspection and testing of existing installations and Portable Appliance Testing

577	Regular maintenance
578	Ability to tracked, evaluated and reported the progress
579	Remove unused equipment and consolidate personal equipment to shared devices
580	Refurbish the existing infrastructure and optimise its operation
581	Replace equipment with energy efficient versions
582	Set timers on equipment with regular schedules
583	Install load-sensing outlets and power strips that turn equipment off when not in use
584	Utilize virtual server software to reduce physical server size
585	Use occupancy-sensing power strips to turn equipment off in unoccupied workspaces
586	Adjust power management savings to reduce energy use during non-working hours
587	Ability to optimise spare capacity for cost-effective
588	(Specific areas for improvement include motors, drives, fans and improved process control and the use of sub-metering and process optimisation etc..)
589	Certification and reporting
590	Sustainable Sites, Indoor
591	Water Efficiency, Environmental Quality,
592	Energy & Atmosphere, Innovation & Design Process
593	Building codes
594	Identify the potential to improve energy efficiency in a range of dwellings
595	Lifetime cost
596	Benefit implications of each design decision
597	Bringing in information on appropriate new technologies
598	Managing communications within the design team
599	Ability to undertake theoretically or statistically valid representative assessments of similar energy using sites, operations or processes.
600	Ability to assess, install and use appropriate measurement and monitoring equipment (temporary or permanent) and application of appropriate techniques for analysis, feedback provision and system/process management based on improved access to information.

Appendix 5 The Skills Set (re-arranged & with some detailed info.)

Technical skills

Energy-related Basic Knowledge

- Brunke, Johansson and Thollander (2014)
  - To get basic knowledge - Ability to distinguish the false or right knowledge ("sometimes peoples' false knowledge can form negative attitudes", e.g. people believe in myths such as that turning off and on your computer will damage it.)
- Cibse. (2018).
  - Understand energy jargon

Subject Related Skills

- Australia, Department of Resources, Energy and Tourism (2010).
  - Ability to understand develop and calculate energy mass balance
- Australian Energy Exchange (2017)
  - Technical understanding of process or sector, including understanding of laws of thermodynamics, heat transfer, energy modelling and their applicability to processes and technologies in different sectors.
  - Ability to undertake and apply specific techniques such as Pinch analysis, development of models and other engineering focused process optimisation techniques.
- Cibse. (2018).
  - Appraisal of different type of circuit protection (fuses or circuit breakers)
  - Appreciate the different type of wiring systems available and how to select the best system with regard to installation, maintenance and cost considerations
  - Appreciate the electrical plant and equipment used in main, sub main and final distribution and circuits
  - Awareness of substation layout of equipment
  - Efficiency by design
  - The characteristics and role of lighting techniques and technologies
  - The PEC Approach- performance, efficiency & comfort
    - Application of controls

        - Tools & Calculations
        - Visualisations
    - Have sufficient understanding of the available measures and technologies and the key considerations and implications of each to advice clients and design teams
    - Light: Terminology & Technology
        - The lighting requirements for places
        - Lighting Units
        - Human response to light
        - Colour temperature & colour Rendering
        - Traditional lamps & LEDs
        - Luminaires & Controls
    - Knowledge of electric shock and the need for continued electrical safety
    - Understand the principles behind good lighting design
- Department for Business, Energy & Industrial Strategy (2017).

  Abdelaziz, E. A., Saidur, R., & Mekhilef, S. (2011).
    - Understand the latest energy-saving technologies, including:
        - Air-conditioner and ventilation system
        - Circulator pumps
        - Drives (VSDs)
        - Economizers
        - High efficiency motors (HEMs)
        - Intelligent measuring systems
        - Knowledge of Electrical Services
        - Variable speed
- Energy Design Resources: Integrated Building Design: page. (2006).

  California Energy Commission. Title 24, Part 6, of the California Code of Regulations (2010).
    - Lighting Design Tools
        - Are detailed hour-by-hour simulation programs perform heating and cooling load calculations take into account interactions between the building shell, lighting and other internal loads, and building thermal mass.
        - Identify and rank energy-efficiency strategies. It evaluate include

daylighting, HVAC controls, thermal mass, efficient lighting, passive solar heating, high-efficiency HVAC systems, and air-leakage control.

- Need to know Building type, location, floor area, number of floors, cooling system type, and heating system type
- Provide a whole-building approach to energy analysis, addressing the energy-related interactions between building shell, lighting, daylighting, HVAC systems, and utility services.

- Energydesignresources.com. (2018).
  - Ability to designing air distribution systems and cooling plants to meet those reduced cooling loads (which offers savings in both capital and operating costs).
  - Ability to identify and minimizing unwanted heat gains to reduce cooling loads.
  - Ability to identify the potential and the most effective solutions from the help of LEED
  - Ability to realize financial, operational, and environmental benefits by changing energy use patterns in response to market signals via Demand response (DR)
  - Ability to use LEED system to measuring how "green" or sustainable a building is in Terms of its design, materials, equipment, and modeled energy performance
  - Be well-versed in all facets of building design, including non-energy- as well as energy related issues a very comprehensive skill.
  - Understand demand response that is an energy management strategy allows electricity consumers to receive financial compensation for temporarily reducing or rescheduling power use upon request.
- Eonenergy. (2018).
  - Ability to design, build and install, which means bespoke energy management system.
- IEEE-USA position statement - Energy Efficiency (2014).
  - Implementing Whole Building Design in new residential construction
  - Requiring that all residential and commercial construction meet LEED design criteria, ability to understand LEED design criteria when design.
  - Specifying high efficiency motor drivers in industrial processes

- Power system data acquisition and control
- Generation control
- Load and energy management
- End-user distribution systems
- Cogeneration
- New technologies associated with transmission systems
- Measures designed to reduce peak demand, including demand response options, such as dynamic pricing.

- Masoso and Grobler (2010).
  - Such energy reduction efforts come in widely scattered forms, ranging from use of more：
    - Adaptive comfort
    - Development of legislature and rating procedures
    - Energy efficient lighting and equipment
    - Insulation
    - Intelligent controls
    - Load shifting
    - Night-time ventilation
    - Passive architecture
    - Phase change materials (PCM)
    - Smart glazing
    - Use of renewables

Legislation & Compliance

- Brunke, Johansson and Thollander (2014)
  - Explain how energy relates to broader sustainability objectives and policies.
  - As with any business policy, an energy policy should be periodically updated.
- Carbon Trust (2011) & ISO, I. (2011)
  - Familiar with the relevant standards / regulations and be able to apply it into the Energy management.
- Cibse. (2018).
  - Have sufficient understanding to discuss the direction of future regulations and planning policy and the implications for projects

- Sufficient understanding of the policy, regulations and drivers for reducing CO2 emissions to be able to assess the implications of these for specific projects
- Understanding the relationship between planning, regulations and other local authority activities
- Understand the principles behind good lighting design
- Governance in Design
  - Legislation
  - Building Regulation
  - CDM Regulations
  - Standards & Guidance
  - Impact Assessment

- Eex.gov.au. (2018).
  - Using the voluntary ISO50001 standard as the basis for energy management system would be a good idea.
- Gold, Furrey and Nadel (2009).
  - U.S. Life-Cycle Inventory (LCI) Database to help LCA experts answer questions about environmental impact
  - If we follow codes and standards (from American Clean Energy and Security (ACES)), then we can reduce national energy consumption by 4.6 percent now and eight percent in 2020 and 2030, respectively.
- IEEE-USA position statement - Energy Efficiency (2014).
  - Ability to adopt a building energy performance standard.
  - Minimum efficiency standards have been the basis for some of the most successful federal and state government policies used to save energy in the United States
- Nisiforou, Poullis and Charalambides (2012)
  - Be able to formulate energy policy, action plan with active/positive commitment from upper managers. (confirms the organization's intent and need toward reduce energy consumption)

Energy Analytic & Design

- Australia, Department of Resources, Energy and Tourism (2010).
  - The Project has found that the greatest demand for skills is for: Identifying

potential opportunities.

- Energy efficiency and opportunity identification (as a distinct skill)

- Australian Energy Exchange (2017)
  - Identify required human, financial and physical resources
  - Understanding of key energy efficiency program requirements
  - Ability to undertake a regression analysis and/or non-statistical modeling to examine the factors that have a greater or lesser influence on energy use;
  - Ability to use an energy use model to identify and quantify cost-effective energy efficiency opportunities;
  - Ability to determine which energy use processes could use an updated approach;
  - Ability to identify the type of data, and the level of skills, in order to undertake energy saving strategies.
  - Ability to understand the variations in energy use between and within energy use processes
  - Ability to undertake whole of system and services thinking.
  - Understanding and analysis of process, site or sector, including dynamic factors and transient behaviour of systems.
  - Ability to identify factors influencing energy use or waste, including procedural, contractual, legal, organisational structure, job descriptions, key performance indicators and behaviour.
  - Statistical analysis skills for energy and production data, including regression analysis.
  - Ability to develop energy mass balance diagrams and models, both averaged and dynamic.
- Brunke, Johansson and Thollander (2014)
  - Ability to design an energy management system to ensure a sustainable mindest to improve energy efficiency
- Cibse. (2018).
  - Understanding of simple theory applied to design calculations
  - Be able to assess the applicability of different technologies using key considerations
- Department for Business, Energy and Industrial Strategy (2017).
  - Identify and deliver opportunities to use energy storage and demand side

management in combination with increased renewable deployment – either embedded on-site, via private wire or via the network.

- Energydesignresources.com. (2018).
  - Ability to understand daylight metrics, various daylight terms, calculation methods that are used in the rating systems
  - Ability to effectively evaluate the impact of their daylighting and electric lighting designs
- Eex.gov.au. (2018).
  - Identify, plan and implement change, include practical systems and procedures to help company reach its energy goals
- Energy Design Resources: Integrated Building Design: page. (2006).

  California Energy Commission. Title 24, Part 6, of the California Code of Regulations (2010).
  - Integrated design strategies that will reduce lifetime costs while also improving occupant comfort. The greatest energy savings can be achieved by planning for energy efficiency right from the beginning of the design process
  - Identify Integrated Design Strategies
  - Do a Whole-Building Analysis require to treat a building as a series of interacting systems, it aims to cut operating and capital costs by taking advantage of this compounding. The analysis begins with site considerations that enable effective use of daylighting and natural ventilation
- Eonenergy. (2018)
  - Ability to analysis evaluate the size and type of the business to design energy management system.
- Gandhi and Brager (2016).
  - Ability to design energy models to simulate power consumption of plug load devices and peak loads.
  - Remove unused equipment and consolidate personal equipment to shared devices
  - Ability to identify and adopt lower energy consumption alternatives
  - Adjusting power management settings, setting equipment timers, and utilizing smart power strips that control energy use are ways to cut down on energy consumption when equipment is not in use. These strategies

specifically address the issue of wasting energy during non-working hours, or when equipment is simply not being used.

- Ability to analyses energy consumption in a facility and priorities effort

- Nicol and Humphreys (2002).
  - The importance of a good indoor environment-determining energy consumption, which in turn impacts sustainability
  - The definition of a good indoor climate is important to the success of a building, not only because it will make its occupants comfortable, but also because it will decide its energy consumption and thus influence its sustainability…Buildings--indoor comfort conditions to help decide on the design and the sizing of heating or cooling systems or passive strategies…Outdoors--how to define comfort in an outdoor context (availability of shade, wind speed and direction, etc…Familiar with adaptive approach and be able to use the standard to design buildings and their services."
  - What should be considered when design a building/ office
    - Individual physical form
    - Heating or cooling system and whether it is used
    - In the possibilities they offer for occupants to control their environment
    - In the policies of management about whether there is a dress code
- Nisiforou, Poullis and Charalambides (2012)
  - Ability to design a more reasonable indoor layout of lights

    Bad light's switch location results "Do not turn off the lights." As "During working hours, is the location of the light's switch was out of arms reach, the lights were left switched on all day even when they were not needed"

    "This is due to employees' behaviour- leaving lights and equipment's on at the end of the day - and partly due to the poor zoning and controls."
  - Ability to allocate/design the office more reasonable

Energy Data Management

- Australian Energy Exchange (2017)
  - Energy and other data collection skills required to determine, collect and manage the most appropriate energy and process related data, including setting appropriate boundaries for analysis.

- Ability to develop and implement effective data management, tracking and reporting systems.
- Energy data analysis skills to apply a range of methods to explore relationship between energy use and a range of variables that may influence it.
- Ability to develop meaningful energy intensity indicators and benchmark energy and production data against historical performance, best practice and theoretical limits.

- Brunke, Johansson and Thollander (2014).
  - Ability of information searching （analyzing by technical staff, or seek assistance from the experts if necessary）
- Cibse. (2018).
  - Ability to use the spreadsheets and associated graphing tools to provide an analytical approach and summary output.
- IEEE-USA position statement - Energy Efficiency (2014)
  - Promote the use of high-speed communications networks and information technologies to substantially improve controls, and access to information and systems efficiencies
  - Timely and secure access to information which is key to efficient energy systems operations
  - High-speed secure communication networks and information technology enable system efficiencies improvement
  - Data from smart metering along with secure two-way communication (i.e., from the meter to the consumer's premises; to controllers, processes and other devices; and from the consumer back to the utility), will provide consumers the potential to moderate electricity usage based on real-time energy cost and environmental impact data
  - Data provides utilities with the ability to adjust energy output and detect problems within their systems.
- IER 2017 Skills Survey
  - Plan to introduce/increase use of digital technologies need to develop new skills in their existing workforce.

Energy Monitor & Survey

- Australia, Department of Resources, Energy and Tourism (2010).
    - Selection and using of metering and monitoring equipment
    - The CO2 emissions calculation methodology
    - The Project has found that the greatest demand for skills is for: Installation and use of monitoring equipment;
- Australian Energy Exchange (2017).
    - Monitoring and investigation: Skills required to assess, install and use appropriate measurement and monitoring equipment (temporary or permanent) and application of appropriate techniques for analysis, feedback provision and system/process management based on improved access to information.
- Brunke, Johansson and Thollander (2014).
    - Ability to know how much electricity, ventilation, air conditioning and light is consumed across the target buildings.
    - Ability to plan and assembled intelligent measuring/ smart metering systems.
    - Frequency: annually-quarterly, monthly-weekly, daily…Sub-metering of energy costs
- Business Juice. (2018).
    - Take regular meter readings to get an accurate picture of how much energy your business is using and where the biggest savings could be made, or save the effort, and install smart meters.
- Cibse. (2018).
    - Understand the need for initial and periodic inspection and testing and PAT testing for continuing safety of electrical systems
    - Set up basic monitoring and targeting to enable benchmarking
    - Energy Monitoring, metering and targeting
        - Ability to decode utility bill
        - Ability to use energy data to identify inefficiency
        - Ability to use simple spread sheets to carry out detailed analysis of energy usage history
        - Ability to compare energy data to its application
        - Ability to estimate / budget for future consumption
        - Ability to monitor short term and long term pattern
        - Ability to easily identify when Best Practice is starting to wane

- Energydesignresources.com. (2018).
  - Ability to use automated monitoring for continuing to monitor and identify issues
  - To maximize the energy efficiency system, basically, we need to use premium efficiency equipment, install appropriate system controls and regular maintenance.
  - Need to treat the tech as a whole system instead of several individual step or approach (System thinking)
- Energy Design Resources: Integrated Building Design : page. (2006).
  California Energy Commission. Title 24, Part 6, of the California Code of Regulations (2010).
  - Commissioning, continuous commissioning, measurement and verification, and post-occupancy evaluations.
  - Studies have found that continuous commissioning can help building managers cut energy bills by 5 to 25 percent
  - Monitor environmental conditions that would affect comfort and indoor air quality
  - Track indices related to productivity: employee absenteeism or the use of sick leave
- Eonenergy (2018).
  - Zonal control – even within a single space
    Guarantee availability and provide 24/7 remote operation and maintenance
    Manages alarms and exceptions 24x7
- Eex.gov.au. (2018).
  - Oversee the development and implementation of an energy management system
- Gandhi and Brager (2016)
  - Set timers on equipment with regular schedules
  - Install load-sensing outlets and power strips that turn equipment off when not in use
  - Manage the equipments respectively according to the unoccupied periods and occupied periods, figure out the peak of energy consumption via monitoring, and make a reminder with occupants during this period.
  - Ability to manage plugs

- Understanding daily, weekly, and monthly plug load patterns will be vital in achieving further reductions in energy consumption.

- IEEE-USA position statement - Energy Efficiency (2014)
  - The importance of data monitoring and real-time data:
    Better access to information would enable greater efficiencies in the distribution system. For example, the ability to monitor and control voltage along the distribution drop could increase efficiency on the customer side. This effect would be particularly pronounced at the peak, when distribution losses are much higher than on the average.
- Nisiforou, Poullis and Charalambides (2012).
  - Energy-efficiency facilities (measures about saving energy of a technological aspect)
  - Be able to evaluate energy consumption/ be able to measure and monitor regularly (weekly is better) for each consumption process, unit ot biulding.

Energy Assessment & Audit

- Australian Energy Exchange (2017)
  - Ability to use building energy rating, simulation, and simulation methodologies to determine energy use, energy efficiency measures and energy ratings for commercial/office buildings.
- Brunke, J. C., Johansson, M., & Thollander, P. (2014).
  - Conduct energy audits (weighted with a factor)
  - Way of energy allocation of: per tonne, sub-metering
- Cibse. (2018).
  - Understand and be able to apply rule of thumbs and methodologies for sizing, costing and assessing the environmental and financial benefits of different systems
  - Assess an organization’s management approach to energy usage
- Energydesignresources.com. (2018).
  - Ability to critically evaluate the entire drivepower system, and also combining good engineering with efficient components(such as premium-efficiency motors and variable-speed drives)
- Trygg, L., Thollander, P., Backlund, S., Olsson, L. (2010).
  - Ability to "allocate energy cost at sub level and a thorough initial energy

audit"

- Allocating energy cost at sub level and a thorough initial energy audit are requirements for sound energy management.

Energy Optimisation

- Australia, Department of Resources, Energy and Tourism (2013).
  - Employ new technologies or processes to optimise the system
  - Be able to optimise the performance of the facility
  - Ability to conduct systems optimization
    - Increased energy efficiency
    - Increased output
    - Less downtime and reduce energy costs
    - Reduced emission
    - Environmental impact
    - Improved product quality or lower emissions.
  - Apply to energy consumption and prices vary with time, dynamic and complex processing environment, highly variable process
- Cibse. (2018).
  - Provide a framework for promoting energy efficiency throughout the supply chain
  - Allow integration with other organizational management systems such as environmental, and health and safety.
  - Assessment of the key technologies
    - The applicability for different building types,
    - Design implications
- Eonenergy (2018).
  - Refurbish the existing infrastructure and optimize its operation
  - Identify potential for energy savings and optimize the existing plants.
- Gandhi and Brager (2016)
  - Utilize virtual server software to reduce physical server size
  - Adjust power management savings to reduce energy use during non-working hours

Research & Development

- Australia, Department of Resources, Energy and Tourism (2010).
  - The Project has found that the greatest demand for skills is for: Technical research and investigation.
- Australian Energy Exchange (2017)
  - Awareness and understanding of new and existing technologies, their feasibility and cost effectiveness, as well as other research and development occurring within the sector and overseas.
- Brunke, Johansson and Thollander (2014).
  - Ability to undertake a technical feasibility study
- Cibse. (2018).
  - Be able to undertake an energy study and understand the appropriate calculation methodologies, benchmarks and assumptions to apply
  - Develop a calculation methodology for predicting likely energy waste and recovery
- Energydesignresources.com. (2018).
  - Ability to bring in information on appropriate new technologies；
- Furnham (2012)
  - Adopt energy-saving strategies and sets difficult but attainable goals
- IEEE-USA position statement - Energy Efficiency (2014)
  - The greatest perceived skills gaps or shortages are research and Investigation (Technical).
  - Develop system designs and technologies to further reduce energy losses in electric power generation, transmission and distribution
- Trygg et al. (2010).
  - Have a long-term energy strategy is crucial for the adoption of cost-effective.

Employee Management & Training

- Australian Energy Exchange (2017)
  - Ability to identify innovative 'out of- the-box' solutions including contractual, behavioural and cultural solutions.
  - Ability to monitor the energy-saving activities of employees
  - Ability to evaluate the performance of employees regard to energy saving
  - Personal accountability

- Brunke, Johansson andThollander (2014).
  - People are sometimes fear to understanding of energy as treat it like a technical subject (very professional), however there are many simple ways to achieve it). To learn to switch off what they do not used (There is a crying need for building occupants to learn to switch off what they do not used). Therefor train and promote energy efficiency on a regular basis
- Cibse. (2018).
  - Promote energy management best practices and reinforce good energy management behaviours
  - Discuss the relationship between energy and management standards
- Department for Business, Energy & Industrial Strategy, Australia (2017).
  - Ability to set up the training programmes to meet specific needs such as finance for energy efficiency technology
  - Raise awareness of state-of-the-art energy efficiency technology and improve related skills through training support
- Eonenergy (2018).
  - Maximised energy savings through occupancy controls and daylight harvesting
- The Telegrapg (2017)
  - Ability to develop accountability of energy management in businesses
- Energy Design Resources: Integrated Building Design: page. (2006).

  California Energy Commission. Title 24, Part 6, of the California Code of Regulations (2010).
  - Reward the most saving effort, as it is importance of financial motivation
  - Ability to establishment of a fee structure that rewards the design team for the extra
  - Effort and risks of taking the integrated building design approach, based on its achieving the desired results
- IEEE-USA position statement - Energy Efficiency (2014).
  - Promote education and user awareness of energy efficiency opportunities

    The end user must be made aware of cost and consequences before they can take action. While education about the economic value of energy efficiency can influence individual decisions, the larger environmental consequences

of the impacts can also provide a motivation for action beyond strictly economic value

- Industrial personnel involved in selecting equipment and systems must be educated in recognizing those products that are truly energy efficient and appropriate for their operating procedures and methods. Better understanding, coordination and selection of systems will contribute to better plant energy efficiencies.

- IER 2017 Skills Survey
  - Ability to write job description.

    Expanding the content of a job (by increasing task number and variety) while also encouraging employees to perform at a higher level. Thus, simultaneously, it is possible to increase job responsibility and control, as wll as task variety and level.
  - Ability to evaluate the performance of employees regard to energy saving
  - Ability to carry out personal accountability - a good job makes workers accountable for their results. In this way they can accept congratulations for a job well done and blame for a job done poorly.
- Nisiforou, Poullis and Charalambides, (2012)
  - The lack of knowledge and behaviour causes an increase in terms of waste in energy consumption.
  - To impose a good energy management system that organization should firstly understand and address employees' issues/problems, satisfied them training them and providing them with personal energy saving solutions.
- Sardianou (2008).
  - Ability to carry out training program to overcome barriers to the implementation of energy-efficient technologies.
- Steg, Dreijerink and Abrahamse, (2005).
  - Built norms for behaviour within the corporation

    As expected, personal norms were especially strong when people felt responsible for energy problems.
- The U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy (2018).

"In the buildings sectors, one of the most important needs is efficient lighting design education. So we must call on our dearth of lighting professionals with such skills. Increased education in efficiency methods will also lead to better maintenance decisions by building owners and operators, who can, in turn, make wiser decisions about maintaining energy consuming systems. Better maintained motors and lighting systems can keep their intended efficiencies."

Business skills

Commercial Analysis

- Australia, Department of Resources, Energy and Tourism (2010).
  - Ability to recognize the business impact of technical decisions
  - Ability to develop and present a business case for energy efficiency projects
- Brunke, Johansson and Thollander (2014).
  - Understanding of economic incentives in energy business
- Australia, Department for Business, Energy and Industrial Strategy (2017).
  - Early engagement in potential funding opportunities to assess how the sector fits with funding calls.
  - To support mature energy efficiency technologies and decarburization investments through developing an engagement strategy with the finance sector and other funders
  - Support and seek out partners for innovation projects to submit bids to access the above funding streams.

Financial Analysis

- Australia, Department for Business, Energy and Industrial Strategy (2017).
  - Ability to conduct a project of finance for energy efficiency technology
  - Financial analysis (e.g. payback period, IRR, NPV etc);
  - Non-conventional financial analysis - whole of business cost benefits analysis;
- Australian Energy Exchange (2017)
  - Ability to calculate energy savings using simple payback methods, and/or other relevant financial analysis for identified opportunities.
  - Ability to undertake non-conventional financial and whole of business cost benefit analysis including evaluation of environmental and social benefits.

- Energy Design Resources: Integrated Building Design. (2006).

  Energy-design based on: Carry out a life-cycle economics analysis：

  1. Gathering basic financial data
  2. Estimating annual energy costs
  3. Estimating first costs
  4. Estimating Calculating life-cycle costs ongoing costs
  5. Calculating life-cycle costs
  6. Comparing life-cycle costs

- Eonenergy (2018).
  - Conception and implementation to project financing

Investment

- California Energy Commission. Title 24, Part 6, of the California Code of Regulations (2010).
  - Understanding the energy investment return mechanism
  - Improvements with a simple payback of two years can yield a return on investment of 15 percent or more.
- IEEE-USA position statement - Energy Efficiency (2014).
  - Purchasers tend to focus more on initial costs, rather than lifecycle costs (i.e., initial costs, operations and maintenance costs, etc.). The fiscal risk of not considering life cycle costs is very high, when considering that buildings can last 100 years or more. Therefore, to achieve sustainable development, it is necessary to change the investment concept which need ability to analyze the Life Cycle Analysis and assessment for an investment.
- Energydesignresources.com. (2018).
  - Ability to use life-cycle energy saving theory to persuade the potential investmentors.
  - Taking the lifecycle economics approach, energy-efficiency investments may be attractive to investors even with simple paybacks as long as 15 years.
- Brunke, Johansson and Thollander (2014).
  - Ability to get beneficial loans for energy efficiency investments / third-party financing
  - Understand project financial investment appraisal
  - Considering investments with a payback time of more than three years was

identified in the literature as an important prerequisite to improve energy efficiency

- Trygg et al. (2010).
  - An important organisation-related success factor for energy management is the employment of a full-time energy manager who is integrated into the management structure, fully responsible for energy consumption and equipped with the necessary authority for energy efficiency investments"

Marketing

- Australian Energy Exchange (2017)
  - Understanding of energy markets, energy pricing and tariffs.
- Brunke, Johansson and Thollander (2014).
  - Ability to understanding the energy capital market
  - Understanding the capital financial market, understanding how to raise money for new projects

Business Operations

- Australia, Department of Resources, Energy and Tourism (2010).
  - Ability to integrate energy efficiency findings into cross business operational plans and practices.
  - Ability to recognize the business implications of energy efficiency and how they integrate into business plans.
  - Ability to manage integration of energy efficiency projects and goals into cross-business operational plans, procedures and key performance indicators, and develop systems that lead to ongoing energy efficiency assessment and implementation
  - To ensure energy efficiency assessments received sufficiently high priority and the required resources.
  - Ability to develop and present a business case for energy efficiency projects to senior management
- Brunke, Johansson and Thollander (2014).
  - Ability to provide the feasible equipment procurement program after analyses the company environment
  - Ability to understand the financial implications of business decisions

Generic skills

Interaction

- Australian Energy Exchange (2017).
  - Ability to determine the roles of internal and external project stakeholders in the assessment, and develop and implement an effective communications and engagement plan to get their buy-in.
  - Ability to report, document and present key findings from energy data analysis in a meaningful manner
  - Report and document the energy efficiency assessment process.
  - Ability to facilitate and manage the energy efficiency opportunities identification process.
  - Ability to develop ongoing communication of energy use and the multiple benefits to get energy efficiency opportunities to stakeholders.
  - Collaborative and cultural change skills to facilitate long-term organisational behavioural change throughout the energy efficiency assessment.
  - Facilitation and negotiation skills required to acquire necessary human, financial and physical resources and support.
- Australia, Department of Resources, Energy and Tourism (2010).
  - Be able to communicate that in the way that meaningful of both sides.
  - Team assembly and personnel linkage;
- Nisiforou, Poullis & Charalambides (2012).
  - Carry out work environment survey to examine the most suitable way that employees are willing accept (like communication, interview or questionnaire)
  - The possibility of reducing the lighting level should be addressed, not only due to the potential energy saving, but also to increase employee's satisfaction. employees prefer to control over their own thermal environment instead of an automatic control of the temperature which is more efficient saving energy.
  - Actively communicate with employees to create a satisfaction level of indoor temperature. (Possible solutions in diminishing this variation in the

satisfaction level are to set up a dress code for men and women and to place mostly women in "heat isolated offices, as women tend to wear different type of clothing then, that most likely has lower insulation values compared to men clothing)

- Be able to make extensive communication of energy issues within and outside of organization, get professional advices from experts or professional organizations

- Department for Business, Energy & Industrial Strategy, UK (2017).
  - Improve knowledge sharing and exchange of best practice in industrial XXX technologies
  - Set up a mechanism to share knowledge amongst relevant sectors.
  - Organize network events between relevant companies, equipment suppliers and research institutions
  - Communicating good practice and being an ambassador for change.
- Eex.gov.au. (2018).
  - Help negotiate improved energy contracts
  - As the link between senior management and the rest of the organisation
- Cibse. (2018).
  - Ability to demonstrate to management the benefits accrued from equipment change, maintenance or better operational practices
  - Be able to write a feasibility study report
  - Report findings to different levels of staff and management
- Australia, Department of Resources, Energy and Tourism (2010).
  - Facilitation and negotiation skills required to acquire necessary human, financial and physical resources and support
  - Ability to determine the roles of internal and external project stakeholders in the assessment, and develop and implement an effective communications and engagement.
  - Workshop and meeting facilitation;
  - Report and documentation writing;
  - Technical report writing;
  - Information presentation skills (presentations/communication etc);

Decision Making

- Australian Energy Exchange (2017)..
  - Ability to develop and present a business case for energy efficiency projects that is meaningful to all relevant levels and areas of management, including senior management.
  - Understanding of energy saving decision making processes, key performance indicators and hurdle rates required by the business.
- Cibse. (2018).
  - Identify and prioritizing solutions
- Brunke, Johansson & Thollander (2014).
  - Make a list of all the energy saving opportunities have to do and prioritize them
  - Raise its prioritization and awareness within the organization

Supervision

- Carbon Trust (2018).

  Simply mean exploiting the interest of the workforce to deliver above and beyond the day job, engaging willing participants on practical actions can deliver significant benefits.
  - Reporting energy waste they notice such as equipment left on unnecessarily
  - Ensuring equipment and machinery are well-maintained and working efficiently;
  - Contributing and gathering ideas for improving the way things are done;
- Masoso and Grobler (2010).
  - Ability to organize energy awareness campaigns, and carry out incentives, punitive measures to create an atmosphere of supervision
- Cibse. (2018).
  - Create transparency and facilitate communication on the management of energy resources
  - Motivate the workforce to contribute
  - Create an effective behavioural performance assessment

Operations

- Australian Energy Exchange (2017).
  - Culture and behavioural change management skills to drive ongoing energy efficiency, particularly around employee engagement and communication, project planning and business decisions.
  - Ability to manage integration of energy efficiency projects and goals into cross-business operational plans, procedures and key performance indicators
- Starik and Rands (1995).
  - promote values of environmental protection and sustainable organizational performance using a variety of methods,
    Written communications,
    Environmental-improvement activities
    Educational activities
- Australia government, Department of Resources, Energy and Tourism (2013).
  - Staging the implementation process to fine tune the process and to build support from managers and operators.

Project Management

- Australian Energy Exchange (2017).
  - Ability to develop an energy efficiency assessment plan (including timelines, budgets etc.) and manage the project within the organization.
  - Ability to project manage energy efficiency opportunity implementation, including design, procurement, construction, installation and maintenance.
- Australia, Department of Resources, Energy and Tourism (2010).
  - Project planning and management - timelines/budgets etc.
  - Detailed investigation
- Eex.gov.au. (2018).
  - Ability to tracked, evaluated and reported the progresses
- Brunke, Johansson and Thollander (2014).
  - Project identification and appraisal, project design, project implementation

Flexibility

- Baker and Standeven (1995).
  - To reduce energy use by discovering adaptive opportunities. Adaptive

opportunity is generally interpreted as the ability to open a window and use a fan to adjust internal temperature, also include dress code working practices and other factors which influence the interaction between occupant and building.

- Change in clothing, actively and posture and the promotion of air movement will change. The adaptive opportunities available in buildings will have no direct effect on the comfort conditions but will allow the occupants to change conditions to suit themselves.

- IEEE-USA Board of Directors (2014).
  - Build flexibility and adaptability into all elements of the physical, regulatory, and institutional aspects of our energy infrastructure

Team Working

- Australian Energy Exchange (2017).
  - Ability to develop or participate in multi-disciplinary teams with complementary skills and perspectives.

- Australia, Department of Resources, Energy and Tourism (2010).
  - Able to work in a multi-disciplinary team to maximize the outcomes from energy efficiency.
  - Conducting an effective energy efficiency assessment requires the right mix of people and skills."
  - The research indicated that effective assessments required the involvement of people from across the organization, with diverse backgrounds and skill sets.
- California Energy Commission. Title 24, Part 6, of the California Code of Regulations (2010)..
  - Team working is important, as different parties may have different motivations for following the integrated approach.

Organizational Ethos

- Ajzen (1991)
  - Employee behaviour is influenced by contextual factors such as the values of the organization and the individual's resulting beliefs about, and norms for acting within, the organization

- Turnbull (2001)
  - Corporate values have a strong influence on individual behaviour in organizations, particularly on middle managers/supervisors whose role requires them to disseminate these values to employees throughout the organization
  - Disseminate these values to employees throughout the organization
- Furnham, A. (2012).
  - Organizations with a strong culture enforced norms and rules shape individual behaviour more strongly than the personality of all the employees in that organization.
- Andersson and Bateman (2000)
  - Positive effects that can accrue from an atmosphere of corporate environmental commitment and stressed the importance of corporate values of commitment to the environment in managers' adoption of proactive environmental strategies.
  - Employees respond positively with creative environmental ideas if they perceive a strong organizational commitment to the natural environment. When supervisors perceive that their company is committed to environmental sustainability, they are more likely to respond with environmental behaviours that are, in turn, directed toward the employees they supervise
  - Ability to adopt environmental strategies of energy saving/ sustainability or new ecological paradigm
  - Ability to enhance the credibility of manager
- Andersson, Shivarajan and Blau (2005).
  - Promote the environmental awareness of employees and improve the effectiveness of energy management
  - Supervisors in a multinational corporation internalize their corporation's commitment to ecological sustainability and, in turn, behave in ways that convey this commitment to their subordinates
  - The basis for personal environmental behaviours in a conjunction of values, beliefs, and personal norms.
- Cordano and Frieze (2000)

  Ramus and Steger (2000)
  - Ability to make a commitment: employees respond positively with creative

environmental ideas if they perceive a strong organizational commitment to the natural environment.

- Starik and Rands (1995).
  - Can illustrate a strong commitment to ecological sustainability
- ISO, I. (2011)
  - Advertising the value of energy efficiency to employees on a regular basis.
- Brunke, Johansson and Thollander (2014).
  - Advertising the value of energy efficiency to employees on a regular basis information for the energy efficiency decisions
  - Popularizing and advocating the knowledge of energy efficiency
  - Ability to add the elements of environmental-friendly/greening into the business culture
- Gandhi and Brager (2016).
  - Why skills need to be behaviours-based
    - Offer rewards for reduced energy consumption
    - Educate and train staff to use new devices and to reduce energy use
    - Email occupant's reminders to turn off equipment
    - Provide feedback displays showing real time energy use
    - Encourage changes in habits
    - Communication planning

Appendix 6 The List of Collected Job Advertisements

Number	Job Title	Company	Field
1	Account Manager	Accenture Energy Practice	Management consulting, technology services and outsourcing
2	Account Manager-Energy Procurement Team	Trident Utilities	Energy consultancy
3	Associate Director-Project Management (Energy)	PPS Rail	Transportation
4	Associate Sustainability and Energy Consultant	Mattinson Partnership	Environmental and engineering recruitment consultancy
5	Business Development Manager-Energy Aggregation	Veolia	Environment consultancy
6	Business Development Manager-Energy Management Service Sales	Scheneider Electric	Energy management & manufacturing
7	Business Development Manager-Energy Management	The Green Recruitment Company	Energy consultancy
8	Business Development Manager-Utilities Energy Services	Dexter Nichoals Ltd	Executive Search and Selection & Headhunting
9	Business Development Manager-Energy Management Solutions	LCS Energy	Energy consultancy
10	Business Development Manager-Utilities or Energy sectors	Nationwide Platforms	Machinery manufacturing
11	Business Development Manager-Renewable Energy	Scott Bader Company Ltd	Chemical
12	Business unit manager-Environment	Eurofins Nederland (Commercial P&L, 3fte)	Life Science Laboratory
13	Commercial Construction-Project Manager (Renewable Energy)	Perfect Green	Energy saving construction installation
14	Commercial Manager-Energy	Zoopla Property Group	Consultancy (real estate)
15	Commercial Manager-Energy Storage	Ovo Energy Limited	Energy supply
16	Commercial Manager-Energy	uSwitch	Energy price comparison and brokerage service
17	Compliance Manager	Solarplicity	Renewable
18	Data Analyst-Energy & Carbon	J Sainsbury's	Supermarket (Retail industry)
19	Data Analyst-Energy	Utility People	Specialist Recruiter for the Energy Industry & Energy Jobs for Energy Professionals
20	Domestic Energy Assessor	Union Technical	Energy saving products installation
21	Energy Account Manager	Ultimate Utility Brokers Ltd	Energy brokers
22	Energy Advisor	CARBON SAVING GROUP LTD	Energy Efficiency renewable products installation & Energy consultancy
23	Energy Advisor	Let's Talk Energy	Energy community
24	Energy Analyst	BIU	Energy consultancy

25	Energy and Environmental Compliance Manager	Resourcematics	Data and analytical services (Energy, Water and Agriculture) & Energy consultancy
26	Energy and Sustainability Consultant	Allen & York	Environment & Energy consultancy
27	Energy and Sustainability Consultant	Mattinson Partnership	Environmental and engineering recruitment consultancy
28	Energy and Sustainability Manager	Sodexo	Food services & facilities management
29	Energy Assessor	Green Age Supplies	Energy consultancy
30	Energy Auditor	Carlton Recruitment	Recruitment Agency
31	Energy Broker	TRUE	Manufacturing (Refrigeration)
32	Energy Broker	Usmart	Data analysis & integration
33	Energy Center Plant Manager	Phoenix Resourcing Service	Property & Build Recruitment Supplier
34	Energy Consultant	CBRE Group	Commercial real estate services and investment firm
35	Energy Consultant	Eco Target Ltd	Energy consultancy
36	Energy Efficiency Team Manager	Mathtinson Partnership	Environmental and engineering recruitment consultancy
37	Energy Engineer	Skyline Engineering Solutions LTD	Engineering intermediary
38	Energy Finance Manager-Maternity Cover	Octopus Investments	Consultancy (Energy,Investment,Financing)
39	Energy Improvement Manager	C & J Holtappel (Energy Recruiters) Ltd	Employment placement agencies
40	Energy Management	Sodexo	Food services & facilities management
41	Energy Manager	Blackbun (ENGIE UK)	Facilities management
42	Energy Manager	Jonathan Lee Recruitment	Emplotment-resated search engine
43	Energy Manager	Mattinson Partnership	Environmental and engineering recruitment consultancy
44	Energy Manager	Sky	Telecommunications company
45	Energy Pricing Analyst	BPG Energy	Energy supply
46	Energy Projects Delivery Manager	Mansell Recruitment Group	Emplotment-resated search engine
47	Energy Projects Operations Manager	Mansell Recruitment Group	Emplotment-resated search engine
48	Energy Sales Consultant / Senior Corporate Account Manager	D-ENERGi	Energy supply
49	Energy Saving Measures Surveyor-ECO Scheme	Arktek Group Limited	Energy consultancy

50	Energy Services Manager	(E (Gas & Electricity) Ltd	Energy supply
51	Energy Solutions Engineer Scotland	Mattinson Partnership	Environmental and engineering recruitment consultancy
52	Energy Storage Vacancies (energy manager & engineer)	Dyson	Manufacture of electric domestic appliances & electrical equipment
53	Energy, Environmental & Sustainability Co-ordinator	CBRE	Real estate
54	Energy+ Technical Bid Manager	npower UK	Energy supply
55	Environment and Energy Manager	Arriva Rail London	Train operating
56	Environmental and Sustainability Manager	Shirley Parsons Associates	Emplotment-resated search engine
57	Environmental Data Analyst	Initial Projects Ltd	Environmental consultant
58	Environmental Manager	Murphy Group	Engineering and construction
59	Environmental Service Manager	Sulzer Ltd	Development and supply of pumping solutions
60	Environmental Sustainability Manager	KN Group	Telecommunications, Transport Infrastructure and Power
61	Environmental Sustainability Project Manager	Julie's Bicycle	Serving the creative community
62	Exceptions Analyst-Data Analyst-Energy	Consult Energy	Energy consultancy
63	Fuel and Energy Auditor	FM Conway	Infrastructure services
64	Graduate Energy Specialist	Bulb	Advertising agencies
65	Group Compliance Manager	TP Group	Activities of head offices
66	Group Environment and Sustainability Manager	Clancy Docwra	Services and advanced engineering
67	Group Risk & Internal Audit Manager	Drax Power Limited	Electrical power generation
68	Head of Partnerships-Energy	Utility People	Energy consultancy
69	Health safety, Sustainability & Environmental Manager	Cluttons	Property consultants and estate agents
70	Health, Safety, Environmental and Energy Manager	Alpro	Food production
71	International Tax Advisor-Energy	EY	Professional services
72	International Tax Assistant Advisor - Energy	EY	Professional services
73	Junior Consultant-Energy Resource Management	Verco	Manufacture of non-domestic cooling and ventilation equipment
74	Junior Energy Manager	Mattinson Partnership	Environmental and engineering recruitment consultancy
75	Manager FM & Energy Oxford	BMW	Manufacture of automobiles and motorcycles

76	NDEA-Full Time Energy Assessor	Core Sustainability	Energy consultancy
77	Performance Manager-Energy (HR-oriented)	Great Annual Savings Group	Energy consultancy
78	Powertrain Simulation Energy Management	Aston Martin	Manufacture of car
79	Principal Energy Manager	The Green Solutions Recruitment	Employment placement agencies & employment agency
80	Product Manager, Energy and Utilities	Vlocity	Telecommunications & information technology service
81	Project Co-Ordination Manager-Renewable Energy	GEV Wind Power Ltd	Energy & technique service
82	Project Manager-Energy Management (MV)	Siemens AG	Industrial manufacturing
83	Project Manager-Energy	PPS Rail	Transportation
84	Project Manager Consultants-Energy, P3M	Informatiq Consulting	Information technology service & IT and computer recruitment job website
85	Renewable Energy Salesperson	Energy Advice Centre	Energy consultancy
86	Segment Manager-Critical Energy manager	Vertiv Co.	Energy consultancy
87	Senior Consultant-Decentralised Energy	Sustainable Energy	Engineering related scientific and technical consultancy
88	Senior Consultant	JRP Solution	Energy consultancy
89	Senior Energy Analyst	Ameresco	Energy consultancy
90	Senior Energy Consultant	Arup	Professional services (engineering, design, planning, project management)
91	Senior Energy Engineer	Exergy	Technology service
92	Senior Project Manager-Energy	PPS Rail	Transportation
93	Senior Sustainability Consultant	AECOM	Engineering related scientific and technical consultancy
94	Smart Metering Auditor (Yorkshire and the Humber)	EDF Energy	Energy provider
95	Supplier Relationship Manager-Energy	TribePost	Recruitment agency
96	Surveyor - Investment and Energy	Anderselite	Recruitment agency
97	Sustainability & Procurement Manager	Telent	Internet systems installation and services provision
98	Sustainability Manager	Acre	Property development and investment
99	Sustainability Manager	Mattinson Partnership	Environmental and engineering recruitment consultancy

100	Sustainability Manager	Mount Anvil	Construction
101	Sustainability Manager	North Midland Construction	Construction
102	Sustainability Manager	Redrow	Construction
103	Sustainability Carbon Consultant	AECOM	Engineering related scientific and technical consultancy
104	Team Lead-Sustainable Energy Use-UK	DNV GL	Accredited management systems certification
106	Technical Director-Air Quality	Wood	Residents property management
105	Technical field manager	nopower UK	Energy consultancy
107	Technical Manager	Shanks Waste Management	Waste recycling
108	Technology Business Development Manager (Energy)	Costain	Construction
109	The Student Energy Project Manager	Amber Energy	Engineering design & Engineering related scientific and technical consultancy
110	Trainee Energy Surveyor	COMPLIANCE 365	Public order and safety activities

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