Defusing carbon bombs –
Analysing activism to keep fossil fuels in the ground

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Intellectual property and publications

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

This thesis follows an alternative, publications-based format and consists of an introduction (section I), three articles (sections II-IV) and a discussion and conclusions section (V). The area of study, which relates to confronting the current state of climate emergency, is very dynamic and requires rapid dissemination of results. The publication of articles in journals before the end of the PhD process is a key benefit of this format.

The first article (section II) appeared as
Kjell Kühne
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The second article (section III) appeared as
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“Carbon Bombs” - Mapping key fossil fuel projects.
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The third article (section IV) is under submission as
Kjell Kühne, Paul Routledge, James van Alstine,
Defusing a carbon bomb: Stopping fracking in Mexico.
to Energy Research & Social Science

Kjell Kühne was the sole author of the first, and the lead author of the second and third article.

For the carbon bombs article (section III), Kjell Kühne was responsible for all aspects of the publication, including conceptualization, methodology, writing, data curation and visualisation; Nils Bartsch participated in defining oil & gas methodology; Ryan Driskell Tate participated in defining the coal methodology, in coal data collection and validation, and in writing - review; Julia Higson participated in coal data collection, and in writing - review; André Habet participated in coal data collection.

For the Mexico case study article (section IV), Kjell Kühne was responsible for all aspects of the publication, including conceptualization, data collection, analysis and writing. My supervisors Dr. James van Alstine and Professor Paul Routledge were involved in conceptualization and reviewing the draft article.

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Abstract

After 30 years of UN Climate negotiations under a demand-focussed framing, we have not yet seen a significant bending of the curve of global greenhouse gas emissions. This invites analysis of supply-side measures (“keeping fossil fuels in the ground” (KING)) to bring emissions down and a growing literature is indeed looking at supply-side mitigation. But it is still far from being a mainstream approach. The current research aims to contribute to the field by pursuing the following objectives.

Firstly, establish a method for quantifying the emissions impacts of efforts to keep fossil fuels in the ground. Secondly, identify the biggest fossil fuel projects on a global level. Thirdly, identify what strategies the climate movement has used where supply-side mitigation has been successful.

To achieve the first objective, I designed a method that breaks supply-side mitigation down into three different categories: keeping fossil fuels in the ground, delaying or cancelling fossil fuel infrastructures and temporary stoppage of projects. I calculated emissions factors that can be easily applied for arriving at estimates of potential emissions of a range of fossil fuel projects.

To achieve the second objective, I used the framing of “carbon bombs” and identified the global list of fossil fuel projects above 1 gigaton of potential CO2 emissions.

To achieve the third objective, I chose a case study of a carbon bomb in Mexico and conducted interviews with experts and did participant observation in the Mexican Alliance against Fracking.

My main results are:

1. A method for quantification of KING movement efforts which is ready to be used by the climate community.
2. The global list of carbon bombs with 425 projects, and the insight that 40% of these projects are new and haven’t started, and the evaluation of their potential emissions exceeding the global 1.5°C carbon budget by a factor of two, pointing to the urgent need to defuse at least some of these carbon bombs.
3. A list of strategies such as researching and distributing information, linking with the frontlines and seeking anti-fracking legislation that have had different degrees of success

in contributing to stopping fracking in Mexico. I also identified the economic environment and in particular fossil fuel prices as a relevant context factor producing strong head or tailwinds for these projects, leading to the new framing of “economic windows of opportunity” for fossil fuel projects that can be an analytical tool for the KING movement to understand its campaigning prospects concerning defusing carbon bombs.

In a context of increasing international momentum around supply-side mitigation and the call to end building new fossil fuel extraction projects getting stronger, I am contributing a method for a wide audience to understand the potential emissions of individual fossil fuel projects, a global map of priority projects to defuse which outlines the global supply-side mitigation landscape, and a detailed exploration of defusing a carbon bomb in practice.

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List of abbreviations

AMLO - Andrés Manuel López Obrador, Mexican president from 2018

bbl - barrel

bboe - billion barrels of oil equivalent

bcm - billion cubic metres

bpd - barrels per day

COP - Conference of the Parties

GEM - Global Energy Monitor

GGON - Global Gas and Oil Network

GHG - greenhouse gas

Gt - gigatons

IPCC - Intergovernmental Panel on Climate Change

KING - Keep it (fossil fuels) in the ground

LINGO - Leave it in the Ground Initiative

LNG - liquefied natural gas

MENA - Middle East and North Africa

mmbtu - million British thermal units

mtpa - million tons per annum

NGO - Non-governmental organisation

NRDC - Natural Resource Defense Council

PEMEX - Petróleos Mexicanos

UN - United Nations

UNEP - United Nations Environment Programme

UNFCCC - United Nations Framework Convention on Climate Change

USD - US Dollar

I. Introduction

I consider defusing carbon bombs one of the most urgent and important tasks for human beings alive today. This thesis aims to make a contribution to this task by providing conceptual tools and strategic information. In this introductory section, I will lay out the societal context for my research and the research objectives, then review relevant literatures and how my research fits into them and adds to them. Finally, I will introduce my research methods and explain my choices.

1. Context of the research

1.1. The fossil fuel age

Since the industrial revolution, humans have continually increased the amount of coal, oil and gas they burn for powering machines and vehicles, for heating buildings and for producing electricity. Over the last decades, the burning of fossil fuels has become so pervasive that many people today, particularly older generations, do not even believe it is possible to live without burning fossil fuels. Yet, in historic terms, the fossil fuel age is a flash in the pan of human history, lasting around 200 years from the introduction of increasingly efficient steam engines by James Watt in 1765 and George Henry Corliss in 1849. If measured from the time when internal combustion engines became widespread around World War II (Smil, 1994), its duration is roughly comparable to a human lifetime of about 70 years (World Bank, 2019). Nevertheless, the idea that humans, through fossil-fuel driven economies have become a geological force constituting what has been conceptualised as the geological age of the Anthropocene (Crutzen, 2006) is increasingly accepted among geologists and others. One of the clear cases of such anthropogenic changes that affect all life on Earth is climate change. It is just one dimension of a wider ecological crisis that has already resulted in biodiversity loss and other impacts upon the environment.

1.2. Climate change and policy response

Climate change constitutes one of the biggest challenges of current times. Overcoming it will require a significant reduction of fossil fuel burning, the resulting greenhouse gas emissions being at the root of the problem. One of the key challenges is to transition from an unsustainable high-carbon lifestyle with its associated cultural and political dynamics (Mitchell, 2011) to one in tune with natural limits and cycles.

The outcomes of climate change are deeply unjust: high emitters are frequently the last to feel the impacts and those most vulnerable to climate impacts have often contributed little or nothing to causing it (see Vanderheiden, 2008). A ‘triple inequality’ exists concerning the unequal responsibility for producing greenhouse gas (GHG) emissions; the unequal ability, capacity and responsibility to mitigate GHG emissions; and the unequal ability and capacity to adapt to climate change. Indeed, the climate negotiations have been mired in this basic contradiction for a long time (Roberts and Parks, 2006) and the goal of meaningfully mitigating GHG emissions through climate agreements has proven elusive so far. The energy sector contributes the most significant share of anthropogenic greenhouse gases through burning of fossil fuels (IPCC, 2014).

The Intergovernmental Panel on Climate Change (IPCC) has summarised the state of research on climate change in repeated assessment reports (the latest full report is IPCC, 2014). The IPCC not only summarises changes that have been observed and are projected, it also has a working group dedicated to summarising the science about climate change “mitigation” (Intergovernmental Panel on Climate Change, 2014). Climate change mitigation in the energy sector can broadly be divided into demand-side and supply-side approaches (Lazarus et al., 2015).

Demand-side mitigation policies are those that intend to reduce energy demand, for example by promoting energy efficiency and renewable energy or through carbon pricing (see Kolstad et al., 2014 and; Somanathan et al., 2014 for in-depth treatments). They constitute the bulk of current mitigation efforts.

Supply-side mitigation refers to efforts towards reduced extraction of fossil fuels or “keeping it in the ground” (see Johnsson et al., 2019, Table 1 for an overview of policies). It is an emerging field and is described in more detail in the literature review section below. The last 30 years have seen few efforts to limit fossil fuel supply. The United Nations Framework Convention on Climate Change (UNFCCC) process has concentrated on territorial emissions, “end of pipe” so to say, and has failed after over 30 years to bring down global greenhouse gas emissions or even just stop their growth. Denniss and Green (2018) and others have thus argued that we should start combining supply- and demand-side measures.

The Paris Agreement in 2015 increased the stringency of the internationally agreed temperature target from maximum warming of 2°C above pre-industrial levels to "well below 2°C" and "pursuing efforts" to stay below 1.5°C of increase in the global average temperature (United Nations Framework Convention on Climate Change, 2016). While "fossil fuels" were not even mentioned in the Paris Agreement, the implications are clear that it leaves an even smaller carbon budget (Millar et al., 2017), no matter whether one approaches mitigation from the demand or from the supply side. On the demand side, an "emissions gap" between agreed targets and national governments' commitments (Figure 1) is widely acknowledged. While the climate stabilisation targets of 1.5° and 2° require a swift reduction of global greenhouse gas emissions, climate commitments by countries taken together only slightly modify a "business as usual" scenario downwards, but on aggregate still let us expect a further rise in emissions in the future. The Paris Agreement itself explicitly refers to the need for enhancing ambition and foresees a process to achieve this (United Nations Framework Convention on Climate Change, 2016). The gap is being monitored in real time by tools such as the Climate Action Tracker (Climate Action Tracker, 2018), and the United Nations Environment Programme (UNEP) has published an *Emissions Gap Report* yearly since 2010 (UNEP, 2021). The gap is now so big that "radical" emissions reductions (Anderson et al., 2014) are the only path left, at least for high-per capita emitting countries.

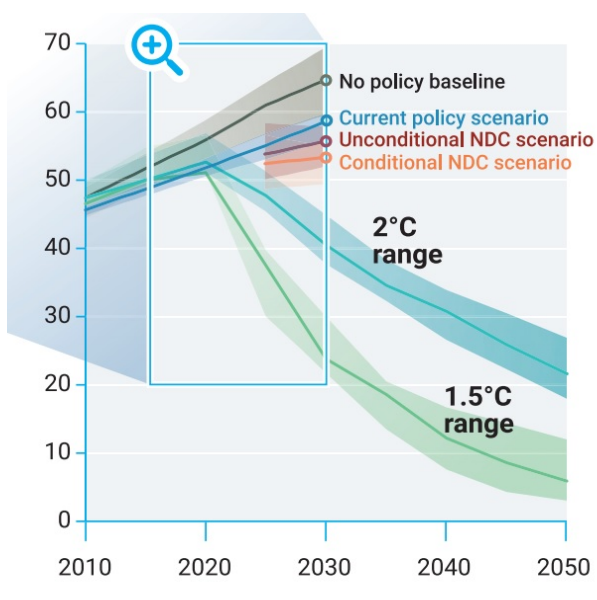

Figure 1. Global annual greenhouse gas emissions in GtCO2eq

Source: United Nations Environment Programme (2018)

1.3. Rationale of the investigation: The imperative of keeping fossil fuels in the ground

Ultimately, the goal of my investigation is to contribute to finding pathways towards climate stability. The impacts of much less than 1.5°C heating that are already unfolding around the world as of 2022 remind us of the urgency to identify tools and actions that can bring us in line with agreed climate goals. However, the emissions gap shows that government policies are not yet aligned. When approaching the question of mitigation from the supply side, the gap is even bigger (SEI et al., 2021). The unburnable carbon approach (Carbon Tracker Initiative, 2011) shows how much of currently known fossil fuel reserves should not be burnt to meet existing temperature targets (McGlade and Ekins, 2015; Welsby et al., 2021). The IPCC's 5th Assessment Report explicitly acknowledged the incompatibility of using more than about a quarter of global fossil fuel reserves with climate targets (IPCC, 2014, p.63). The rest must stay unburned. Solutions are urgently needed towards keeping the vast majority of proven fossil fuel reserves (Kühne, 2016) and even a significant portion of already “developed” reserves (Trout et al., 2022) in the ground. (for a detailed history of ideas and efforts around keeping fossil fuels in the ground, see Leave it in the Ground Initiative (n.d.))

There is a growing Keep it in the ground (KING) movement, but a substantial impact on global emissions has yet to be seen. While fossil-fuel extraction is driven by powerful political, economic and cultural processes, the forces that stand against it are in many cases relatively localised and frequently disconnected (Osuoka and Zalik, 2010; Castree, 2015). Some of the efforts at keeping fossil fuels in the ground have failed, such as the Yasuní-ITT Initiative, which proposed that the world compensate Ecuador for keeping its oil in a particularly biodiverse region in the ground. Others are temporary in nature, and still others have seen a success that was later rolled back, such as in the case of Donald Trump who, as president of the United States, promoted drilling for oil and gas in protected areas and offshore.

So far, there are only a few “first movers” among governments with explicit commitments to keep fossil fuel reserves untouched (Carter and McKenzie, 2020). But with the launch of the Powering Past Coal Alliance in 2017 and the Beyond Oil and Gas Alliance in 2021, there are now governmental fora for efforts to end all three fossil fuels. Nevertheless, at present, energy policies in most countries continue to target an increase rather than a reduction of fossil fuel supply, especially for oil and gas, pushing the fossil fuel frontier further into sensitive environments and non-conventional fuel reserves. The renewed (and in my opinion misguided) narrative of “energy security” based on fossil fuels in the aftermath of Russia’s invasion of Ukraine and its impacts on global energy markets further increases the timeliness of looking for new ways to frame mitigation, because the conventional approaches do not seem to be very crisis-proof. This explains the urgency of the current research.

1.4. Research objectives

My research is rooted in scholar activism (see the methods section below) and aims to contribute to academic discussions through new arguments and new conceptual tools while at the same time providing strategic guidance for the KING movement.

My research objectives are to:

1. Establish a method to quantify the impacts of efforts to keep fossil fuels in the ground.
2. Identify the biggest fossil fuel projects on a global level that KING activism should target.
3. Investigate the strategies that the climate movement has used to successfully achieve supply-side mitigation.

Objective 1 “Establish a method to quantify the impacts of efforts to keep fossil fuels in the ground.”

In order to take the “next big step in climate policy” (Erickson et al., 2018) and include supply-side measures in a consistent fashion, it is essential to be able to establish their efficacy, including via quantification of the amount of emissions at stake. But how should they be quantified? Territorial emissions per year, the current standard at the UNFCCC do not accurately capture the picture, because fossil fuels are widely traded, and the size of resource endowments in an exhaustible resource is a significant factor to be taken into account. Whether one should look at flows or stocks is not a trivial question when looking at the picture of fossil fuels and climate change. The absence of a well-documented, peer-reviewed method for quantifying supply-side mitigation efforts poses an obstacle. The method which I have developed, described in the first of the three articles of this thesis (section II), consists of separate indicators, one for reserves kept in the ground for definite wins and another two in terms of tons of CO2 emissions per time unit of delay or interruption. The reserves-based method relates well to a carbon budget framing of the climate challenge (Messner et al., 2010), the second relates to the current UNFCCC approach of yearly emissions (see Eggleston et al., 2006). The carbon bombs article, the second of the three articles of this thesis (section III), uses the same framing as the reserves-based method with slightly refined emissions factors.

An important concern in developing this method is to close the "usability gap" of climate information (Lemos et al., 2012), which tends to keep academics and other experts apart from the wider public and even climate activists, disempowering the latter. As explained in more detail in the article, I hope to provide a useful tool for movement colleagues to become more fluent in the "emissions language" that many institutions that deal with climate change speak nowadays.

Objective 2 "Identify the biggest fossil fuel projects on a global level that KING activism should target."

In order to identify useful targets for global KING activism where it would make sense to concentrate efforts, the first and foremost concern is project size. CO2 mixes very well in the atmosphere, quickly turning a local emission into a globally shared burden. The bigger a fossil fuel project, the more coal, oil and gas it extracts, transports or burns, the more important a target it should be. But <u>which are the biggest fossil fuel projects in the world?</u> This seemingly basic question had not previously been answered in a systematic way and thus turned into the focus of the second article on carbon bombs (section III). Related and more specific sub-questions are: Where are these projects located? What is their state of development? How big is their potential contribution to climate change?

Objective 3 "Investigate the strategies that the climate movement has used to successfully achieve supply-side mitigation."

For arriving at a better understanding of how to stop fossil fuel projects, my initial assumption was that we simply needed to analyse successes. Understanding strategic choke points for fossil fuel projects and identifying previously successful strategies for keeping fossil fuels in the ground should put us in a good position for repeating the successes. The first challenge that arose was that successes of keeping fossil fuels in the ground and cancelling extraction are very few. My initial list of candidates was narrowed down to three cases and included the German lignite mine of Hambach, Canadian tar-sands, and Mexican fracking, where a president with a "no fracking" pledge entered office for a 6 year term one month before I started my PhD research. Because social movements and activist efforts in the Global North tend to be much better studied than those in the Global South, and my personal involvement with the Mexican Alliance against Fracking provided an opportunity, I chose the success against fracking in Mexico as a case study of a carbon bomb that was in the process of defusing. This case study forms the basis for my third article which investigates the strategies used by the Mexican anti-fracking movement, the effectiveness of these strategies and the political and economic factors that have contributed to stopping fracking in Mexico.

What follows in the next section is a review of the key literatures that underpin this research.

2. Literature review

In this section, I will highlight the gaps in the academic literature which I address, namely the lack of a quantification method for emissions impacts of KING efforts, the lack of an identification of the biggest fossil fuel projects on a global scale and a detailed understanding of how the KING movement operates and effects its wins. A number of conceptual contributions will help fill those gaps and these are described in more detail in this section. I will also explain why it is useful to use a new concept, that of the KING movement, to speak about the efforts to keep fossil fuels in the ground. The contribution I aim to make with my research is to bring energy geographies and social movement studies into fertile contact by 1) enabling a quantitative assessment of the impact that the KING movement exerts on carbonscapes by creating a new evaluation method, 2) providing a new analytical lens, that of "carbon bombs" to analyse the supply-side mitigation picture and 3) showing how the KING movement is exerting agency in carbonscapes through exploiting specific instabilities. In all cases, I will develop and apply new concepts to allow for a fresh perspective on these issues. A detailed discussion of my contributions from a theoretical, methodological and empirical perspective can be found in the discussion chapter (section V) of this thesis. Here, I will discuss existing work in the fields of supply-side mitigation, related to carbon bombs, on the social movement at the heart of my research (the KING movement), and a useful framing for understanding KING movement efforts: "carbonscapes".

2.1. Supply-side mitigation

Any policies that make a difference to the possibility or timing of fossil fuel extraction can be considered supply-side mitigation policies. Examples include fossil fuel subsidy reform, especially for production subsidies (Bast et al., 2015), moratoria on licences and leases (Mulvaney et al., 2015), extraction taxes (Richter et al., 2015; Faehn et al., 2017) and divestment of fossil fuel companies (Ansar et al., 2013; see InterAmerican Clean Energy Institute, 2016 for further examples). Lazarus and van Asselt (2018) provide a good overview of the field. As opposed to demand-side action, which is the mainstay of mitigation policies under the UNFCCC, the supply side of fossil fuels has only recently started to receive more attention and is starting to be considered a useful and important complement to more traditional mitigation measures (Lazarus et al., 2015; Green and Denniss, 2018). The Stockholm Environment Institute has been particularly active in the discussion, facilitating networking among practitioners and addressing issues such as Keystone XL pipeline emissions (Erickson and Lazarus, 2014), carbon in the ground on US federal lands (Erickson and Lazarus, 2016), and ways forward for the topic at the UNFCCC (Verkuijl et al., 2018; Piggot et al., 2018; Erickson et al., 2018) and beyond (van Asselt, 2014).

An important - yet rarely answered - question is about the effectiveness of mitigation options on the supply side. Some of the proposed policies, such as a global fracking ban or a global moratorium on new coal mines (Mendelevitch, 2018) hold the potential to keep huge amounts of fossil fuels in the ground. But just how much, is very difficult to tell, because there are no simple methods to readily translate the potential impact of those policies into emissions.

Recent work on supply-side mitigation has tried to capture the growth of action on that front in numbers (Gaulin and Le Billon, 2020; Temper et al., 2020), made the case for a supply-side mitigation treaty (Asheim et al., 2019; Newell and Simms, 2020), or explained the benefits of supply-side policies (Green and Denniss, 2018). What is missing, however, is a simple way to quantify the emissions reduced by keeping fossil fuels in the ground. Erickson and Lazarus (2014) offer a model that evaluates the emissions impacts of the Keystone XL pipeline, including market leakage effects. However the model is not simple and hard to replicate for non-experts. I will try to fill that gap with the paper on KING metrics (section II of this thesis).

A friend of mine once told me “Good ideas - hell is full of them!” Unfortunately as of today, the field of supply side mitigation presents many loose ends and is littered with good ideas that have died somewhere on the long way to implementation. Examples are the moratorium on new coal mines[1], the discussion on the justice dimension of keeping fossil fuels in the ground (Kartha et al., 2018; Le Billon and Kristoffersen, 2019; Muttitt and Kartha, 2020), Collier and Venables excellent - yet unheeded - article *Closing coal: Economic and moral incentives* (2014) which argues very convincingly for a new approach to phasing out fossil fuels globally, starting with coal in the richest countries, or the call for *Yasunization* by Temper et al. (2013) which suggests spreading non-extraction around the world.

A more realistic picture of opportunities to restrict fossil fuel supply can be achieved by looking at what industry investors frame as risks (see Krane (2017) for an overview). From an activist perspective, explicitly stated risks can be translated into an opportunity to impact operations

[1] The author used to work on the No New Coal Mines Campaign. Because the idea didn’t catch on at the time, we moved on to work on other things.

significantly by materially exacerbating those risks (e.g. the risk of litigation, by filing lawsuits) or at least highlighting them in communications at key moments such as annual general meetings.

Addressing the supply-side of the climate equation is thus to this date only an academic and bottom-up activist exercise, but not yet on the agenda of the relevant governments (Verkuijl et al., 2018) with sporadic notable exceptions. However, given the physical realities of climate change laid out in the section on the imperative to keep fossil fuels unburned, sooner or later, the question will need to be addressed. A timid first step that is already being implemented around the world is fossil fuel subsidy reform (van Asselt, 2018). It sounds strange that during times of ever increasing climate damages governments would still be supporting fossil fuels with public money. Unfortunately fossil fuel subsidies have proven very resistant to change. Erickson et al. (2017) quantify how much more oil gets extracted in the United States because of fossil fuel subsidies and Schwanitz et al. (2014) tried to assess how global emissions would behave if fossil fuel subsidies were removed globally.

McGlade and Ekins (2015) tried to show the geographical distribution of fossil fuels unused when limiting global warming to 2°C, from an economic perspective. Geographical is to be understood here as classifying them by region (almost continent level). They took the reserve numbers and a carbon budget (one that stays below 2°C warming with 50% probability), and let a model eliminate the most expensive reserves to arrive at figures of unburnable carbon. They say Arctic hydrocarbons and unconventional oil and gas should not be extracted and exploration is unnecessary. This is a very useful first approximation from an economic angle to understand which regions may harbour the cheapest and most expensive fossil fuel. In 2021, Welsby et al. (2021) updated the analysis for a 1.5° scenario.

Besides economics, there are certainly other arguments for non-extraction, such as nature conservation, indigenous rights or peace. But even the economic factor is maybe not as important as an economist would want to believe. An instructive example is the presence of *zombie energy*, such as from lignite in Germany at the moment: the mines and power plants are making losses as far as the overall project is considered, but as long as the payments for electricity that they receive are enough to cover operating costs and thus making a contribution to reducing losses, they will keep operating. They are also kept running as a bargaining chip for teasing out further subsidies from the government which has set aside a sizable budget for the coal phase-out. This lock-in effect of fossil fuel extraction (Erickson et al., 2015) needs to be examined further, because once the initial investment is made, prices could potentially go very low before the oil and gas stops flowing. Especially for state-owned companies, decisions to keep extracting are often taken in spite of the economic argument, and then sustained with government subsidies - calling into question the premise that only the most economically favourable supply will survive. The regional level figures can serve for a rough orientation, but need to be translated to national or even project level evaluations to become actionable. Based on these previous analyses, we focused further into the picture in the carbon bombs paper reproduced in section III of this thesis.

2.2. Carbon bombs

The report, *The sky's limits* (Muttitt, 2016) has shown that after the Paris Agreement, we must not open any new coal mines, gas or oil fields. The existing ones are more than enough to take us beyond 1.5° warming. However, new ones are still being built. Chris Smith and colleagues (2019) have shown that we do have a chance to stay below 1.5° if we stop adding new fossil fuel infrastructure immediately, and at the end of their useful life replace them with zero carbon infrastructure. Tong et al. (2019) disagree, they come to the conclusion that we will stay below 2°, but for 1.5° we need to retire some of the fossil fuel infrastructure early. In any case, coal-fired power plants, gas pipelines and oil wells in new fields are still being built. We will have to retire fossil fuel infrastructure early, and possibly it will be a hard fight. Hard, but not impossible to win. The German *Ende Gelände* movement has shown for seven years in a row (2015-2022) how activist power can temporarily shut down big fossil fuel infrastructures in a peaceful way, while accelerating the emergence of a consensus in society to shut them down permanently (Sander, 2017). I expect the struggle against coal in Germany to be won fairly soon. But the struggle against fossil fuels on a global scale will continue for some time. To inform it, we need a strategic assessment of global KING mitigation potential. For the KING movement, key questions are:

1) Which are the biggest fossil fuel projects in the world?
2) Where are they located?
3) What is their state of development?
4) How big is their potential contribution to climate change?

Some of these questions are partly addressed by existing work, mostly in grey literature.

The Point of No Return report by Greenpeace was a first attempt to build a global list of "carbon bombs" (Voorhar and Myllyvirta, 2013). In it, Greenpeace mapped 20 huge new fossil fuel extraction projects and the amount of emissions they would contribute over their lifetime. Cimons (2016) updated this analysis. In a 2019 presentation by the Global Gas and Oil Network (GGON) we can find the potential emissions from planned oil and gas extraction projects worldwide up to 2025 and 2030 (Berman, 2019). Figure 2 is taken from a report by Oil Change International that maps the oil and gas industry plans in the United States (Trout and Stockman, 2019).

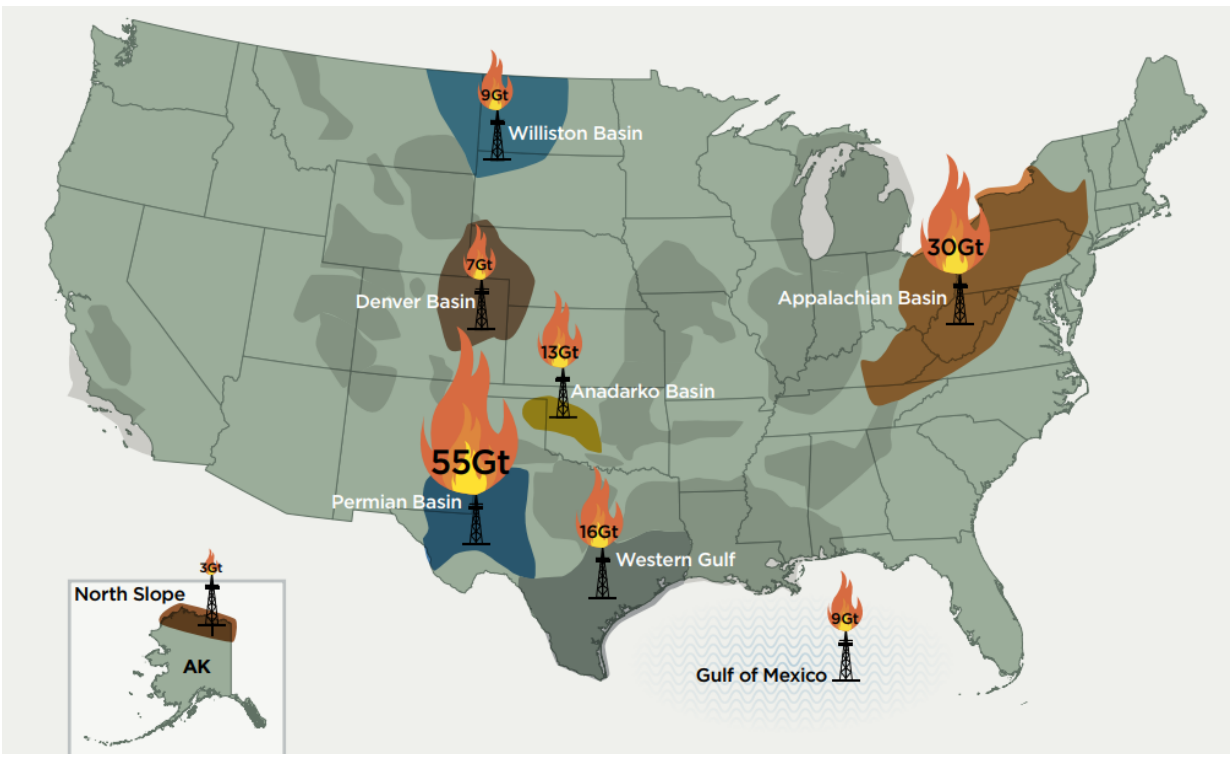

Figure 2. Major U.S. Oil & Gas Basins Showing CO2 Emissions from Projected Total Production, 2018-2050 in Gigatons CO2
Source: Trout and Stockman (2019, p.25)

Dustin Mulvaney and colleagues have mapped and quantified "*The Potential Greenhouse Gas Emissions of U.S. Federal Fossil Fuels*" (Mulvaney et al., 2015). Figure 3 shows where in the United States fossil fuel reserves are located under federal lands. This gives a first impression that allows some conclusions, such as the fact that most of the coal is located in the mid-Western United States which are relatively sparsely populated and therefore require transport infrastructure to be brought to market. In the case of coal, the industry downturn of recent years in the US has led companies to look towards Asian markets. A look at the map suggests that the coal would have to be transported over the Rocky Mountains to the West coast to be exported. Stopping new coal export terminals on the US West coast has proven to be a bottleneck and hence an excellent choke point for activists to focus on (Cornot-Gandolphe, 2015; Allen et al., 2017).

What the map does not tell us, is the relative importance of different areas, economically, but also from a climate perspective. We need geological data to complement this. For example, between the different regions, the Gulf of Mexico is by far the most important for oil and gas. 51 out of 53 billion barrels of oil equivalent (bboe) have been extracted there, and 5.3 bboe of the remaining reserves of 5.7 bboe offshore oil and gas are located in that region (Bureau of Ocean Energy Management, 2017). This puts the importance of Arctic, Atlantic and Pacific offshore drilling into perspective.

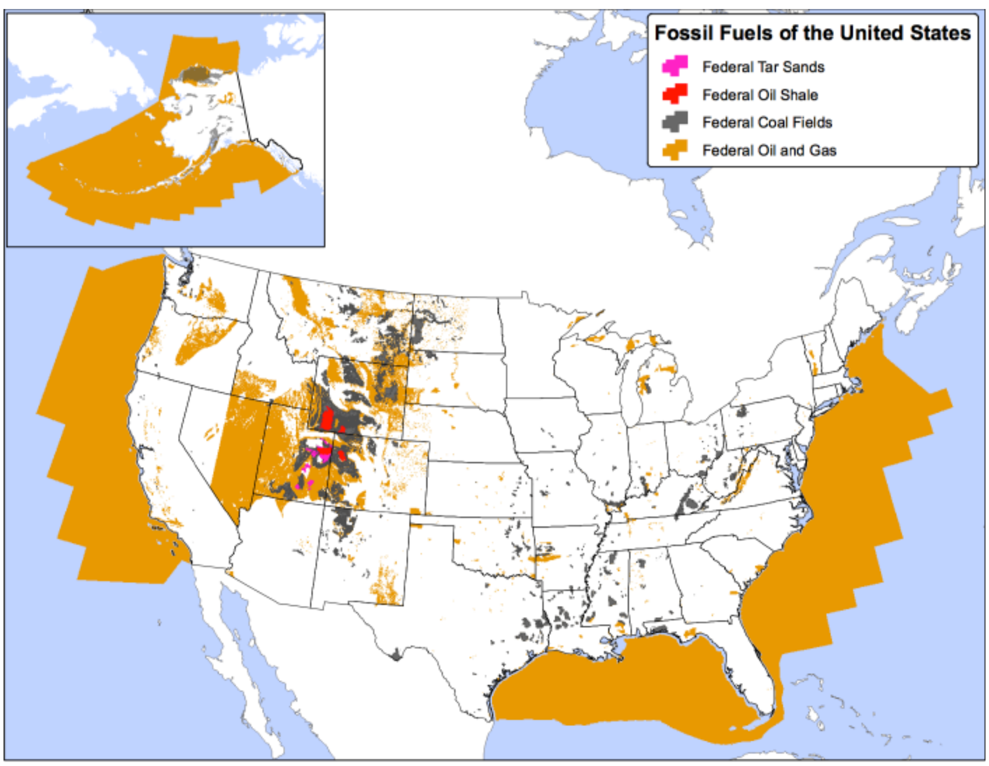

Figure 3. Map of federal fossil fuels in the US
Source: Mulvaney et al. 2015

One billion barrels of oil translates to roughly 0.31 gigatons (Gt) of CO2 emissions when burnt, meaning that overall offshore oil reserves in the United States could emit up to 1.8 gigatons of

CO2. This is surpassed by the North Antelope Rochelle coal mine, the world's largest in reserves which has 2.3 billion tons of coal with an emissions potential of 4.6 Gt CO2. This illustrates the need to draw on geological data and translate it into potential emissions to understand the relative importance of different fossil fuel projects and sectors. Mulvaney and colleagues have actually done that, as can be seen in Figure 4. The potential emissions from coal are the biggest.

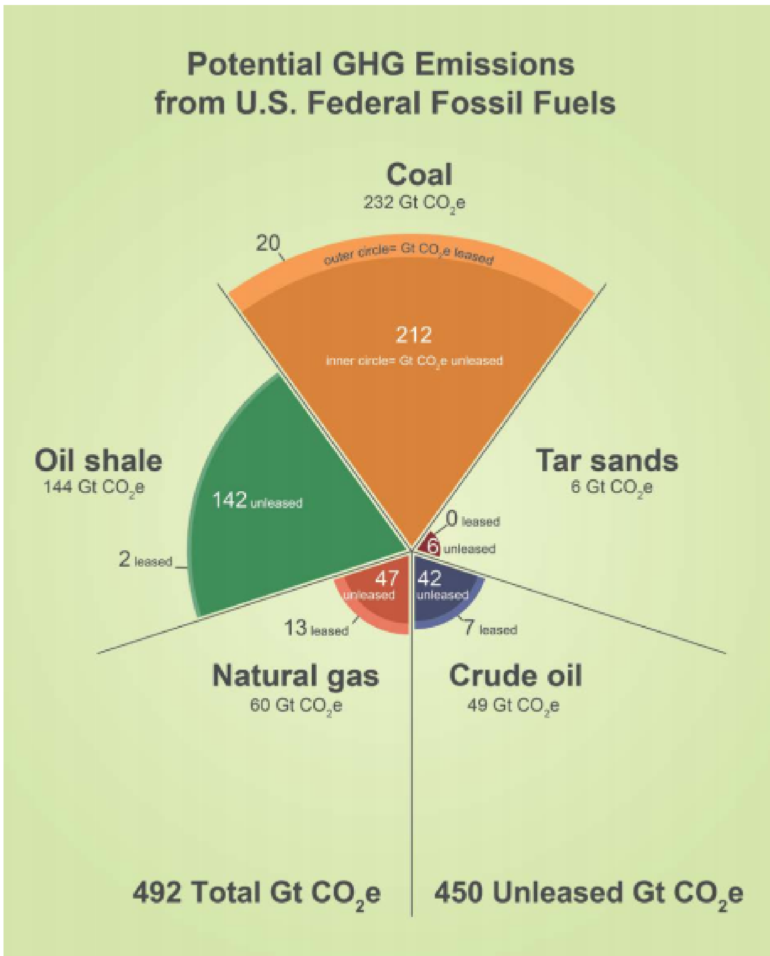

Figure 4. Potential greenhouse gas emissions from US federal lands

Source: Mulvaney et al. 2015

An equivalent picture on a global level has been drawn by several authors in very broad strokes (Meinshausen et al., 2009; Kühne, 2010; Carbon Tracker Initiative, 2011), showing the incompatibility of extracting global fossil fuel reserves with climate targets. In 2014, the IPCC's 5th Assessment Report also explicitly recognized the fact (IPCC, 2014, p.63). But this is only the starting point of the journey: a huge “overhang” of unburnable carbon reserves that must be translated into more manageable units which can be targeted by climate policy or KING activism. Coming back to the initial questions of characterising the biggest fossil fuel projects globally has subquestions about the projects’ size, location, stage of development, and potential climate impact, I hope to fill an important gap for the KING movement by answering them more fully in the article on carbon bombs (section III of this thesis), with global coverage, a standardised procedure and relatively precise mapping.

2.3. The *Keep it in the ground (KING) movement*

Social movements are networks of distinct organisations and individuals participating in an effort to realise a collective goal through nontraditional means (Nicholls, 2007). Tilly (2004) argues that social movements were invented in Britain in the 18th century. Since then, they have become an important ingredient of the political process and the evolution of societies worldwide. Traditionally, social movement research has looked at how resources are mobilised (McCarthy and Zald, 1977), what role identity, framing and emotions play in social movements (Snow et al., 1986; Polletta and Jasper, 2001; Jasper, 2011), how they engage with the political processes and institutions (Touraine, 1981), and how a new kind of movements could be explained that goes beyond defending one’s own interest (Pichardo, 1997; Castells, 2012). I will add to two strands of social movement research: social movement impact theory, discussed below in section 2.2.3. and political opportunity theory discussed in detail in the Mexico case study (section IV of this thesis).

2.3.1. Defining the KING movement

In this thesis, I call the movement to keep fossil fuels in the ground *KING movement* (*K*eep fossil fuels *IN* the *G*round). I define it as the movement which struggles to stop fossil fuels (coal, oil and fossil gas in all its forms, including tar sands) from being extracted, transported and burnt or turned into short-lived products (such as plastics or fertiliser). The work on alternatives to fossil fuels is included, as well as the work on game changers for the fossil fuel industry, such as a climate bailout, climate litigation and fossil fuel subsidy reform (Leave it in the Ground Initiative, n.d.).

In this section we will take a closer look at the KING movement, whose intellectual roots go back to the 1990s (Krause et al., 1990; Hare, 1997; Klein, 2014, p.267). However, the idea of keeping fossil fuels in the ground only became more accepted in the mainstream in the 2010s, made known through Ecuador's *Yasuní-ITT Initiative* (Larrea and Warnars, 2009), the concepts of *unburnable carbon* and *stranded assets* (Carbon Tracker Initiative, 2011), and Bill McKibben's *Global Warming's Terrifying New Math* (McKibben, 2012).

The first author to speak of a global movement against fossil fuel extraction was Naomi Klein. In her book *This changes everything: capitalism vs. the climate* (Klein, 2014), she introduced the term *Blockadia*, which she learned from the Tar Sands Blockade direct action group (p.261). She characterises this movement as follows:

> *"Blockadia is not a specific location on a map but rather a roving transnational conflict zone that is cropping up with increasing frequency and intensity wherever extractive projects are attempting to dig and drill, whether for open-pit mines, or gas fracking, or tar sands oil pipelines." (p.254)*

Joan Martinez Alier and colleagues have taken up this framing (Roy and Martínez Alier, 2017; Martínez-Alier et al., 2018) and developed an interactive online map of Blockadia struggles (Environmental Justice Atlas, n.d.).

While Klein thinks of Blockadia as a movement against all the injustices and negative impacts of the fossil fuel industry, Benedikter et al. (2016) talk specifically of a "Keep it in the ground" movement (which they abbreviate KIITG) and describe twelve of its constituent parts, as well as some successes. They state that Blockadia is the same movement and add some important new elements to the list of movement parts such as the *No New Coal Mines* campaign, proponents of the *Keep it in the Ground Act* in the US, the *Lock the Gate Alliance* in Australia, and the German coalition *Ende Gelände*.

A third author describing a movement against fossil fuel extraction and looking at some of the obstacles of building it is Georgia Piggot (2018, p.946). She calls it "supply-side movement" and describes it as follows:

> *[...] a wide variety of civil society actors – from researchers, to landowners, environmental organizations, and lawyers – using a range of tactics to limit fossil fuel use.*

In a fourth piece of relevant work, *Activism and the fossil fuel industry*, Andrew Cheon and Johannes Urpelainen (2018) describe four US-based movements: the one against the Keystone XL pipeline, anti-fracking, fossil fuel divestment and anti-coal. They also include a brief look beyond the United States at what they call the "campaigns against fossil fuels", shying away from the term movement when talking about the international dimension, because in their view, the US movement is much stronger than the bits and pieces they have encountered internationally. Table 1 summarises their findings in comparing the US to the global picture.

	American Campaign	**Origin of International Campaign**	**Nature of International Campaign**
Pipelines	Combines fossil fuel, climate disruption concerns with local land, water issues	Independent from American campaign	Exclusively motivated by local issues
Divestment	Removing the social license of the fossil fuel industry	Outgrowth of American campaign	Similar to American campaign
Fracking	Partly about fossil fuel, climate disruption concerns; strong local component	No organized campaign	High variation across local contexts strong local component
Coal	Partly about fossil fuel, climate disruption concerns; strong local component	Independent from American campaign	Partly about fossil fuel, climate disruption concerns; strong local component

Table 1. Comparing US and international campaigns against fossil fuels
Source: Cheon and Urpelainen, 2018

As we can see, there is no commonly used name for the movement against fossil fuels, although the mentioned works refer roughly to the same movement. In the author's experience, most of the actors of this movement only understand themselves vaguely as part of a common struggle, sometimes thought of as the climate movement, or the movement for climate justice. But with no name and no institutionalisation, how much of a proper movement can it be, rather than an analytical category invented by scholars? As of today, the movement actors themselves hardly coordinate their actions or see themselves as part of a common movement. By giving it an easy to remember name, I hope to enable the emergence of a collective identity among the diverse and disconnected struggles, previous scholarship on which I will briefly survey below. This may inspire the actors of the movement to think of themselves as part of a bigger entity, and perhaps to start coordinating more closely.

Allow me to make a few comments about the shortcomings of “Blockadia” as a framing for the movement. Firstly, the word “blockade” carries strong negative connotations. I believe that a KING movement will be perceived as a more constructive force than a movement that calls itself Blockadia. Secondly, Naomi Klein did not foresee the emergence of Ende Gelände, a strong German alliance that uses civil disobedience to temporarily shut down fossil fuel infrastructure and demand a shift in energy policy, notably an immediate coal exit. Since its emergence in 2015, Ende Gelände has become one of the most dynamic actors of the KING movement, already inspiring similar actions, such as *Limity jsme my* in the Czech Republic, *Code Rood* in the Netherlands and *Folk mot Fossilgas* in Sweden. Klein’s conceptualization as Blockadia being driven by frontline communities (*activists by necessity*), puts Ende Gelände at the margins, not at the heart of the movement. While nobody within Ende Gelände would deny the moral leadership of activists by necessity, marginalising Ende Gelände is not necessary. Thirdly, the name KING movement seems a better fit to integrate the work on alternatives to fossil fuel extraction, which Klein, too, considers to be part of Blockadia (Klein, 2014, p. 350). While the intention is explicit, the name defeats the purpose. If your very essence is blockading something, then any constructive work on alternatives lends itself to suspicion that it may be just an instrument to achieve ulterior motives, namely the actual blockade. The concept of a KING movement is inclusive enough for both activists by choice and by necessity, as well as allowing for other movement activities that have nothing to do with blockading, e.g. the work on eliminating fossil fuel subsidies or changing lobbying rules, and even lobbying work inside the “climate circus” of the UNFCCC which is slowly starting to bring supply-side issues onto government agendas.

2.3.2. Elements of the KING movement

Let me now turn to some elements of the KING movement, where previous academic works exist.

Divestment

Bill McKibben sparked the divestment movement with his “climate maths” article (McKibben, 2012) and a subsequent “Do the maths” tour. Besides some descriptive accounts of the movement (Grady-Benson and Sarathy, 2016; Bratman et al., 2016; Ayling and Gunningham, 2017), scholars have explored the moral case for divestment (Lenferna, 2018), asked whether divestment makes a difference for valuation of fossil fuel assets (Ansar et al., 2013; Ritchie and

Dowlatabadi, 2015), and explored its impact in other spheres (Rowe et al., 2016; Gunningham, 2017).

Yasuní

The Yasuní-ITT Initiative proposed by the Ecuadorian government in 2007 was a first KING effort by a government. For international help, Ecuador proposed to leave almost a billion barrels of oil in the ground, protecting extraordinary biodiversity and indigenous people in voluntary isolation at the same time. The Correa government withdrew the proposal in 2013, leading to the establishment of *Yasunidos*, a movement for the defence of Yasuní (Coryat, 2015). The proposal achieved wide international notability with calls to "yasunize" the planet emerging (Temper et al., 2013). A fair lot has been written on Yasuní, from descriptions of the proposal (Larrea and Warnars, 2009; Martin, 2011), economic analyses (Rival, 2010; Vallejo et al., 2015), a political science analysis (Milanez and Santos, 2016), to an analysis of discourse (Espinosa, 2013) and articles about what went wrong (Davidov, 2012; Pellegrini et al., 2014).

Coal

On coal, we have histories of the movement against mountaintop removal mining in Appalachia (Montrie, 2003; Howard and House, 2009) accounts of a lignite mining region in the Czech Republic (Frantál, 2016), the German *Ende Gelände* movement (Bosse, 2015; Bosse, 2017) and the movement in the US (Berg, 2014), as well as a look at the international movement (Cooke, 2010).

Tar sands

For the tar sands in Alberta, Canada, the argument has been made that activism killed the growth of the industry (McKinnon et al., 2015). Besides a more general description of the resistance (Gareau, 2016), different aspects have been examined, such as movement strategies (Haluza-Delay and Carter, 2016), criminalization of resistance (Le Billon and Carter, 2012) and the political science aspects of the struggle (Hoberg et al., 2012; Hoberg, 2013; 2016; 2018).

Fracking

The "global revolt against fracking" (Kinniburgh, 2015) is an important part of the KING movement. For a global image of resistance to fracking see the "Fractracker" map (FracTracker, n.d.). In the literature, we can find accounts of the resistance against fracking in Newfoundland

(Carter and Fusco, 2017), along with an anti-fracking mobilization toolkit for activists (Fusco and Carter, 2017), in Pennsylvania (Andrews and McCarthy, 2014; McLaughlin and Cutts, 2018), New York State (Klein, 2014, pp.273–274; Dokshin, 2016), the US in general (Negro, 2012), the UK (Nyberg et al., 2018), and France (Weile, 2014). People around the world have come together in yearly days of action called "Global Frackdown" since 2012 (Hopke, 2015; 2016).[2] Particularly interesting are accounts on framing, because we can see how a collective, global identity gets actively constructed, moving from a NIMBY (Not In My Backyard) to a NOPE (Not On Planet Earth) frame (Robinson, 1999). One of the Irish groups participating in 2018 chose their group name accordingly as "Not Here, Not Anywhere".

Australia

For Australia, Murray (2011) lays out the case for direct action on fossil fuels, and Rosewarne et al. (2013) describe the rise of the KING movement in Australia. Hutton (2012) draws lessons from the *Lock the Gate Alliance*, and Oakley et al. (2013) summarise a campaign against a new coal terminal.

Other literature

Some authors have summarised the global situation for the movement (Princen et al., 2013; Foster, 2013; Princen et al., 2015; Temper et al., 2020). Abramsky (2010) brings together a diverse set of actors engaged in various energy related struggles around the world, including many that aim at keeping fossil fuels in the ground in his edited book *Sparking a Worldwide Energy Revolution: Social Struggles in the Transition to a Post-Petrol World*. For example, Nnimmo Bassey (2010) argues that Nigeria would be better off keeping its oil in the ground and Osuoka and Zalik (2010) look at the challenges faced by Oilwatch Africa, one of the early networks with a strong KING focus.

With the exception of a toolkit for anti-fracking activists built on experiences in Canada (Fusco and Carter, 2017), there is relatively little in the way of literature to help replicate successful movement efforts. I aim to contribute to that field with a case study on how fracking was stopped in Mexico (section IV). One effort that could be considered a coordinated action of the KING movement were the international days of action *Break Free from Fossil Fuels* that were organised in 2016, 2017 and 2018 (Break Free, 2016; Greenpeace International, 2017; 350.org, 2018). Break Free was not conceived as an open, inclusive activity, but rather focussed on a

[2] The author participated in several previous editions and helped facilitate one in 2018.

limited number of countries with existing strong groups working on fossil fuel projects or with capacity to organise actions against them (Bates, personal communication). *Reclaim Power* is another initiative which has coordinated international days of action against fossil fuels between 2013 and 2018. Both initiatives have not yet been covered in the literature.

In theory, the *Rights of Mother Earth* approach, which considers the Earth and its life-support systems as a subject worthy of legal protection, could be a powerful ally of the KING movement. However, when the same governments who have these rights in their constitutions (Ecuador and Bolivia) promote extraction in Earth's most vulnerable environments, such as rainforest areas inhabited by indigenous people in voluntary isolation, and criminalise the opposition to such activities, it is hard to see how these governments could possibly be allies, not enemies of the movement (Lalander, 2014).

For understanding the KING movement's potential in acting as converter in the global carbonscape, a more thorough understanding of it is needed: A description of its history is lacking, as well as a description of its economic context in terms of oil, gas and coal prices, and a description of its political context with headwind or tailwind from different government administrations in different countries. We do not have an up-to-date mapping of actors who are part of the KING movement, nor a description of its ideological roots. We are also - and maybe most importantly - lacking a thorough examination of its successes. Klein has started this effort, talking about "early wins" of the movement (Klein, 2014, pp.300–304), also hinting at the usefulness of delays, as have Benedikter et al. (2016), naming some (then) recent developments. In conclusion, while there are articles on several diverse aspects of it, much remains to be done in terms of describing the KING movement and providing conceptual tools for guiding its journey to success in converting the global carbonscape.

2.3.3. Social movement impact and the KING movement

As laid out in more detail in section II, social movement *impact* theory ask whether and how social movements achieve their goals (Gamson, 1975; Piven and Cloward, 1979). It has examined questions such as whether violence makes a difference, how movements interact with political elites and how being organised increases the odds of achieving favourable outcomes. A key challenge of the field has been defining "successes" of social movements (Giugni, 1998). Following a request by members of the Global Gas and Oil Network (GGON), I developed the method described in section II of this thesis specifically to translate successes of the KING movement into terms of emissions avoided. This corresponds to both a real-life need for quantifying and communicating successes and to a gap in the literature on social movement impact with regards to this part of the climate movement. The article adds to impact theory an easy way to quantify successes of the KING movement.

The “political mediation” strand of movement impact research insists that movements need political operators and allies to implement their demands and goals in the political structure. “Windows of political opportunity” (e.g. Tarrow, 1996) which I reference and build upon in my third article (section IV) are just one of the key ways that this has been conceptualised in social movement studies. For the KING movement, however, political action (new laws and rules on a local, regional or national level) are just one among several pathways to success. The KING movement does not only drink from the well of politics. Law suits, physical blockades and chasing investors away are additional strategies that have the potential to delay and cancel fossil fuel projects, and once this happens, the ultimate impact question is very easy to answer for the KING movement.

Weick (1984) found out that “small wins” are helpful to maintain momentum in a movement. As Cheon and Urpelainen (2018, p.21) have pointed out, in this regard, the KING movement counts with favourable conditions in theory, because in each struggle against an individual project, there are usually several small wins (cancelling, delaying, getting others to speak out against the project). However, this cannot be expected to turn into “momentum” if there is no communication between the different parts of the movement. As explained above, for the KING movement, there is currently hardly a collective identity, and this holds back such momentum. Nevertheless, a dynamic of small wins, echoed and multiplied through global social media networks is an empowering vision for the future of the KING movement, already partly alive in the divestment movement today.

2.3.4. Economic windows of opportunity for fossil fuel projects

While for KING activists, it is one of the fundamental tasks to identify tactical points for individual projects, the geographic literature is mostly silent on the issue. Often, these tactical points correspond to geographic locations, but sometimes, they are located in specific administrative procedures, such as environmental impact assessments or in specific moments of the political process, such as elections. In the case of the political process, they have been conceptualised as *windows of opportunity*. In the Mexico case study (section IV), we introduce a new concept that borrows from the multiple streams model of Kingdon (1984), but turns the framing around for fossil fuel projects and into *economic windows of opportunity*. While in Kingdon’s model, a social movement would have to rely on an open window of opportunity to further its objectives, in our adaptation, it is the fossil fuel industry which needs several streams to combine to produce an open window of opportunity to move a project forward. The ups and downs of prices of oil and gas (Serletis and Shahmoradi, 2005; Ewing and Thompson, 2007) and to a lesser degree electricity lead to very different environments within the fossil fuel industry and constitute crucial business factors that merit an explicit consideration. In a more strictly political opportunity sense, different governments having different attitudes towards the fossil fuel industry are another important part of the context for KING movement efforts. Our concept of economic windows of opportunity brings two new angles to the conversation. Firstly the economic dimension, which carries much weight in a capital intensive industry such as fossil fuels. Secondly, it casts the fossil fuel industry's undertaking as the exception, and the stagnation of a fossil fuel project - when at least one window is closed - as the rule. This conceptualization of what is at stake in KING contests also makes it clear that delays may become wins, if they manage to push things back long enough for a window of opportunity to close.

To make best use of the opportunities provided by changes in government, it helps the KING movement to understand the political economy of the opponent and have ideas for driving a wedge into their lines with proposals that pitch them against each other (Denniss, 2015; Downie, 2019). Combining such an understanding with timescales inherent in the project itself (arranging finance, permitting procedures, hiring staff, etc.) constitutes very strategic information that can help KING activists concentrate efforts at strategic moments, as windows of opportunity for moving the project forward may constantly be opening and closing. In section IV, I intend to lay out the most important elements of this picture for a struggle to defuse a carbon bomb in Mexico.

This answers a call by Gavin Bridge (2018, pp.17–18) for energy geographers to focus more on the disassembly of the incumbent fossil energy regime. Instead of a merely descriptive stance, my aim is to provide the tools - appropriate conceptual lenses and strategic information - for that disassembly to be undertaken by the growing climate movement.

2.4. Carbonscapes and their instabilities

As for geographers' engagement with our issue of interest, we find no standard treatment of energy issues, but rather a field that has been labelled as *energy geographies* (Calvert, 2016).

In this field, *carbonscapes* are a useful concept that was introduced by Haarstad and Wanvik (2017, p.433) and defined as: “the spaces created by material expressions of carbon-based energy systems and the institutional and cultural practices attached to them”. *Instabilities of carbonscapes* point to the potential for change in these carbonscapes. The authors draw upon assemblage theory for their arguments. Assemblage theory allows the integration of material elements with social and cultural elements into one assemblage (McFarlane and Anderson, 2011). Opposed to rigid structures of systems, this theory envisions “entities without essence” rather than stable, organic wholes (Haarstad and Wanvik, 2017). Components of assemblages have “relations of exteriority” - the potential of being assembled somewhere else or in a different way. As long as they stay in their current, contingent assemblage, these will not be realised. But “deterritorializing” forces can drive them apart and “converters” can trigger a transformation of assemblages. Haarstad and Wanvik’s repertoire of converters consists of sudden oil price changes, resistance movements, geopolitical incidents, oil spills, “hot” policy ideas, transformative leadership, rezoning and technological innovation (Table 2, p.445).

The carbonscapes approach has only been used in a relatively limited number of works, analysing the brewing conflicts with local populations during oil extraction in Ghana (Siakwah, 2018), coal resistance in the UK and Indonesia (Brown and Spiegel, 2017), the converter role of a wildfire in the Canadian tar sands (Wanvik, 2019) and an article that explains how fracking happens in a water-scarce area with strong opponents: the rapid assembly and disassembly of the fracking assemblage allows its water use to go below the radar (Kroepsch, 2019). However, these works do not systematically explore the converters that activists can take into their hands. This is a gap I intend to address: producing knowledge on how to exploit fossil carbonscape instabilities. I also bring another - more global - perspective to the carbonscapes literature: strategically resisting, slowing and shutting down fossil fuel extraction projects on the most relevant fronts (namely the carbon bombs identified in section III) to transform the *global* carbonscape.

In understanding the material and cultural configurations of our fossil fuel-addicted societies, I have chosen the carbonscapes approach over others. One alternative would have been the *systems of provision* approach (Fine and Leopold, 2002) which aims to describe whole supply systems in different sectors. It allows to integrate economic and cultural factors, capturing the whole supply chain from extraction to the consumer. Being rooted in consumer theory, however, the emphasis is heavily on the consumer end of the story, trying to answer such questions as why demand is flexible in some sectors and not in others (Bayliss et al., n.d.). My main interest, on the other hand, lies on the extraction side. For oil, and increasingly for fossil gas, we have a global market, so extraction is not necessarily linked to consumption in a particular place. A global commodity can go anywhere and international prices are the key benchmarks driving extraction investment cycles. The further downstream we move, the more flexibility the oil, gas or electricity has to find new consumers should the current one(s) cease to buy, making interventions less and less effective. My interest is how these processes get disrupted, and in my research I therefore put the focus on the upstream portions of the carbonscapes in question. Together with its explicit focus on instabilities, the carbonscapes are thus a better fit for my objectives than the systems of provision approach.

To bring the rather impersonal energy geographies into dialogue with the social movements literature, it furthermore makes sense to look at carbonscapes through the lens of *agency*. KING activists are agents whose principal purpose is to transform a carbonscape profoundly, thus focussing on a decidedly human, purposeful “converter” that may destabilise a carbonscape. By focussing on such “resistance converters” as agents, in section IV of this thesis I will show how activists are transforming fossil fuel assemblages. Becoming more effective at defusing carbon bombs could turn the KING movement into one powerful converter for the global carbonscape.

3. Methodology

In this section I will discuss why a critical realism stance is best fit for my research objectives, explain how this research project draws on the traditions of scholar activism and finally introduce the methods I have applied to achieve my research objectives.

The work sits at the intersection of a few different disciplines and bodies of literature which all have shaped the approach: firstly, social movement studies, which analyse strategies and successes or failures of activists and include the political opportunity literature, an approach from political science; secondly, environmental science, which deals with questions of greenhouse gas emissions and how to conceptualise them, combining physics, chemistry and - in the specific case of fossil fuels - geology; thirdly, the carbonscapes approach from human geography which links the first two; and lastly, the activist & policy community that is advancing the agenda of “supply-side mitigation”, which is in itself an interdisciplinary field that combines environmental and political sciences, economics and energy studies. The last of these four fields has exerted the greatest influence on the questions and choices of this research, due to its urgent practical relevance to global climate change pathways.

Before looking at critical realism, let me begin with some remarks on quantitative versus qualitative research and how my research combines these two approaches.

I am convinced that my subject requires a good dose of quantitative understanding. My journey as a climate activist took an important turn when I asked a quantitative question in 2010 during preparations for the 16th Conference of the Parties to the UNFCCC (COP16): How many fossil fuel reserves are there and how do these quantities relate to global climate targets? Since then, the contradiction between the large quantities of fossil fuels that must stay in the ground, and the failure of governments and movements to stop the extraction of ever increasing quantities of them has been the key theme of my activism, and pathways towards resolving that contradiction is a key theme of this piece of academic research as well. Since 2010, many authors have made quantitative contributions to the field (see the literature review in the background section of the carbon bombs article, section III.2. of this thesis), but a lacking sense of scale of fossil fuel projects still prevails. We know that fossil fuels are bad, but how bad is a question that cannot be answered without quantification, at least when global climate change is our issue of concern. In order to make strategic choices on where to wage KING battles, the climate movement first needs a quantitative understanding of the problem. Through my literature review, I came to realise that a part of the problem lies in a lack of a method to quantify the emissions effects of KING interventions. If there is no good way to quantify, then quantification would remain rare. So I set out to create that quantification tool for my fellow KING activists. The result is the first article reproduced in section II of this thesis. My research therefore does not only take a quantitative approach, it even creates a method for others to do quantitative work on the climate movement and climate policy. My second piece of writing identifies the biggest fossil fuel projects on a global scale, using a very simple way of quantifying them. I know from my own experience that the field of climate policy is plagued by technicisms and models that only experts can understand - and this hinders engagement by wider audiences, as I discuss in section II. In order to untangle those complexities, rather than contribute to the problem, I kept the methods very straightforward and hopefully understandable for the lay activist in both cases where I went deep into quantitative terrain.

For my third research objective of identifying successful KING movement strategies, a quantitative approach was not fit for purpose, simply because there are so few wins of the KING movement to date. I initially intended to collect and map the successful instances of fossil fuels kept in the ground, just to find that the actual successes were very few and far in between. When there are not many cases to draw conclusions from, we need to learn as much as we can from the few available examples. Therefore I chose to explore one case of success in depth, this time with a qualitative lens. Because I am ultimately interested in generating useful information for people to achieve non-extraction of fossil fuels, I needed to find out what my colleagues in the Mexican Alliance against Fracking *did* that could be replicable in other geographies. And for answering that question, a qualitative approach, that uses the actors' world views, experiences and perceptions as starting points, seems to be the most useful strategy. I interviewed not only activists, but also academics, government and industry representatives to complement the picture of what activists did and what worked for them, with external perspectives on the situation, to understand where activists were perceived by other stakeholders as a force behind certain developments, as opposed to market forces, for example. This qualitative endeavour interestingly led back to a quantitative insight: oil and gas prices are a key ingredient of the windows of opportunity landscape in which the KING movement operates. My choice of quantitative versus qualitative methods was thus guided by the different questions at hand.

3.1. Critical realism

The philosophy of science I subscribe to and apply in my research can best be characterised as critical realism (Archer, 1998). This philosophy of science current, which is particularly present in the social sciences, combines a positivist idea about the existence of an objective reality with the relativity of historically and culturally situated heuristics for understanding the phenomena that are being researched.

I certainly consider some elements of my issue of research to exist independently of our observation, such as substances in the ground, e.g. coal or oil, or in the atmosphere, e.g. carbon dioxide, and that our numerical evaluations, however biased they may be, correspond to some kind of physical reality. The bedrock of climate change physics confronts us with the challenge of having to stop the biggest fossil fuel projects. And for that we need to be able to identify which ones are the biggest projects, not just which ones make the most noise in the media or are the most visible socially and culturally. In order to gauge if we are actually winning on a significant scale in a game where goals are scored in parts per million of CO2 in the atmosphere, we need a quantitative method to tell us where we are at. So while I recognize the constructed nature of carbon bombs and the KING movement and even the categories of "potential emissions", they correspond to physical realities of certain amounts of fossil fuels in the ground or pieces of infrastructure that are designed to process or transport certain amounts of fossil fuels. Here, I take a decidedly positivist perspective on the issue.

On the other hand, I appreciate the power of framing to transform perceived realities, and as such, constructivist approaches have great appeal to me. Identifying carbon bombs or a KING movement are very much constructions that I hope will help many people understand the world in certain terms and motivate them to specific actions - which in turn will transform the physical realities which I also assume.

For my case study of fracking resistance in Mexico, I use abduction, because we can observe that fracking has not advanced in the country. And there is a very active group that has stopping fracking at the core of its existence. Identifying a causal link between the actions of the Alliance and the failure of fracking in Mexico is not trivial, however, and the case study tries to identify parts of the picture that we can describe with confidence. This is the best we can do, and it needs to suffice to extract some replicable lessons that the KING movement can absorb to start winning faster.

Ultimately, I am most interested in the usage value of my scientific contribution. This may explain my pragmatic combination of approaches that originate in different schools of thought, but can each add value to our challenging undertaking of bringing about a swift end of the fossil fuel age, a goal that I pursue in both my research and my activism. This goal gives me clarity in evaluating methods against a simple measure: how much can they contribute? Ultimately, the judge am I, with my previous experience and beliefs about how the world works. It may sound disappointing to some more theoretically grounded colleagues, but my approach to scientific work is decidedly eclectic: if I can see value in a method and I believe I can master it, often also in collaboration with colleagues, to an acceptable degree, to produce an outcome that in front of my mind's eye makes a significant contribution to achieving my goal, I try it out. Sometimes I fail along the way, and sometimes I make it past the finishing line of a peer-reviewed article. But I would be lying if I said it all sprang from a coherent and systematic engagement with an immense body of literature on the philosophy of science. The roots may be shallow, but if the fruit is tasty, eat it. This is the best I have to offer to the academic community.

3.2. My positionality: scholar activism

The overall framework for my research is scholar activism. Geographers have been concerned with social justice issues since the 1970s and have actively participated in different forms of activism (Routledge, 1996). Especially feminist geographers have early on recognized issues of power and social responsibilities of scholar activists which put them in a particular role to make a difference 'on the ground' (Staeheli and Lawson, 1995). Scholar activism has developed practices aimed at social transformation, such as jointly producing knowledge with social movements that is more accessible and understandable, as well as actionable (Chatterton et al., 2007). Participating in activism has been one of the important methods of scholar activist geographers (Kindon et al., 2007). I have used an approach to developing research questions and agendas outlined by Derricksonand Routledge (2015, p.2) that they call triangulation. It involves asking research questions that 1) are rooted in actual struggles, 2) serve the publics, institutions and political projects of movements and 3) are the ones movements want answered. My research objectives arise from the battles I have been fighting in the KING movement against fossil fuel projects and companies, and in defence of a livable climate over the last decade and for the purpose of this PhD research were combined with the goal of furthering academic discussions around the climate movement, the supply-side mitigation landscape, measuring movement impacts and instabilities in carbonscapes.

After working with the Mexican government in 2010, which was presiding the UN climate negotiations that year, in 2011 I started the Leave it in the Ground Initiative (LINGO) and since then have been working on supporting struggles to stop fossil fuel projects and identifying potential game changers for the fossil fuel industry such as climate litigation, subsidy reform, central bank mechanisms, grassroots activism and trade agreements, among others. As an observer to the UNFCCC, a participant in a variety of civil society campaigns for climate ambition (including the Mexican Alliance against Fracking), and a climate educator working in a number of countries (Mexico, South Africa, Brazil, China, Indonesia, Germany, DR Congo), I have gathered diverse perspectives on climate activism and policy from different vantage points. For this research, I thus drew on my personal experiences from international climate negotiations, business and entrepreneurship, NGO campaigning, national governments and grassroots activism. I have never stopped to consider myself a climate activist, even when joining the spaces and adopting the language and conventions of the abovementioned communities. My background and previous experiences with climate change policy and activism have strongly influenced the way I have approached my research, the questions I have asked and my notion of what I considered potentially useful contributions to make. To “do good on participants terms” (Wynne-Jones et al., 2015) is an important principle of participatory action research. Whether I have managed to implement this principle well will have to be judged by my KING movement colleagues.

Decolonisation is a slow and ongoing process and studying at a British university automatically immerses one in this ongoing struggle. Even though I did not start with a keen eye for colonial dynamics, living and working in Mexico and other countries with people from all walks of life, from national government officials in the capitals to indigenous communities, academics, business people, social movements and organisations for the past decade and a half, I hope to bring some cultural sensitivity to the task and allow the perspectives of my non-Western, and here - due to my case study - especially Mexican, colleagues and allies shine through and thus contribute to the decolonisation of the body of knowledge I am helping grow.

In identifying valuable research objectives under the more general question of “how to keep fossil fuels in the ground”, I discovered a gap in methods (article one on “KING metrics” reproduced in section II), a gap in the quantification of our challenge (article two on “carbon bombs” reproduced in section III) and an important qualitative question on how we are winning our struggle against a carbon bomb in Mexico (article three on the “Mexico case” reproduced in section IV of this thesis). The first two were desk-based undertakings (well fit for the COVID pandemic at the time) and the latter required my continued participation in the activities of the Alliance and a number of interviews to deepen and complement activist perspectives. I am actively involved in my Mexican case study, the efforts to prohibit fracking in Mexico since LINGO is a member of the Mexican Alliance Against Fracking since 2015. Similar to Russel (2015), I did not perceive a distance between me as a researcher and my colleagues as the “object” of my research. I fully subscribe to his notion of creating tools for transformation via research. However, in contrast to him, I would not like to call myself “militant researcher”, because military analogies can sometimes backfire. Having chosen just such an analogy for my second article (carbon bombs), I did my fair share of reflection on the pros and cons of such an analogy and when selecting a label for myself, I prefer scholar activist, or “third space” (Routledge, 1996) scholar, which means that my work aims to contribute to both activism and academia.

One might argue that some of the pieces of research could have been undertaken without wearing a scholar activist hat. However, stepping fully out of an activist role and into a scholar role, without any second thoughts about “how does this help the struggle?” would not come naturally to me. In fact, it would feel counterproductive, because it would take away time from my activism in times of a climate emergency, without giving something valuable back. Therefore, my personal standard is that my academic contributions in the field must always be useful to the cause. I see my roles as activist and academic as highly synergetic: my deep involvement with KING activism gives me a deep pre-existing knowledge of the field and its dynamics, and a network of contacts which would be impossible to acquire when just starting out in the field. My role as PhD student (with a scholarship) gave me the possibility to dedicate myself fully to KING movement issues without needing to worry about securing funding and feeding my family. At the same time, the structured scholarly approach led me to consciously choose very strategic questions and be thorough in collecting the data to answer them, as well as rigorous in considering alternative explanations for my findings, resulting in reliable and comprehensive information for our movement.

3.3. Research design

I will now give an overview about the general design choices made in the research. This chapter is to be read together with the respective methods sections of the articles (sections II, II and IV) which give more detailed information about the methods applied.

3.3.1. Methods used

I used five common methods, which I will briefly describe in the following, along with custom-made new methods which I will detail further in section 3.3.2.

Literature review

Reviewing the existing literature on and around a topic of interest characterises the first phase of any academic engagement, and it allows scholars to build upon the foundations laid by previous authors. I single this out as an important method, because it might seem counterintuitive that there would be no global mapping of the biggest fossil fuel projects in the world and no method for quantifying the impacts of fossil fuels kept in the ground. My literature reviews confirmed those gaps, which I was aware of from previous years of activism, and allowed me to identify the works that were most closely related to these two basic questions. For my first article on KING metrics (section II), I critiqued existing emissions accounting methods and showed that they are not yet fit for the purpose of helping the KING movement show its climate impact, mainly due to being too unwieldy for a wide application by practitioners.

For the carbon bombs paper (section III) a literature review of available emissions factors was fundamental, because this allowed me to build on the work of well-established institutions and complement only those pieces of the picture that were lacking for accomplishing the task of a globally comprehensive mapping of the biggest fossil fuel projects.

Case study

Case studies are an appropriate method in the social sciences, when *why* or *how* questions are asked, when we have no control over behaviour and when we are dealing with contemporary phenomena (Yin, 2017), all of which applies to my research on the Mexico case (section IV of this thesis), where I took the following methodological steps:

1. Description of preliminary understanding of activist strategies
2. Desk-based review of literature and documentation (see next method)

3. Preliminary case timeline
4. Preliminary hypotheses on activist strategies in the case
5. Interviews
6. Completing the timeline
7. Description of activist strategies

I considered the following criteria for choosing a case study: fuel type, conventional vs. unconventional, development stage, significance on a global scale (GtCO2), Global North/South. The carbon bombs analysis confirmed the significance of the Mexican Eagle Ford Shale on a global scale: it is among the top 50 fossil fuel projects worldwide. My familiarity with the case, it being a new project that has been kept from starting up so far and being in the under-researched Global South facilitated the choice.

The choice of this case study has some implications for generalizability: fracking for shale oil and gas is a relatively new technique, as described in more detail in the case study. The temporal, spatial and financial dynamics of fracking projects are quite different from conventional oil and gas projects and as such, and whereas other fracking projects - of which there is a significant number on the list of carbon bombs (Appendix 1) - may be similar to the one in the case study, it would be hard to generalise findings onto conventional oil and gas projects, or coal mines.

Desk-based/archival research

Desk-based or “archival” research consists in searching established databases and/or the internet for specific pieces of information. This is useful when there is previous work available, particularly in grey literature, as is common in my field of inquiry. In some cases, the best available databases consisted in my own previous collections of material, e.g. on successes of the KING movement in stopping fossil fuel projects, on non-academic attempts at quantification of the impact of such successes (both for the article on KING Metrics, section II) and on background information about fracking in Mexico (for the Mexico Case study, section IV).

I complemented my own knowledge base with internet searches that turned up additional work which had escaped my attention and then further complemented this with emails to knowledgeable colleagues in their fields in order to find additional cases of KING movement successes. However, results were so sparse that I decided to do a deep-dive into one of the few examples rather than a wider mapping of cases, as I had initially envisioned to achieve my third research objective of understanding KING successes better. In this kind of research, there is a trade-off between depth and thoroughness and time investment which is important to keep in mind for a PhD student with limited capacity. My decade-long engagement meant that I was already aware of the most significant developments in the field, so a thorough process, starting from zero in a systematic way, would have turned up many results which I was already aware of. Doing such desk-based research in a very structured and thorough way, for example on successes of the KING movement, would have taken up the lion’s share of my time budget, and I chose not to do this in favour of other research objectives. As my research progressed, Gaulin and Le Billon (2020) and Temper et al. (2020) published overviews of cases of resistance against fossil fuel projects, providing a good basis for future research. These multi-author articles also confirm my idea that it would have been a research project of its own to establish these baselines of KING activism.

For the Mexico case study (section IV), on top of the standard internet search of related terms, I reviewed many documents mentioned by my interviewees.

Interviews

Interviews are a method used for qualitative research (see discussion above). Closed questions allow eliciting certain information that we know beforehand to exist and that is relevant to our research objective, while open questions invite interviewees to elaborate on something where the structure of the information is not entirely clear beforehand. This was the case for my objective to understand effective strategies of the Mexican KING resistance better, so I used a semi-structured interview with mostly open questions to guide interview partners through a conversation that focused on the historic development (and stalling) of fracking in Mexico, the strategies of the KING movement and its impact. The interview guide is reproduced in Annex 4.

A semi-structured interview has a few drawbacks. It requires more skill on the part of the researcher to focus the conversation on topics of interest for the research and of expertise for the interviewee. It also requires more preparation to identify beforehand what the respective interviewee would best be able to talk about. Lastly, its responses are not as easily quantifiable as those of a structured interview and one relies more on the perception of the researcher to match responses with existing constructs and hypotheses. Also, the “saturation point” where responses repeat known information and fail to bring new insights is a relatively subjective matter. Methods to more objectively identify that point have only recently been developed (Guest et al., 2020). However, the extra work was manageable and together with my supervisors, who became co-authors on the paper of the Mexican case study, we decided that the insights from the interviews were enough to warrant submission to a journal. The article reproduced in section IV will be submitted to *Environmental Politics* in early 2023. My sampling strategy is summarised in Table 2. Activists were divided into two categories, those who are active on a national scale and participate in the media and policy circuits in Mexico City, and those more active on a local scale in one of the states where fracking activities were happening or proposed. Prior to the interview, I shared a consent form and a participant information form elaborated according to guidelines by the University of Leeds with my interviewees and maintained their anonymity, as requested by some of them.

Universe	People who understand the issues and have knowledge of fracking projects.
Sample size	min 20, max 30. There is only a small number of people who understand the issue.
Strategy	Quota sampling, aiming for at least 3 participants from different sectors: 1) national-level activists 2) local-level activists 3) government 4) industry 5) research Snowball: ask participants for further recommendations.
Sourcing	Personal contacts, recommendations from interviewees and my network, cold approaches via email.

Table 2. Sampling strategy for the Mexico case study (section IV of this thesis).

Participant observation

Many scholar activists before me used participant observation to gain insights into the struggles they wrote about (see e.g. Kindon et al., 2007; Chatterton, 2008; Russell, 2015; Derickson and Routledge, 2015). In my case, continuing to participate in the Mexican Alliance against Fracking, where my organisation had already been a member for four years when I initiated my research in 2019, was an obvious choice. I wanted to understand what we did, how we did it and what was effective and what not, and for that, I expected that being a part of the struggle would give me a vantage point for observing how a Mexican carbon bomb got defused. In the end, I found out more new and interesting things via the interviews than via participant observation. However, the Alliance activities often consisted in discussing different strategies, approaches and pieces of information and how they fit into the bigger picture. Often, these discussions are followed by publications of the Alliance. Therefore, it did not seem as if the participation with the Alliance had given me any information that could be considered that of an "insider", because in the end, I was citing publicly available material. But dealing with these relevant topics over and over certainly helped me get a solid map of the issues and an understanding of how different dots connect and thus made me more effective at asking specific questions during my interviews which then did result in new insights.

3.3.2. Methods development

As mentioned before, there was no readily available method for quantifying emissions avoided, or "carbon kept in the ground" when I set out. In GGON, where I started participating in 2019, the question of how to measure the success of efforts to end oil and gas burning was already present. Together with colleagues from the Stockholm Environment Institute and fellow NGO Global Energy Monitor (GEM), I developed the idea of carbon metrics to measure fossil fuels kept in the ground. Part of my preparation to develop a method to calculate KING movement impact was to analyse existing quantification approaches and their shortcomings. This included accusations against the KING movement in an industry report (Global Energy Institute, 2018) and court proceedings against activists who had effectively stopped a coal power plant (Connolly, 2019). The work consisted of collecting and processing different emissions factors, understanding them and analysing which ones would be reasonable to use as averages/standards and which ones were more niche applications. I corresponded with several KING movement colleagues in the process, and thus call it an instance of co-design in the article (section II). In the process of understanding how different KING movement efforts could be mapped onto quantifiable emissions measures, three different categories emerged.

Another concept that I created to mentally grasp the entity we are dealing with in the KING movement, is that of "potential emissions". This is a counterfactual. If the project were to go forward, it could result in this amount of emissions. However, because we are interested in stopping it, we do not need excessive precision in the estimates, which allows for simpler methods. The potential emissions counterfactual is also much simpler than other counterfactual assumptions, such as for example the assumption of “additionality” which plagues carbon offsets (Mason and Plantinga, 2013).

The definition of a carbon bomb as a fossil fuel project bigger than 1 gigaton of potential CO2 emissions was also an experiment in a sense. One could in theory use any other size threshold as well, a gigaton simply seemed like an easy-to-communicate figure. My concerns here were that the resulting dataset would not be too small, with just a handful of huge projects in a small number of countries, and not too big, with thousands of projects located everywhere in the world. The output turned out to be in a useful ballpark: the resulting list is not too long, so as to be overwhelming, with the exception of Chinese coal, which even to me as a sinologist and China lover looks quite overwhelming, and not too short, excluding a big number of struggles where people are actively fighting. The reader finds it reproduced in Appendix 1 of this thesis.

For identifying the biggest oil and gas projects on a global scale, we used the commercial database provided by Norwegian industry analytics company Rystad. Rystad data is not perfect. Their definition of a “project” which we simply took over for the paper includes things such as whole shale basins with many different companies active in the United States, whole regions in Russia, or all unexplored open acreage in a country. We decided not to unpack this diversity, in order to be able to present a global picture in a reasonable processing time. Individual figures have been flagged as problematic in some cases by movement allies since publication and we have also been asked about the exclusion of certain projects. This was usually a consequence of Rystad counting things as separate “projects”, or because the sum of potential emissions stays below a gigaton. Such are the cases of the Scarborough gas project in Australia that threatens marine biodiversity and important cultural heritage and the Tilenga field in Uganda which shall feed the highly contested East African Crude Oil Pipeline. While the cut-off is very clear in our research, I have informally encouraged movement colleagues to call these projects carbon bombs anyway, because our academic analysis did not establish a copyright on the term, and if the framing is helpful for their struggle, they should use it.

3.3.3. Data collection

Carbon Bombs

A key challenge for identifying the biggest fossil fuel projects in the world is data availability. A first version of a global “fossil fuel registry” was just launched in September 2022 (Global Registry of Fossil Fuels, 2022), but it is only partial, because it relies exclusively on public sources (West, personal communication). In order to answer the question on the biggest fossil fuel projects globally, I started with informal inquiries with colleagues working in the field and discovered that the data situation is very confusing, turning the answer to such a simple question into a worthwhile enterprise for a scholar activist whose subsistence is covered in order to enable him to answer difficult, non-trivial questions and go onto lengthy data collection missions - in cyberspace in this case.

For coal data, I enlisted the help of several volunteers to perform a bottom-up screening of national geographical services data in all nations that have coal. After working on this for several months, we already had a good database for most countries, but some - such as China - still proved hard to process. I was then made aware of the work of a team at GEM which was preparing the launch of the “Global Coal Mine Tracker” (Global Energy Monitor, 2021) - the first globally complete dataset of the biggest coal mines. Through a helpful exchange with the colleague leading that work, we discovered the complementarity of our work and the GEM colleague agreed to become a co-author of the carbon bombs paper. We cross-checked our bottom-up database with the unpublished Global Coal Mine Tracker and realised that for the countries we had finished, our results were practically identical. This validated the result of our work, as well as giving us confidence in using the tracker as data source for the remaining countries we had not processed previously.

For oil and gas, the picture is somewhat clearer, but hidden behind a paywall. Only with paid access to the commercial and proprietary Rystad database can one get a globally complete and detailed picture of reserves and extraction figures for oil and gas. Once again, I was lucky enough to secure the help of a colleague from the organisation Urgewald which has access to the Rystad database (something that even the University of Leeds which has both world-leading climate scientists and a strong foot in the field of oil and gas doesn’t have) as a co-author for the paper, which allowed us to use Rystad data for the carbon bombs analysis (section III) under their existing subscription. The key work was fine-tuning the data request with the Urgewald colleague.

Mexico case

Between 2019 and 2022 I invested 240 hours into participating in the different activities of the Mexican Alliance against Fracking, including a number of zoom calls (the Covid pandemic fell into this time) and two in-person Alliance meetings. Whenever I spotted a new contribution towards answering my research questions, I added these to my notes. In the end, the interviews I conducted brought out many more additional pieces of information for me and other Alliance members with whom I shared my advances in understanding informally and formally through a presentation at one of our assemblies, and via sharing the draft article resulting from my research. However, I would likely not have started at the level of understanding of fracking in Mexico that I did if I had not already been part of the Alliance during several years. As such, the preceding years can also be considered an important preparation for the research, even if the participant observation during the research period did not bring out many new issues.

For further information on the data collected, please refer to the respective articles in sections II, III and IV.

3.3.3. Data analysis

For the KING metrics article, the main tasks of data analysis consisted in applying my new method to actual use cases. These examples are reproduced in the first article (section II).

For the list of carbon bombs, some analysis needed to happen to relate our list of carbon bombs with current questions of climate policy. This is discussed in the article (section III).

In the Mexico case study, the main analysis task was to review the transcribed interviews and identify pieces of information that spoke to our hypotheses, helped frame them, furnished evidence or posed challenges to our interpretations. The relevant passages from the interviews are cited directly in the text in the article (section IV).

In Table 3 below, I give an overview of the different methods I used to meet my research objectives.

Research Objective	**Subquestions**	**Data collection**	**Data analysis/generation**
Establish a method to quantify the impacts of	How can we quantify the impacts of KING activism?	Survey of existing emissions quantification methods (literature review)	Analyse scope and shortcomings of existing methods

efforts to keep fossil fuels in the ground		Identify examples of non-academic impact quantifications (desk-based research)	Analyse scope and shortcomings
			Generate new method with three categories, definition of “potential emissions”
	How can we close the “usability gap” for a new quantification method?	Collect examples of quantifiable KING successes online through web search, emails to colleagues	Apply the method to real-life cases and improve it, based on the experience; Generate standard emissions factors for typical use cases; Publish the relevant table of the paywalled article publicly on the LINGO website
Identify the biggest fossil fuel projects on a global level that KING activism should target	Which are the biggest fossil fuel projects in the world?	Rystad database (oil & gas), Bottom-up collection from national geological services, Global Coal Mine Tracker (coal), Literature search (emissions factors)	Generation of a carbon bomb definition; Applying the definition to the dataset; quality control on the output
	Where are these projects located?	Rystad database (oil & gas), Bottom-up collection from national geological services, Global Coal Mine Tracker (coal)	Calculating country figures and identifying globally significant clusters
	What is their state of development?	Rystad database (oil & gas), Bottom-up collection from national geological services, Global Coal Mine	

		Tracker (coal)	
	How big is their potential contribution to climate change?	Rystad database (oil & gas), Bottom-up collection from national geological services, Global Coal Mine Tracker (coal); IPCC report, Literature search (emissions factors)	Generating definition of “potential emissions”; Comparison with IPCC carbon budget
Investigate the strategies that the climate movement has used to successfully achieve supply-side mitigation	Where have KING activists successfully stopped fossil fuel projects?	Emails to colleagues	Screening question for selection of the case study
	Which strategies did the Mexican anti-fracking movement use?	Interviews, desk-based research, participant observation	Reviewing interview transcriptions, generating a list of strategies
	How effective were these?	Interviews, desk-based research, participant observation	Matching significant milestones of the struggle with strategies
	Which political and economic factors have contributed to stopping fracking in Mexico?	Interviews, desk-based research, participant observation	Reviewing interview transcriptions for factors mentioned

Table 3. Research objectives, sub questions and methods

After exploring the context for my research, the literature upon which it builds and with which it engages and the rationale for the methods I have applied, we will now turn to my results. In the following chapters, the reader will find three separate articles, two of which have already appeared in journals. The first one lays out my new method for quantifying the emissions impacts of KING efforts, the second one maps the global landscape of the biggest fossil fuel projects (carbon bombs) and the third analyses how one such carbon bomb is being defused in Mexico. A final chapter will bring these three articles back together in a critical discussion.

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II. Big numbers for bold activists: A quick method for estimating potential emissions of fossil fuel projects.

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Abstract

Due to the failure of reducing global greenhouse gas emissions with demand-side measures alone, in recent years, supply-side approaches to climate change mitigation have garnered increasing attention. But so far, there are few established ways to quantify the impacts of supply-side mitigation strategies. In order for supply-side mitigation to be perceived as an effective means to climate ends, activists and decision-makers alike need to show its impact in comparison with demand-side measures. While emissions accounting is a prolific field with many precise - and complicated - methods, we lack straightforward methods that are readily understood by more than a small group of subject experts. In order to make the conversation about carbon kept in the ground accessible to a wider audience, I propose quantification methods for the emissions impacts of stopping fossil fuel projects. The nature of the fossil fuel supply chain requires distinguishing three different kinds of interventions and the methods I propose result in a baseline estimate of the potential emissions impacts for each of them using widely available fossil fuel reserve figures and nameplate capacity figures of fossil fuel projects. I explain these methods in detail, discussing conceptual issues and including some caveats to their application and apply them to real-life cases. I point to how the estimates generated with these methods can be used as a basis for gauging the impact of the Keep it in the Ground movement, as well as an input for performing more sophisticated analyses.

1. Introduction

In early 2019, German coal giant RWE demanded compensation for damages of over 2 million Euros of five activists who had blocked one of their coal power plants for several hours to protest the continuing burning of lignite in Germany at the beginning of the UN climate summit in Bonn [1]. What RWE may not have considered is that unwittingly, they prepared the ground for more people getting interested in direct action against coal infrastructure. If the damage to the coal company is so big, this kind of activism must be very effective. The ensuing discussion in court about how much of an impact on actual coal burning the action had points to a wider issue: quantifying the emissions impact of efforts to keep fossil fuels in the ground is far from easy, as no standardised methods exist.

I lead an organisation that works on keeping fossil fuels in the ground. In my activist work I have repeatedly had to invest hours and days to make my way through complex technical reports to understand the emissions implications of the fossil fuel projects I was trying to stop. As an activist scholar, I have processed the academic literature and calculated average emissions factors that can be used by anyone to estimate potential emissions for a project with reasonable accuracy. With this work, I hope to provide a useful tool for my activist colleagues.

As the United Nations Framework Convention on Climate Change (UNFCCC) and governments have been struggling to turn the tide on global emissions [2], one key shortcoming of the current climate change mitigation approach that has been pointed out by different authors is that it addresses fossil fuel extraction insufficiently [3,4]. A growing number of scholars working on “supply-side mitigation” and a movement that aims to “keep fossil fuels in the ground” [5] have set out to close that gap. So far, they have rarely managed to translate the impacts of their actions and policies into the mainstream emissions language. With this article, I show how three different kinds of supply-side measures can be quantified in emissions terms, thus providing the tools the supply-side community needs to be able to make their efforts visible to the mainstream climate community and comparable to other efforts. As I shall explore in more detail, being able to measure the impact of a movement with a simple and straightforward indicator is a fortunate situation and quite unique in the field of social movement studies.

Global greenhouse gas emissions have increased over the past three decades in spite of intensive negotiation efforts and by 2020 25 editions of the annual COPs (Conferences of the Parties to the UNFCCC) [6]. One of the reasons that has been pointed out is the failure to reign in fossil fuel supply [7]. This “supply side” of the mitigation challenge has been receiving more attention over the past few years with various authors arguing that fossil fuel extraction needs to be addressed [3,4,8]. Recently, the United Nations Environment Programme pointed to the “production gap” between fossil fuel extraction and climate commitments [9]. While governments pursue ambitious climate targets, they keep fossil fuel projects running at the same time and the gap between what could be emitted under the targets and what they are planning to extract is large. While the literature on supply-side mitigation is growing and adding more detail about different policies [10], dynamics in “first mover” countries [11] and equity questions [8,12], one shortcoming so far has been a lack of quantification of the emissions impact of supply-side policies. One challenge is that global energy markets exhibit complex dynamics that take expert knowledge to understand and assess. In the absence of a simple method that can be used by a wider range of stakeholders, a quantification of the emissions impacts of stopping specific fossil fuel projects remains the exception, rather than the rule. While I do not aim to capture these complex market dynamics in this article, I do aim at providing a tool that can quantify the “push” that a fossil fuel project exerts on the energy system in a standardised way which I call potential emissions.

Even though quantification has proven challenging, still action against fossil fuel projects for climate reasons is a growing phenomenon [5,11] which I call the Keep it in the Ground (KING) movement.[1] It largely overlaps with what Naomi Klein has called “Blockadia” [13], Georgia Piggot has characterised as “supply-side movement“ [14] and Cheon and Urpelainen name “campaigns against fossil fuels” [15]. The KING movement comprises those actors who strive to stop fossil fuels (coal, oil and fossil gas in all its forms) from being extracted, transported and burnt or turned into short-lived products (e.g. plastics, fertiliser). Examples include NoTAP, Ende Gelände, WeShutDown and actors assembled in coalitions such as the Global Gas and Oil Network (GGON), Beyond Gas Network, International Coal Network and Oilwatch among others. Those working on alternatives to fossil fuels, fossil fuel finance and divestment, litigation against fossil fuels and fossil fuel subsidy reform, among other strategic approaches [16] are also included. Because there are joint efforts, such as the Break Free from Fossil Fuels [17] or

[1] Instead of KIITG or KIIG, I use the abbreviation KING which is much easier to pronounce.

the Reclaim Power and Rise for Climate coordinated action days, the term movement is more appropriate than campaigns. Blockadia has negative connotations and could stigmatise movement members, and supply-side movement is a technical term that does not appeal to activists. Therefore I apply the new term KING movement. The mitigation impacts of the KING movement have not been thoroughly examined and even less quantified, due to a lack of methods for quantifying avoided emissions through KING movement efforts.

In order for supply-side mitigation to be perceived as an effective means to climate ends, practitioners need to show the impact of its activities and ideally be able to compare them with demand-side measures. I propose a practical, standardised way to quantify the potential CO_2 emissions impact of supply-side mitigation measures that have so far been difficult to quantify and only sporadically and inconsistently been quantified at all. I expect efforts towards keeping fossil fuels in the ground to intensify in the future. Gaulin and Le Billon [10] have shown an increase of such activities over recent years, and in a situation with a large fossil fuel “production gap” [18] and a growing number of climate emergency declarations around the world [19], I expect this trend to continue. The methods for quantifying the impacts of such activities proposed in this article could become widely used in the climate movement and as a tool informing climate policy, making this a timely and constructive contribution to the global response to the climate challenge.

I will start by reviewing existing methods of emissions accounting, with a special focus on understandability, as well as previous attempts at accounting for supply-side mitigation outcomes. I briefly touch on social movement impact literature, because my methods may provide useful information for standardizing the way the KING movement measures its impact. I then go on to present three methods for quantifying the potential emissions impacts of supply-side mitigation activities within a clearly delineated and simple framework: 1) non-extraction of fossil fuel reserves, 2) delays or cancellations of new pieces of fossil fuel infrastructure and 3) temporary stoppage of already operating fossil fuel projects. I focus on average emissions factors and main effects, providing a table for quick reference in each of the categories. In the discussion section that follows, I review secondary effects not included in my model that those looking for more detailed figures may want to take into account and discuss the limitations of the methods.

2. Counting emissions

At the international level, the current standard approach towards emissions accounting measures and compares emissions per year that have occurred in a specific territory. The Intergovernmental Panel on Climate Change (IPCC) has published guidance for countries on how to report their emissions to the UNFCCC [20]. This is a choice of one option - namely focussing at the “end of the pipe” - over other alternatives, such as consumption-based [21] or extraction-based emissions accounting [22]. Estimating annual territorial emissions is not an easy undertaking as it requires extensive and detailed statistics and inventories. There are five global emissions datasets (IEA, EIA, CDIAC-FF, EDGAR and BP) with slightly differing methodologies which generate their estimates on the basis of energy datasets from IEA Energy Balances, BP EIA and the UN Statistics Division. [see 23 for an overview] Another choice implicit in this approach is to focus on the flow of emissions per year, and not the cumulative amount, an alternative that has been suggested by proponents of the “carbon budget” approach [6,24]. The latter relates well to the physics of climate change, because long-term climate change depends more on cumulative emissions than a particular amount in any given year [25]. Since staying below 2°C or 1.5°C warming is the key objective of the Paris Agreement, checking the progress of mitigation efforts against the dwindling carbon budget is necessary and useful. However, because the UNFCCC functions via consensus, it is hard to introduce a new approach that would profoundly change things - and up to 2021, neither consumption-based, nor extraction-based accounting, nor the carbon budget approach have seen a breakthrough at the UNFCCC. Still, carbon budget figures have been reported in the latest IPCC reports [26,27]. For the moment, these figures do not lend themselves to ready translation into mitigation policies measured in emissions per year. But as the question of “keeping carbon in the ground” described further below becomes more prominent, a reevaluation of numbers through the carbon budget lens might take place. The first of my methods is especially compatible with that approach and might facilitate a reevaluation of the mitigation picture in light of the relatively simple account of cumulative emissions [28–30].

Linking annual territorial emissions data to climate targets is even more complicated. The UNFCCC’s ultimate objective of preventing dangerous anthropogenic interference with the climate system [31 Article 2] has been operationalized via a temperature target in the Paris

Agreement, but yearly emissions can only be put in relation to this temperature target via complicated scenarios with a large set of assumptions. A key tool for translating climate science for policy making have been Integrated Assessment Models (IAM). The challenges associated with the use of these tools have long been pointed out [32], such as hiding their assumptions in the fine print [33] and a complicated relationship with issues of uncertainty [34]. In general, the basic predicament is that only experts really understand what is happening "under the hood" of the scenarios used. The Emissions Gap report published by the United Nations Environment Programme each year since 2010 [e.g. 35] which tries to make the issue more relatable by contrasting a scenario that calculates the emissions reductions pledged by countries with a scenario that would meet temperature targets, thus quantifying an “emissions gap” at different points in time, is no exception to that situation. Emissions accounting being an expert-driven domain with little chance of laymen to even understand the basics may result in misunderstandings and misrepresentations of climate science, as is apparent for example with the widely quoted “12-year” deadline supposedly set by the IPCC which results from multiplying recent annual CO_2 emissions to arrive at the carbon budget for 1.5°C temperature rise, which is controversial [36]. A similar “usability gap” between producers and users of information has been shown and discussed in the related field of climate change risks by Lemos et al. [37].

The question of suitability lingers over any efforts to use a numeric language which I call “emissions language” to express climate change dynamics [38]. The academic literature on narratives and framings of the climate question has focused its attention on storytelling [see 39 for a good overview], sparing emissions language from a closer examination so far. What can be said is that emissions language is not very easily processed, as carbon emissions are invisible [40] and people get easily confused [41]. Initiatives focussing squarely on reducing carbon emissions rely on a number of lexical strategies to translate carbon emissions into more understandable ideas [42].

2.1. Existing emissions accounting methods

Before we explore the new methods I propose, let us take a look at other existing methods and their potential for bridging the emissions accounting expert - climate community gap.

For companies, there is the widely accepted *Greenhouse Gas (GHG) Protocol* [43] which specifies how companies should report their emissions. The protocol has been developed by two non-governmental organisations in an intensive multi-stakeholder process and provides detailed guidance to companies on how to count their emissions. In the absence of governmental regulation on the topic, this protocol has developed into a widely recognized global standard [44]. Using the GHG Protocol is a field of expert knowledge and following these guidelines needs financial resources and specialists to complete properly as well as the voluntary participation of companies.

The widespread "*carbon footprint*" approach [45] is normally based on lifecycle analysis, process analysis or input-output analysis for arriving at estimates of CO_2 emissions for certain activities or entities, or even products. For individuals, there are many offerings of online calculators, providing a relatively easy-to-understand solution for the household level or for trips. Carbon footprints are the closest to my ambition of an easy-to-use indicator of emissions, and have been calculated for a variety of applications, such as coal-fired electricity in China [46], fossil-fueled electricity in Iran [47], upstream emissions of different kinds of gas extraction [48] or a whole chemical plant [49]. Whitaker et al. [50 fig. 1] have mapped the complexity of the life cycle for coal-fired electricity and standardised parts of it. However, the vast variety of different methods used and lack of standardisation in most spheres make it difficult to understand what is included in each case [see 51]. So while carbon footprints are not the end of the discussion, for the estimation of Liquefied Natural Gas (LNG) terminals' emissions in this paper I do build on the results of Alvarez et al. (2018) [52] who aim at capturing the average carbon footprint of the gas supply chain in the US.

The described approaches are comprehensive in their coverage of their specific target (countries, companies, products, etc.), yet they are too complex to allow the wider climate community to interpret new data without relying on intense work of experts. In the quest for useful ways of measuring the emissions impact of efforts to keep fossil fuels in the ground, I will therefore try to strike a balance between accuracy and understandability that makes some controlled concessions on the former and aims for a higher level in the latter.

Limiting fossil fuel production has been called "the next big step in climate policy" [4]. When undertaking that step, as mentioned, indicators of progress are needed to establish

effectiveness of the approach. One indicator is whether extraction plans are getting in line with annual emissions permissible under the emissions scenarios mentioned above. This is the approach taken in the "Production Gap Report" which translates one of the approaches not chosen - that of the extraction lens of emissions accounting - into the habitual emissions per year language of the UNFCCC process [9,18]. However, this approach is not easily compatible with the carbon budget approach mentioned above, because very different pathways - and resulting annual emissions - may result in the same overall carbon budget. But the carbon budget approach is preferable as a reference due to its closer match with the response of the global climate system than annual emissions. Another advantage of the carbon budget approach, particularly as viewed through the supply-side, “keep it in the ground” lens is that reserves figures are more definite than the parameters used in current emissions scenarios. In a sense, it turns a hypothetical scenario, an intellectual exercise with a mathematical model with many associated challenges and opportunities for misuse [53] into a concrete and physically tangible question of barrels of oil and tons of coal that will either be extracted or they will not. I contend that this framing is much easier to grasp for the human mind than the current mainstream approach described earlier. It makes it clear that each ton of fossil carbon extracted from the ground in one place means an additional ton needs to stay underground in another. As of now, this direct confrontation between different fossil fuel interests, competing for limited “carbon space” in the atmosphere is not yet observable.
Other authors think similarly, as a number of precedents pointing into the same direction show.

Firstly, the government of Ecuador proposed a similar indicator at the UNFCCC in 2010 which they called “net avoided emissions” [54]. The concept was connected to the Yasuní-ITT Initiative which the Ecuadorian government subsequently abandoned in 2013, and the concept has not seen any further development at the UNFCCC.

Secondly, the unburnable carbon approach [55], popularised by US author and activist Bill McKibben [30] aims to establish how much of currently known reserves are unburnable under existing temperature targets. This approach has been used to calculate regional amounts of unburnable carbon from an economic perspective for a relatively high carbon budget of a 50% chance of staying below 2°C [56]. After the Paris Agreement, numbers have tightened and now keeping more than 80% of proven fossil fuel reserves in the ground is essential for meeting the Paris targets [57,58]. While some governments have already committed to keeping certain fossil fuel reserves untouched in the ground, e.g. Mexico, USA, Canada and Norway [9 Appendix C], none have quantified these non-extraction commitments and included them in their Nationally Determined Contributions.

One challenge for this approach is that as of now, reporting of fossil fuel reserves is not standardised internationally. Hence the creation of a global registry of fossil fuels [59] would be a welcome step towards a globally transparent and easily understandable map for the global potential emissions landscape from fossil fuels.

2.2. Social movements and emissions accounting

The social movement impact literature has studied questions of whether and how social movements achieve their goals [60,61]. One of the debates in the field centres on what is to be considered a success [62]. While in many cases, this is not easily defined [63,64], the KING movement is in the fortunate situation of being able to quantify its success with a rather straightforward criterion: avoided fossil fuel extraction. This can relatively easily be operationalized by recording the cancellation of fossil fuel projects. As an example, the international coal movement closely tracks the global coal power plant “pipeline” and measures its success in stopping new coal-fired power [65,66]. This approach has recently been expanded to all new fossil fuel infrastructure with the Global Energy Monitor website [67]. The step that is missing is to translate this into emissions language.

In Giugni et al. 's 2013 classification of political, biographical and cultural movement outcomes [68], avoided extraction and avoided emissions fall squarely into the political category, but it is a new kind of political outcome not mentioned by previous authors. The proposed methods thus also contribute to the social movement impact literature, allowing the KING movement to track its impacts in a transparent and standardised way.

Tabara and Chabay [68] have combined *human information* and *knowledge systems* as conceptual tools for the rapid transformations towards sustainability which society now needs. In their view, knowledge is not independent from actors, but rather depends on who knows it. Following that argument, easy-to-use methods for calculating emissions can facilitate the involvement of a wider set of stakeholders in informed discussions about mitigation strategies.

3. Research aims and design

In the quest for useful ways of measuring the emissions impact of efforts to keep fossil fuels in the ground, a balance needs to be struck between accuracy and understandability. The methods for quantifying emissions impact of different supply-side mitigation activities in this article are readily usable for non-experts and can thus get a wider range of societal actors engaged in the conversation, avoiding the expert trap described above which emissions accounting has found itself in. While recognizing the danger of scientization previously mentioned, this article aims to help KING activists get to a level of literacy that allows them to participate in discussions on emissions on an informed basis.

The recent rise of the "climate emergency" framing [19] provides additional backing for my approach which prioritises simplicity over level of detail. When responding to an emergency, easy access to an understandable picture of reality is key [69 p. 10]. To meet that standard, the methods I propose make the following controlled concessions on accuracy: Firstly, I use average global emissions factors for potential emissions of different fuels. This simplifies the vast variety of fossil fuels to just four average types: coal, oil, gas and LNG. For those interested in creating more accurate estimates for a specific project, the global averages provided in the Annex can easily be refined with more specific numbers wherever these are available. Secondly, I exclude a number of secondary effects (discussed in detail in section 5) which tend to contribute minor modifications to the emissions picture, in opposite directions. The methods are intended to complement rather than replace other more detailed methodologies and could be of particular interest to the KING movement for tracking its impact.

The current paper is a result of the author's involvement in the KING movement since 2010. He is director of the Leave it in the Ground Initiative and has collaborated closely with movements and activists opposing oil & gas extraction in Mexico, coal mining in Germany and worldwide, and fossil gas extraction and transport. A number of situations where quantification of emissions impacts was desirable, but not easily accessible gave rise to the question of practical ways to quantify potential emissions of the targeted fossil fuel projects. Exchanges with members of the KING movement, particularly from GGON, and others who have previously attempted to quantify the potential emissions impacts of efforts to stop fossil fuel projects preceded the drafting of the document.

Lemos et al. [37] have pointed to several strategies to increase usability of scientific information, which I have applied for this article:

Interaction between producers and users of knowledge. KING movement concerns led to the development of the methods in this article, making it an instance of co-design [70].

Value-adding. The tables with average emissions factors for typical fossil fuel projects have been included in order to make the method readily usable for a wide range of actors interested in performing their own emissions calculations for a specific project.

Retailing, wholesaling and customization. The distinction of three different methods for different keep-it-in-the-ground efforts is an instance of customization. The author is actively involved in practical applications of the methods that can be considered retailing [e.g. 71,72].

4. Quantifying carbon kept in the ground

4.1. Conceptual framework

The fossil fuel supply chain consists of fossil fuel reserves in the ground, extraction projects with a certain extraction capacity per year, transport and transformation projects with a certain annual capacity each, and consumers, which in some cases are big projects with a quantifiable annual capacity as well, such as power plants. (Table 1) My model aims at establishing the potential CO_2 emissions enabled by these pieces of the fossil fuel supply chain. I make two simplifications: firstly, I use average global emissions factors; secondly I exclude secondary effects (described in more detail in the discussion section) and take the “nameplate” capacity of fossil fuel projects at face value, in order to derive a rough estimate of its *potential* emissions (see Figure 1) - as opposed to actual or projected emissions, which would need an inclusion of some secondary effects. This limited scope helps focus attention on what I believe to be the key ingredients for understanding the impacts of efforts to reduce emissions from fossil fuels. Avoiding a project and its associated emissions does actually not require very precise accounting - after all the intention is that those emissions never see the light of day. What is lost in accuracy and detail is gained in simplicity and transparency of the model. The accuracy of the results generated with this model can be improved by using country- or project-specific values where available, rather than global averages and replacing the respective values in the tables provided in the Annex, and by quantifying secondary effects discussed in section 5.

Supply chain link:	Reserves	Extraction	Transport	Consumption
Quantification:	Total carbon content	Annual capacity	Annual capacity	Annual capacity

Table 1. The fossil fuel supply chain

For the sake of simplicity, I do not include the following secondary effects in the model: positive and negative leakage of emissions reductions, capacity factors and greenhouse gases other than CO_2 (See Figure 1). These are discussed in detail in the discussion section. I instead encourage others to complement this with their work. My main aim here is to provide a simple and replicable method with reasonable accuracy. I use the most comprehensive inputs I can reconcile with the simplicity mandate, and exclude a quantification of those other issues for arriving at a reasonably accurate estimate, especially since they act in different directions, e.g. methane adds some impact, a low capacity factor reduces impact. While calculating these secondary effects would require much more resources, modifying the initial results from the proposed method in relatively minor ways as explored in the discussion section, I explicitly mention these "known unknowns" should other authors wish to elaborate and refine the results produced with this method, especially in cases where these secondary effects are sizeable or can be captured in a standardised way.

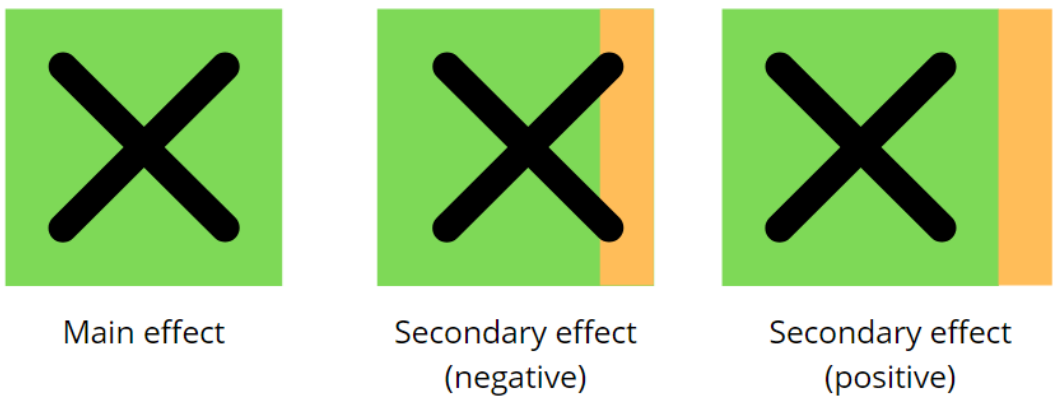

Figure 1. Main potential emissions effect and secondary effects

In this paper, I use standard emissions factors from the IPCC for different fuels [73], which is already a simplification, because these factors specify an average carbon content for different types of coal, oil and gas.

I assume that each transport project is resolving a bottleneck between a supply of fossil fuels and a potential market, enabling the link between the two. By closing that bottleneck, in my simple model, the corresponding reserves are not extracted and the corresponding demand is not serviced, "avoiding" the corresponding emissions.

4.2. Non-extraction of reserves (Method 1)

In this straightforward method, the potential CO_2 emissions from burning all reserves in an area, project or concession are quantified.

Formula:

Reserves amount x Emissions factor = Potential CO_2 emissions

The simplifying assumption is that all of the reserves could be extracted and burnt (ignoring the relatively small portion of non-fuel use), and that by cancelling extraction, the fossil fuel reserves are kept in the ground [see 74 for a more detailed method that does account for non-fuel use and some other factors].

When applying this method, close attention must be paid to different reserve categories (see Figure 2), because the resulting emissions estimates will differ greatly. Therefore being explicit about the underlying data is essential for results to be comparable. When aiming at comparing two policies or impacts, reserve categories should be harmonised first.

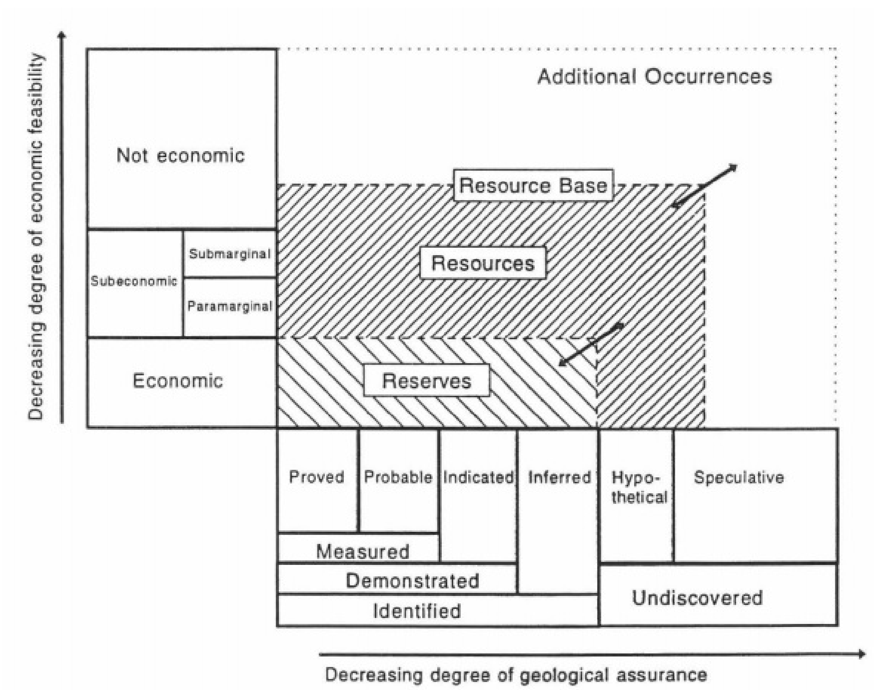

Figure 2. Classification of energy reserves and resources [from 75]

However, for my method, numbers from any category can be used and converted into equivalent emissions. Table 2 gives an overview of emissions factors that can be multiplied with reserve figures in the most commonly used units for all three fossil fuels.

Fossil fuel	**Emissions factor (tons CO_2/unit)**		
Oil	Thousand barrels (kbbl or mbbl)	Million barrels (mmbbl)	Billion barrels (Gbbl)
	418.6	418,601	418,601,288
Gas	Thousand cubic meters (Mcm)	Million cubic meters (MMcm)	Billion cubic meters (bcm)
	2.0	2,019	2,019,600
	Million cubic feet (MMcf)	Billion cubic feet (bcf)	Trillion cubic feet (tcf)
	57.2	57,188	57,188,164
Coal	Thousand tons (kt)	Million tons (Mt)	Billion tons (Gt or BT)
	2,000	2,000,000	2,000,000,000

Table 2. Potential emissions per unit of fossil fuel reserves (Sources see Annex 1)

This method can directly translate a non-extraction commitment into a respective contribution to or subtraction from the global carbon budget, or national carbon budgets where these exist.

Decisions to keep fossil fuels in the ground are unfortunately subject to review. This danger of reversals is analogous to what is known in the literature on avoided deforestation as *permanence* issue [76]. The method does not address the permanence of a decision to not extract, it simply estimates the size of the apple of discord in terms of climate impacts.

Example

The North Antelope Rochelle coal mine in the United States has proven and probable reserves of 1610 million tons of coal [77]. Multiplying this with the emissions factor from the Table 2 gives 3.22 Gigatons of potential CO_2 emissions for this single project, roughly equivalent to annual CO_2 emissions of the European Union in 2018 [78].

4.3. Project cancellation/delay (Method 2)

The nameplate capacity in terms of extraction, transport, processing or burning of fossil fuels of a project provides the basis to calculate the potential emissions of a project per year.

Formula:

Annual nameplate capacity (x Capacity factor) x Emissions factor = Potential CO_2 emissions

This method is based on the assumption that a project is needed and would operate at full capacity in the first years after starting operations. In real-life, projects are often oversized and struggle to operate at full capacity. However, my method gives the benefit of the doubt to project developers, assuming they are acting in good faith on a real need and market-savvy enough to propose a project that has a market to serve and thus the potential to run at full capacity. When estimates of a lower than full capacity factor are available from the developer, obviously these should be used. In some cases, existing market analysis indicates that a project would be running at less than full capacity, such as in the case of coal-fired power plants which are increasingly losing market share to renewables and are known to operate at low capacity factors [79]. But, as mentioned before, I suggest using my method to establish a baseline of potential emissions generated if the project did operate at full capacity and then integrate capacity factor data in a second step, if available.

This method is fungible with the approach used at the UNFCCC to quantify countries’ emissions and can easily be applied to project delays due to lawsuits, blockades etc. by multiplying the daily/yearly emissions with the number of days, months or years of the delay (see Table 3).

Project category	**Unit (capacity)**	**Emissions tCO_2/year**	**Emissions tCO_2/month**	**Emissions tCO_2/day**
Oil pipeline	kilo barrels per day	152,789	12,732	419
Gas pipeline	billion cubic metres per year	2,019,600	168,300	5,533
	million cubic feet per day	20,874	1,739	57
Coal power plant	gigawatts	7,603,649	633,637	20,832
Coal mine	Million tons per annum[2]	2,000,000	166,667	5,479
Project category	**Unit (capacity)**	**Emissions tCO_2e/year**	**Emissions tCO_2e/month**	**Emissions tCO_2e/day**
LNG export terminal	million tons per annum	5,495,920	457,993	15,057
LNG import terminal	million tons per annum	5,687,420	473,952	15,582

Table 3. Potential emissions per unit of capacity of typical fossil fuel projects. Sources: Annex 1

Example

In Italy, the NoTAP movement opposes the Trans-Adriatic Pipeline (TAP) connecting Europe to more Russian and Azeri fossil gas [80]. The movement has been accused of delaying the pipeline by a year. The annual capacity of the pipeline is 10 billion cubic metres (bcm) of gas. Applying the average emissions factor from Table 3 results in an avoided 20.2 million tons of CO_2.

[2] A coal mine can be evaluated both through the lens of production capacity with this method, or through the lens of coal reserves with Method 1.

4.4.Temporary stoppage (Method 3)

When operations are temporarily halted, such as in the case of ShutItDown [81,82], Ende Gelände [83] and other temporary occupations of fossil fuel infrastructure, it is important to understand the functioning of the supply chain in order to estimate the impacts of the actions.

Formula:

Operational daily/hourly capacity x Emissions factor = Potential CO_2 *emissions*

Storage capacity, such as coal storage at a power plant or oil storage at the end of a pipeline can mitigate supply swings, thus making temporary stoppages ineffective. There may be other benefits to these actions such as drawing public attention to the problem and changing narratives around it, but here I am concerned with easily quantifiable climate impacts. If there is sufficient storage capacity to smoothen out the disruption, the impact of the activity remains symbolic. Only if the effect is passed through to the last link in the supply chain, for example if coal power generation is impeded, we can quantify the impact. Below, I discuss two examples where this is possible. Table 3 can be used to calculate the potential emissions figures in this category.

Example

Ende Gelände has repeatedly stopped the supply of coal to individual coal-fired power plants in Germany with actions of mass civil disobedience since 2015 [83]. Public data on coal power plant output gathered from the German electricity exchange makes it possible to quantify the impact of Ende Gelände on output of coal power. Figure 3 shows how one block of the coal plant undergoing blockade was turned off and another halved its output.

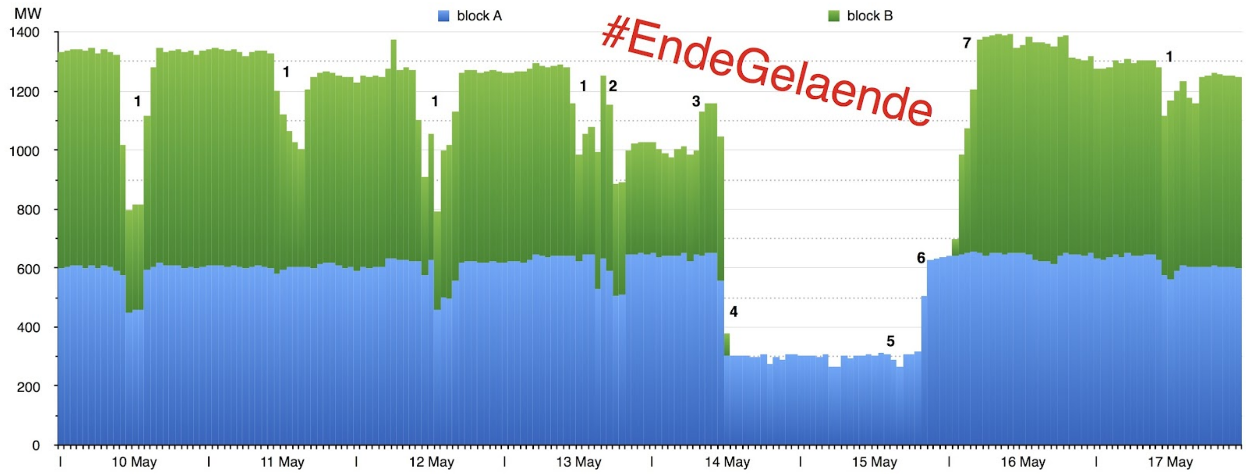

Figure 3. Ende Gelände 2016 blockade impact on Schwarze Pumpe coal power plant output. [from 84]

In the case of the WeShutDown action in Germany in November 2017, mentioned in the introduction, activists have quantified their impact with a method, analogous to my proposed method at 26 thousand tons of CO_2 [85]. The company has not yet presented its calculations to substantiate its compensation claim in court (WeDontShutUp, personal communication).

5. Discussion

I have discussed the shortcomings of existing emissions accounting approaches, pointing out that while detailed and comprehensive, they are not easily accessible to non-experts and thus limited in their reach. To mitigate this shortcoming for the field of supply-side mitigation strategies, I have given emissions factors for typical fossil fuel projects that these efforts address: Firstly, reserves of oil, gas and coal to be kept in the ground, and secondly pieces of infrastructure: oil and gas pipelines, LNG terminals and coal mines and plants that may either be delayed or cancelled, or blocked for a short period of time.

In the case of oil and gas reserves and pipelines, I used emissions factors provided by the IPCC, reformatting them for easy use by practitioners. In the case of coal reserves, I used the factor provided by the Emissions Gap Report. In the case of LNG terminals, to my knowledge I am the first to provide a standardised figure translating production capacity to average emissions. In the case of coal power plants, my figure of 868gCO_2/KWh that arises from the calculation detailed in the Annex is slightly lower than the 1001gCO_2/KWh identified as a mean by Whitaker et al.'s systematic review for US coal-fired power plants [50]. This can be explained by two factors, namely that he includes methane, which I exclude (see the more detailed discussion below), and that the global fleet of coal power plants which is the basis of my calculation is more modern on average than the US fleet and slightly more efficient.

A caveat that needs to be taken into account for using this method for real-life impact estimates are the secondary effects named in Table 4 and discussed in further detail below, which are not captured by the method.

Effects captured	**Secondary effects**
Non-extraction of reserves Reduced emissions due to cancellation or delay of fossil fuel infrastructure projects	Carbon leakage (-) Non-CO_2 greenhouse gases (+)[3]

[3] Methane is included in my figures for LNG terminals, because it accounts for a significant percentage of their warming impact.

(extraction, transport, processing, consumption) Reduced emissions due to temporary stoppage of fossil fuel infrastructures	Capacity factors (-) Non-fuel use of oil, gas and coal (-) Project construction and operation (+)[4] Policy change (+) Cultural change (+)

Table 4. Effects captured by the methods and secondary effects not included. (+ effect increases potential emissions, - effect reduces potential emissions)

Carbon leakage occurs when the reduced availability of fuel on the market results in higher prices which incentivize other extractive projects [86,87]. The size of the effect has been estimated to centre around a mean value of 12% for international leakage [88] and has been discussed in detail by other authors [see e.g. 89]. Adding a piece of infrastructure will not increase consumption by the same amount, because in a functioning market, demand and supply are in equilibrium and the shift in that equilibrium is what determines an increase - or decrease in overall emissions. The key ingredient for these calculations are elasticity values for both demand and supply. Upon cancelling a project, and after a time lag, the system reacts with an increase in extraction, partly compensating for the original reduction. In my model, this reaction of the market is considered a secondary effect. The exact timing of this response to my knowledge has not yet been examined in detail by any author. In addition to the supply-side effect of incentivizing additional extraction, on the other hand, an increase in price reduces demand. These demand-side reactions of the system work in synergy with the KING movement intervention, reducing demand and counteracting leakage. My simple model does not pretend to capture these dynamics. A different kind of carbon leakage through the electricity market happens when coal power plants get shut down, but are replaced on the grid with additional plants, e.g. burning gas. Plevin et al. [89] have warned that life-cycle analyses could misguide

[4] For LNG, liquefaction and shipping emissions (in the case of import terminals) are included, as can be seen in the Annex.

policy through overstating mitigation benefits when excluding market effects. The same challenge arises when using my models in a myopic way, and accounting for the full amount of shutting down the coal plant while ignoring the contribution of the newly operating gas plant. I encourage authors to use a realistic level of analysis when trying to come up with realistic estimates. The quantification of the reduced emissions from the coal plant estimated with my method would still be an essential ingredient of a higher-level analysis.

The emission of *non-CO_2 greenhouse gases*, notably methane accompanies most fossil fuel extraction, but is highest for unconventional gas extracted with fracking [90]. Whether methane is considered in estimates, matters for the climate bottom line, and also whether it is transformed into CO_2 equivalencies using a 20 year or a 100 year time frame. One possible approach to the methane issue, the one chosen in this study for most fuels, is to exclude the effects of methane altogether, making the method much simpler, while resulting in slightly lower numbers. Because adequate data for methane leakage rates is often lacking, I have used this approach as a starting point. However, adding the effects of leaked methane into the equation helps paint a more precise picture of climate impacts. When comparative or actual data are available, it should be included, being explicit about the data sources and time frames used [see 91 for an example of an analysis that includes methane and offers two different time frames]. I have included the effect of methane only in the calculation of LNG terminals' emissions impact with a 20-year time frame of reference, because it accounts for about half of the global warming contribution of these infrastructures.

Low c*apacity factors* of infrastructures have the potential to modify emissions substantially. The technical annual capacity is often not equal to the yearly output of a facility. Where this kind of information is available, it can easily be integrated, reducing the potential emissions from the ideal level to the level realistically expected to happen. Assuming a use at full capacity can be considered an optimistic estimate of potential emissions impacts, because project developers may overstate demand and some fossil fuel projects such as coal-fired power plants [79] and LNG terminals [92] tend to run below capacity. This is an issue that lies outside the scope of my model which needs to be separately addressed. The intended use of the model is to establish a baseline which assumes the use of the infrastructure at full capacity, from which deviations such as a lower use due to a weak market etc. can then be calculated in a second step.

Non-fuel use of oil, gas and coal accounts for a small part of what gets extracted every year [see 9 Annex Table B3 for a global breakdown]. In a real-life scenario, these percentages are not directly burned as fuel and subtracted from projected emissions. In my model, I do not correct for this factor, because estimating these percentages is methodologically challenging while contributing a minor modification of the overall figure.

Project construction and operation are minor sources of emissions, when considering the overall impact of a fossil fuel project and are therefore not included in my method, except for LNG where they are significant. These emissions arise from the operation of extraction equipment and from the transport of the fossil fuel. Interestingly, fossil fuel companies sometimes present calculations where these are the only emissions considered, while emissions from the oil, gas and coal they produce are filed as "scope 3" emissions that are not under their direct control, resulting in a very distorted picture. Applying the methods in this paper will easily identify that contradiction.

Cultural change and even *policy change* is sometimes an effect of KING struggles. While my model might be used to paint a more black-and-white picture where emissions are either happening or avoided, in real life, the struggles that are lost may be influential in changing public opinion and altering the playing field for all future fossil fuel projects, increasing movement leverage. It could be argued that both the struggle against the Keystone XL pipeline and the Dakota Access Pipeline (DAPL) have left a mark in the United States with non-quantifiable side-effects that may be much greater than the actual emissions saving if the projects were stopped. In the European Union, the sustained local opposition against TAP among other factors has led the European Investment Bank, the world's biggest publicly owned lender, to reconsider fossil gas projects and decide to not invest in such projects any longer. In all three cases, my method would only indicate relatively minor emissions benefits through delays of the named projects, while DAPL and TAP were eventually built. The wider political and cultural significance and consequences of the struggles against these projects could thus be underestimated, when focussing too narrowly on emissions only. In this regard, my method does not allow for the description of the social, cultural or political dynamics of ending the fossil fuel age. The discussion on "social tipping points" [93,94] is key to understanding the path that leads us there. In building movement momentum, small wins also count, and in the end, social change is not really numbers driven. In Giugni's (2007) analyses of environmental movements, including the anti-nuclear, he finds that a positive impact depends on mobilisation occurring together with having political allies and being backed by public opinion [95]. On shutting down fossil fuels, we are slowly moving into that space, the big political allies being the last factor often missing.

Emissions language is one of the elements that contributes to the “scientization” of climate policymaking [96] which is an obstacle to engaging wider audiences and depoliticizes climate debates [97]. Engaging people with emissions language is an uphill battle. As such, emissions calculations might not seem to be a good empowerment tool for climate activism.
There are other ways to frame a KING battle: you could simply say No to the project, because there are good arguments why further fossil fuel infrastructure should not be built [see e.g. ,58,98], or use rights-based approaches to stop a project. But if the project is strong and likely to go forward, you will sooner or later find yourself wanting to quantify the GHG emissions as an argument against the project. So while I see "emissions language" as a double edged sword, I cannot ignore the fact that it is commonly spoken in the climate community, is the core language of the UNFCCC and a certain "literacy" in this language is necessary to be taken seriously. Recognizing its downsides doesn’t make it go away: climate activists will be confronted with emissions language in many spheres. My hope is that by simplifying emissions calculations in a useful and transparent way, I will enable activists to engage in strategic, political discussions where this language is spoken without having to spend long hours over spreadsheets.

The results produced with my methods can be used for educating others about a particular project. For outsiders, without quantification it is often difficult to imagine the dimension of a project.

An issue of importance for social movement scholars (and activists) is the question of attribution of successes [see e.g. ,99 for a discussion of the anti-coal movement]. While I recognize the importance of the question and encourage others to undertake more work in identifying these dynamics, my scope is limited to estimating the size of potential emissions from a project. Answering the question of who stopped a project and how, requires different methods from mine.

The outcomes of the methods are not to be mistaken for the key indicators on where and how to move beyond fossil fuels. They are only supposed to indicate the size of a certain piece of infrastructure in terms of its potential climate impacts, which is in itself useful knowledge because it allows the identification of the biggest “carbon bombs”. Users will have to identify relevant numbers for comparisons themselves. My methods can thus be used to easily generate an estimate for any fossil fuel project where a numeric indicator of its size or capacity is known and compare supply-side interventions to other mitigation measures. They can also serve as a measuring stick for the KING movement in its efforts to counter fossil fuel extraction, and for those concerned with climate change mitigation more widely to add up “unburnable” carbon which ultimately must become the dominant reserve category on this planet.

6. Conclusion

Humanity's answer to the climate emergency increasingly shifts its focus from merely cutting demand towards avoiding new builds or even shutting down fossil fuel infrastructure projects. I have proposed three methods that allow us to quantify the potential climate impact of such efforts. The first method quantifies avoided emissions overall, and the second and third methods allow to estimate avoided emissions per year and per day. Together, these three methods provide tools for understanding the climate dimension of projects as well as a basis for more elaborate considerations such as secondary effects on markets.

Because we are still dangerously far from an effective response to the climate emergency, widening the mitigation toolbox to include more supply-side measures is a step in the right direction. The methods presented in this article may allow a wider range of actors to easily and effectively gauge the mitigation impacts that different interventions can have. As such, it may facilitate a wider adoption and a more prominent role of supply-side measures in mitigation strategies, which at least governments so far leave as untapped potential [100]. Existing carbon accounting methodologies are robust, but due to their complexity, necessarily expert driven. To be useful and accessible for the activist community and transparent to the public I have created simpler methods that focus on average emissions factors and main effects, excluding smaller secondary effects.

For the KING movement, these methods can serve several purposes: to answer the question potential movement supporters ask first: "why should I care?" with an easy to grasp comparison of the potential emissions impact, to provide quantitative arguments in lobbying/advocacy work or in courtrooms, to quantify the impact of their activities towards funders and maybe even to track its impact as a movement in a standardised fashion.

I invite scholars and activists to use these tools for their own analyses of fossil fuel projects and their blockades, delays or cancellations. These simple and effective methods to quantify climate impacts may give us orientation on our common journey beyond the age of fossil fuels.

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8. Addendum

The *apple of discord* mentioned on page 79 is an image from Greek mythology where an apple with the inscription “for the most beautiful” sparked a quarrel between women who assumed they each deserved it. I use it here to refer to the fossil fuel project under contention between project proponents and KING movement opponents.

On page 85, two corrections need to be made to the sentence “The size of the effect has been estimated to center around a mean value of 12% for international leakage [88] and has been discussed in detail by other authors. [see e.g. 89].” It should read: “mean value of 12% for international leakage of trade-exposed, carbon-intensive production in response to carbon pricing”. (Plevin et al. 2014) is not the correct citation for [89], the correct one is: Erickson, P., Lazarus, M. Impact of the Keystone XL pipeline on global oil markets and greenhouse gas emissions. Nature Clim Change 4, 778–781 (2014). https://doi.org/10.1038/nclimate2335

My method for arriving at “KING metrics” in this article are meant to provide a highly practical tool, in particular for activists. However, a few additional limitations and caveats need to be pointed out.

8.1. Supply elasticities

In real life, the phenomenon known as *supply elasticity* eats into the emissions savings theoretically calculated with my model. This should not be underestimated, because the additional emissions can be substantial. The study cited in the article with 12% leakage, Böhringer et al. (2012), refers to energy-intensive trade-exposed goods and demand leakage. What we are concerned with, however, is supply-side leakage. For my method this means that the impacts on incentivizing additional supply (compared to the game of “whack-a-mole” by some colleagues) need to be taken into account, because they could mean a significant reduction of the impact in a real-life situation.

It is important to keep in mind that each fossil fuel has its own market configuration which influences supply elasticity. When studying supply elasticities, economists use models, and tend to describe the outcomes of the model runs as *short-run* and *long-run* elasticities. In the following, I will discuss some of these, separately for oil, gas and coal.

For *oil*, Kilian (2022) argued that on a one-month time scale, supply elasticity is zero. This means that there is strong inertia in the system and it takes at least several months to respond to a changed price environment. Caldara et al. (2016) summarise 6 studies that provide short-run elasticities, half around zero or negative, and half around 0.2-0.3, and summarise this as a “consensus” view of 0.13. Güntner (2014) found very modest responses by oil extracting countries to “demand shocks” that increase prices, up to two years after they happened. Only non-OPEC countries seemed to slightly adapt to that situation. This means, that at least in a time frame of 2 years, hardly any leakage of avoided extraction should be expected via supply-side channels. Horn (2004) gives long-run supply elasticities of 0.1 for non-OPEC and -0.4 to -0.6 for OPEC, which means that OPEC restricts supply when prices are high. Reaction times to price signals are much shorter for shale oil and this has modified the behaviour of oil markets in the last decade and a half (see Kleinberg et al. 2018 for a detailed discussion).

For *gas*, both Krichene (2002) and Ponce et al (2014) find negative short-run elasticities for gas, meaning that there is no increase in output with higher prices, on the contrary. In the long-run, Krichene does find a moderate supply elasticity for fossil gas, though. In comparison with oil, which is a global commodity, gas is more dependent than oil on relatively inflexible infrastructure such as pipelines and LNG terminals and thus also less flexibly traded. It is also often associated with oil in the ground and extracted alongside it. Because oil is the more valuable product, Where it cannot be burned due to environmental regulations,

For coal, Burniaux and Oliveira Martins (2012) have discussed the role of coal supply elasticity for carbon leakage. They estimate that leakage would likely be very small, but this is not focused on KING measures, but rather on demand-side reductions and therefore not instructive for our question. Beck et al. (1991) have examined supply elasticities for Australian black coal and estimated a short-run elasticity of 0.4 and long-run elasticity of 1.9. These figures are likely to be on the high end of the coal spectrum, because only a small part of the global coal market is internationally traded coal, due to transport costs being an important consideration. Cui and Wei (2017) in discussing Chinese coal point out that the government coal price controls reduce the supply elasticity in the industry.

What do such numbers mean for the results of my model? In general terms, it can be said that the smaller supply elasticities are, the better for a high impact of a KING intervention. When the supply side of the market fails to respond, it means that leakage is small.

8.2. Other limitations

When evaluating the impacts of blockades of power stations, it is important to keep in mind that in most cases, even turning off a power station completely will not lead to a situation where the "lights go out" and the emissions are saved. They may be saved locally (or shifted back in time, see the next comment), but generally, other power generators will pick up the market share left unattended by the power plant in question. One option to account for this would be to subtract grid-average emissions from the emissions saved. Another option would be to try and identify the marginal producer(s) during the time of interruption and calculate the additional emissions from their extra operations. In both cases, the results from my model are needed as inputs for these calculations.

It could be argued by the activists, taking more of a moral than a realist perspective on the matter, that burning fossil fuel is wrong and it is beyond their immediate control if other actors engage in additional such wrongdoing, when they have successfully impeded it in one particular place.

My model helps quantify emissions delays. Delaying does, however, not necessarily mean that these emissions will never happen. It could be, for example if an infrastructure project is pushed back in time, that the full amount of emissions is still generated, just later in time. I find it important to point out that the same weakness applies to the framing of emissions reductions commitments under the UNFCCC, where annual emissions are in focus, but cumulative emissions are not. I am hopeful that the increasing competitiveness of renewable energy in electricity, transport, heating and other applications will turn many project delays into emissions partly or fully avoided, rather than simply shifted in time. See also the discussion of "winning by delaying" in my Mexico case study (Section IV.5.Discussion and conclusions).

Leakage in transport is another example of the simplification I had to make for an easily applicable model, but where reality tends to be much more complex. There are just a few fossil fuel projects that have only one way to get to their market, such as oil and gas projects that depend on a particular pipeline and do not have alternative routes, or coal or gas that needs to go through a particular port or LNG terminal and would else be stranded. And even in these cases one could think of the possibility of building a different pipeline along a new route. However, in many cases there are several transport options (as the Lac Mégantic disaster in Canada in 2013 with crude oil transported by rail testifies to), so the emissions impacts of stopping a piece of transport infrastructure where alternative routes exist can not easily be captured with my model.

Finally, because I have prioritised simplicity and understandability, there could be a risk of activists mistaking our model for a detailed and complete depiction of reality and - unwittingly - setting them up for undermining their own credibility. This stems from the different issues discussed before which may modify the picture and on the one hand could lead to suggestions that activists are exaggerating, undermining their credibility for example in front of courts, governments, investors or the media when using figures derived from the model. On the other hand, not taking into account secondary effects that work in the sense of increasing the numbers, could undermine activists credibility in front of their own peers, when presenting unrealistically low numbers that exclude - for example - the impacts of methane. Both are undesirable and therefore a keen understanding of the limitations and caveats of the model is essential for minimising this risk and using the model in the best possible way.

A last concern is that activists might use the model to arrive at a “wrong” prioritisation of fossil fuel projects to fight against if they apply the model without attention to the caveats and arrive at wrong conclusions about what will happen if they block or shut down a certain project. The choice of activist targets is rarely guided mainly by project size, my own organisation, LINGO, being one exception to the rule, with our work stream focusing specifically on carbon bombs. More often, other factors such as previous experience, access to information, logistical resources etc. play a greater role. However, I was compelled to mention that risk, since after the UNFCCC process has spent three decades in a so far unsuccessful effort to bring greenhouse gas emissions down, it would be tragic if the KING movement were also to focus on the wrong targets and lose even more time.

8.3. References

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III. “Carbon Bombs” - Mapping key fossil fuel projects

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Abstract

Meeting the Paris targets requires reducing both fossil fuel demand and supply, and closing the "production gap" between climate targets and energy policy. But there is no supply-side mitigation roadmap yet. We need criteria to decide where to focus efforts.

Here, we identify the 425 biggest fossil fuel extraction projects globally (defined as >1 gigaton potential CO_2 emissions). We list these "carbon bombs" by name, show in which countries they are located and calculate their potential emissions which combined exceed the global 1.5°C carbon budget by a factor of two. Already producing carbon bombs account for a significant percentage of global fossil fuel extraction. But 40% of carbon bombs have not yet started extraction.

Climate change mitigation efforts cannot ignore carbon bombs. Defusing them could become an important dimension of climate change mitigation policy and activism towards meeting the Paris targets. So far, few actors, mainly from civil society, are working on defusing carbon bombs, but they are focussing on a very limited number of them. We outline a priority agenda where the key strategies are avoiding the activation of new carbon bombs and putting existing ones into "harvest mode".

1. Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) negotiations have framed climate change mitigation as a demand-side challenge for the past three decades, avoiding an explicit focus on fossil fuel extraction (Aykut and Castro, 2017; SEI et al., 2019). The IPCC has warned in its special report on the 1.5° target that swift reductions in emissions from fossil fuels are necessary and business as usual emissions would take us past the mark in less than two decades (IPCC, 2018). However, additional fossil fuel extraction projects are still being planned by energy companies, including state-owned enterprises (SOEs). These add to the overhang of “unburnable carbon”. While mechanisms to untangle this situation are already being discussed (Asheim et al., 2019; e.g. Newell and Simms, 2020; Pellegrini et al., 2021; van Asselt, 2014; West, 2020), they have not seen a breakthrough at the international policy level.

Potential emissions from fossil fuel reserves exceed admissible emissions by a factor of four to seven (Intergovernmental Panel on Climate Change, 2014). Because the overhang in unburnable carbon is so huge, in the dwindling time frame to meet the Paris targets, we need to be able to identify priorities for supply-side mitigation activities, the “next step in climate policy” (Erickson et al., 2018). Non-governmental organizations have identified and criticized a number of large scale fossil fuel expansion plans (Berman, 2019; Voorhar and Myllyvirta, 2013). But so far we lack a comprehensive and detailed map of specific fossil fuel extraction projects that are relevant to the global greenhouse gas emissions roadmap.

We aim to contribute to the characterization of the global supply-side mitigation landscape by answering some questions about the biggest fossil fuel projects globally, which we call “carbon bombs”. We define a carbon bomb as a proposed or existing fossil fuel extraction project (a coal mine, oil or gas project) that would result in more than 1 gigaton of CO_2 emissions if its reserves were completely extracted and burnt. Where are they located? What is their combined size? What is their status? How easy is it to find information on them? Is their role in disrupting the climate being questioned nationally?

In order to answer these questions, the first step is to establish the identity of these projects. We therefore provide a complete global dataset of carbon bombs. We use a simple method for estimating potential emissions, based on reserve data and average emissions factors.

This global list of carbon bombs is a first step towards defusing more of them. In the discussion section, we suggest an agenda for defusing carbon bombs which starts by cancelling new projects first and putting existing ones into “harvest mode”, thus avoiding stranded assets.

2. Background

The idea that we need to regulate fossil fuel projects and analyze their potential emissions is not new. Even before the UNFCCC was established, the issue had already been identified and a global budget for fossil fuels had been proposed by Krause et al. (1990) to deal with climate change. To provide a background for our research, we will briefly outline how the topic of foregoing extraction for climate reasons has been dealt with in academia, civil society and government.

2.1. Academia

Grubb identified non-conventional fossil fuels as a future key arena at the intersection of climate and energy policy in 2001 (Grubb, 2001). Meinshausen et al. charted a global carbon budget for temperature targets against proven fossil fuel reserves (Meinshausen et al., 2009).

In 2015, McGlade and Ekins detailed which fossil fuel reserves would stay in the ground for a 2° target, based on economic considerations (McGlade and Ekins, 2015). In 2021, Welsby et al. updated this analysis. These analyses paint an outline of the global supply-side mitigation picture (Welsby et al., 2021). We believe it is useful to further expand this picture, based on the following considerations.

Firstly, the authors list much coal (~2000 Gigatons worth of CO_2). This might be an overly optimistic scenario, as recent work has shown that coal is not available in as large quantities as previously assumed (Ritchie and Dowlatabadi, 2017). Additionally, coal is quickly losing competitiveness against renewables, to the point that half the global coal power plant fleet could already be profitably replaced by renewables plus storage (Bodnar et al., 2020). Therefore we tend towards the view that much of the coal in their scenario is not likely to get extracted. By using a dataset that identifies existing projects, we intend to help focus supply-side mitigation efforts where they may make a difference, i.e. in places that are arguably close to extraction. Secondly, while economics provides an important perspective on fossil fuel reserves, uneconomic projects are often enabled through subsidies (see e.g. Erickson et al., 2017). We therefore believe that mapping carbon bombs independently of economic considerations is admissible and in fact useful. And lastly, Welsby at al.'s analysis provides data at the regional level without naming individual projects. Policy decisions are typically taken at the national level, and movements tend to center on specific projects. Providing detail down to the project level would be useful to practitioners.

After NGOs took the lead for a while in spearheading keep-it-in-the-ground efforts (see the following section), calls from the scientific community have intensified over the last years to address climate change mitigation from the supply side (Erickson et al., 2018; Green and Denniss, 2018). Scientists of the Stockholm Environment Institute have published a series of papers and briefs (Erickson et al., 2017; Erickson et al., 2018; Erickson and Lazarus, 2014; Lazarus and van Asselt, 2018; Piggot et al., 2018) and organized several international conferences on supply-side mitigation. In 2018, Newell and Simms proposed a fossil fuel non-proliferation treaty (Newell and Simms, 2020), a vision that has since galvanized research and activism alike along the lines of anti-fossil-fuel norms (Green, 2018).

Academic contributions have also examined equity considerations, additional challenges beyond purely technical considerations (Gambhir et al., 2018; Kartha et al., 2018; Le Billon and

Kristoffersen, 2019), the movement against fossil fuel projects (Benedikter et al., 2016; Cheon and Urpelainen, 2018; Gaulin and Le Billon, 2020; Klein, 2014; Piggot, 2018) national and subnational *first movers*, some of which are described in the “government” section below (Carter and McKenzie, 2020), and methods to quantify the emissions impacts of the movement (Kühne, 2021).

A related topic of academic inquiry has been into *stranded assets*. In the context of our question, they refer to those fossil fuel assets that become worthless because of global climate action. The concept was introduced by the Carbon Tracker Initiative (2011) and has found its way into the mainstream of the financial community. Academics have subsequently used the framing to look at a number of fossil fuel and other sectors globally and in different countries (e.g. Caldecott et al., 2016, 2015, 2013a, 2013b; Dietz et al., 2016). These analyses help flag the companies and projects most exposed to potential asset stranding for investors. This perspective is an interesting complement to the carbon bombs lens, because it can help identify those projects that could be disastrous from an economic perspective on top of the climate one. On the other hand, it can help understand which projects are economically so solid that stopping them might be challenging.

2.2. Civil society

A number of contributions - conceptual and more tangible - have come from environmental non-governmental organizations (NGOs) and other activists. These include the concept of *carbon bombs*, which has been used by civil society at least since 2013 (Voorhar and Myllyvirta, 2013) and alludes to the close link between a fossil fuel based energy model and climate change related casualties.

A growing *Keep it in the Ground (KING) Movement* against fossil fuel infrastructures (Kühne, 2021) has used different tactics ranging from publishing reports over lawsuits to civil disobedience (Benedikter et al., 2016; Gaulin and Le Billon, 2020; Klein, 2014; Piggot, 2018). Multiple 'frontline struggles' are being waged across the planet against fossil fuel extraction (e.g. tar sands, fracking, new coal mining) and associated infrastructures (e.g. airports, motorways, pipelines and corporate headquarters). As an example, the German direct action coalition *Ende Gelände* regularly stages actions of mass civil disobedience to shut down coal mines in Germany (Bosse, 2017), including both carbon bombs on our list (Appendix 1). Fracking is another activity that faces increasing opposition. In 2015, more than 1000 organizations called for a global ban on fracking (PowerShift, 2015). These are just two examples of the resistance of the KING movement.

In a more conceptual line of work, in 1997, Greenpeace published a report named “The Carbon Logic”, adding detail to the connection between fossil fuels and different climate targets (Hare, 1997). Almost 20 years later, Oil Change International’s report “The Sky’s Limit” showed that existing coal mines and oil and gas fields can take us past the carbon budget after the Paris Agreement (Muttitt, 2016), providing a factual basis for the argument against new approvals of additional fossil fuel projects. Organisations that started with tracking all coal power plants (Global Energy Monitor, 2020; Shearer et al., 2019, 2018) are now moving on to monitoring all coal mines and oil and gas projects globally (Global Energy Monitor, 2021, n.d.). A global registry for all fossil fuel reserves has been called for (Byrnes, 2020) in connection with the proposal of a fossil fuel non-proliferation treaty mentioned above, and a methodology is now under construction (Byrnes, personal communication). Once published, this may help standardize the way fossil fuel reserves and resources are reported and identified globally.

A very influential NGO has been the Carbon Tracker Initiative, which in 2011 published its first "Carbon Bubble" report which looked at the financial aspect of private companies owning rights to exploit "unburnable" carbon that exceeds the global 2° carbon budget. Since then, many sectoral and other reports have followed, and the danger of fossil fuel investments becoming stranded assets is recognized in the financial community. Following their lead, the Carbon Underground 200, publishes a list of fossil fuel reserves of publicly traded companies (FFI Solutions, 2020) which however does not cover most SOEs.

Complementary to this work, 350.org started a fossil fuel divestment movement in 2011 under the "keep it in the ground" banner (Alexander et al., 2014). By the end of 2018, 8 trillion US dollars had been committed to not be invested in fossil fuels any more (Hanley, 2018). This is relevant for the availability of capital for fossil fuel extraction projects, including carbon bombs.

From the mentioned examples it is clear that civil society has been watching the fossil fuel industry and its plans closely and there are a number of published reports singling out some of the biggest planned fossil fuel projects which also appear on the carbon bombs list (Berman, 2019; Bingler, 2020; Cimons, 2016; Voorhar and Myllyvirta, 2013). However, these reports are not the result of a systematic, global approach towards identifying the biggest fossil fuel projects, but rather respond to the needs and dynamics of campaign-driven organisations. They characterise "hot spots" of current struggles against fossil fuels so to say. This is helpful for understanding how the struggles to defuse carbon bombs unfold in real life. But it leaves a gap in terms of gaining a complete global overview of which projects are already active and which ones are in preparation, especially in countries without ongoing NGO campaigns. We aim to close that gap with the current research, aiming at policy makers and activists both on a global and on a national level.

2.3. Governments

The UNFCCC so far uses a decidedly non-fossil fuel framing, thanks to the efforts of Saudi Arabia and other allies with strong fossil fuel interests (Aykut and Castro, 2017, pp. 185–191). Different commentators have decried this (McKibben et al., 2012; Monbiot, 2015, 2007) without much impact. However, there are other fronts where the framing has taken root. The IPCC's 5th Assessment Report mentions explicitly that we have 4 to 7 times more fossil fuel reserves than can be burned (IPCC, 2014 Section 2.2.5.). Also according to the IPCC, the 1.5°C target requires limiting global emissions to no more than 420 Gt CO_2 from 2017 (IPCC, 2018, p. 12), and fossil fuel extraction could only occupy part of that carbon budget. In 2019, UNEP and partners published the first "Production Gap Report", listing national extraction reduction policies and calculating the gap between fossil fuel extraction plans and the Paris temperature targets (SEI et al., 2019). While the Paris Agreement was silent on fossil fuels (Piggot, G., Erickson, P., Lazarus, M., and van Asselt, H., 2017), it did set a date for "net zero" emissions in the second half of the century. Subsequently, the needle has shifted orientation towards a 2050 deadline for fossil fuels (International Energy Agency, 2021; United Nations Secretary-General, 2020).

In 2007, Ecuador proposed the Yasuní-ITT Initiative where close to a billion barrels of oil would be left in the ground in one of the most biodiverse corners of the planet - in exchange for the international community giving financial help amounting to half of the expected income from the oil, to be used for changing the Ecuadorian economy onto a post-carbon course (Larrea and Warnars, 2009). The initiative ultimately failed, but raised the profile of the question about appropriate mechanisms for keeping fossil fuels in the ground on the international level - a question that still remains unanswered.

In 2015, President Tong of Kiribati called on other leaders to establish a moratorium on new coal mines and coal mine extensions. Later that year, the Suva Declaration by Pacific Island leaders called on governments to initiate a dialogue on a moratorium on fossil industry development, especially coal mines. So far, the call remains unanswered.

Other nations have also taken action: Costa Rica has a moratorium on oil exploration in place until 2021 (Sequeira, 2014), some countries and states have banned fracking (France, Bulgaria, Germany, Ireland, Québec and New York State) and thus stopped extraction of oil and gas from shale formations that cannot otherwise be recovered. Greenland recently became the first country to ban oil and gas exploration for climate reasons (Buttler, 2021). Spain and New Zealand have also stopped giving further oil & gas licenses and California intends to end oil & gas extraction by 2045 (Lo, 2021). Both the Powering Past Coal Alliance launched in 2017 and the Beyond Oil and Gas Alliance launched in 2021 have formed coalitions around the common agenda of phasing out these fossil fuels. These *first movers* are setting precedents for other countries to follow, even if policies and proposals sometimes fail, are temporary, or get rolled back - as in the United States, where the Trump administration promoted drilling for oil and gas in protected areas and offshore, rolling back previous measures against extraction.

Between the top-down approach of global climate targets and the bottom-up efforts of first movers, there is currently little connection. With the carbon bombs analysis we hope to cover some of the middle ground, bridging the two, and showing where progress needs to be made for arriving at globally relevant numbers.

2.4. Defusing carbon bombs

In order to identify worthwhile objectives for supply-side mitigation efforts, we provide a list of the biggest individual units of potential fossil fuel emissions: carbon bombs. Framing climate change mitigation as “defusing carbon bombs” can capture the highly abstract challenge of managing global CO_2 emissions in a concrete way and offers a “collective action frame” (Benford and Snow, 2000) that builds a bridge between the global level of the climate system and concrete energy policy and activism choices by establishing a middle level of discrete and discernable projects that are on a scale that can be influenced through the actions of small groups of people. At the same time the wording implies the urgency of the matter.

3. Method and data

For calculating potential emissions of carbon bombs we use average IPCC emissions factors for direct CO_2 emissions from burning the fossil fuels in question (Eggleston et al., 2006). For projects already in operation, we include them in the list if they still have more than 1 gigaton worth of CO_2 emissions in remaining reserves. The method is purposefully straightforward: our aim is not to project the precise amount of emissions that would be generated over the lifetime of each project, but rather give an estimate of the potential climate impact from the largest projects.

We only include extraction projects, but not transport infrastructure (LNG terminals, pipelines, ports), nor demand-side pieces of infrastructure such as power plants in our analysis. This avoids double counting in our global analysis. Drawing on additional datasets, future work could conceptualize such pieces of infrastructure as carbon bombs as well. *Oil and gas pipelines* could be considered carbon bombs if they allow for the additional extraction and transport of oil or gas that results in over 1 Gt CO_2 emissions. This is the case for many pipelines, assuming a 40 year lifetime and use at full capacity, any pipeline with a capacity over 200,000 bpd of oil or 10 bcm of gas per year qualifies for that status. *LNG terminals* with a capacity bigger than 15 mtpa can be carbon bombs over a 40 year lifetime. As an example, the South Korean Incheon LNG terminal has a processing capacity of 38 mtpa, resulting in a potential of 1 Gt CO_2 emissions over less than 12 years (see Kühne, 2021 for a quick method to estimate emissions of such projects). *Coal power plants* could theoretically reach the size, but the Global Coal Plant Tracker (Global Energy Monitor, 2020) lists only two canceled projects worldwide with lifetime CO2 emissions over 1 Gt CO2.

3.1. Reserves data

The sources presented in Table 1 were screened for carbon bombs, identifying projects that are already in operation or planned.

For oil & gas reserves, we used the Rystad UCube database, a commercial database and identified all projects, existing and planned, with more than 2.5 billion barrels of oil equivalent reserves or 400 bcm of gas equivalent reserves. A project is defined as follows in the Rystad database: "*Project is a practical aggregation of assets. Typically a Project consists of assets to be developed as one industry project. For US onshore Project corresponds to all assets in same basin in same state, or same shale.*" After performing the calculation with the emissions factors described below, projects with less than 1 Gt CO_2 potential emissions were discarded from the list.

Fuel	Database/Publication	Identification criterion	Year of publication
Coal	BP Statistical Review of Energy	countries with >375 million tons reserves	2020
	US EIA	mines with >10 million tons annual production, reserves bigger than: 385mt anthracite 375mt coking coal 410mt bituminous 500mt coal (general) 555mt sub-bituminous 835mt lignite	various

	Global Energy Monitor Coal Mine Database	Reserves bigger than thresholds above	2021
Oil & Gas	Rystad UCube	>2,500 million bbl oil equivalent reserves	2020

Table 1. Data sources for identifying carbon bombs.

For coal reserves, in a first step we identified all countries over a threshold of 375 million tons of coal reserves in the BP Statistical Review of Energy (BP, 2019). Only countries individually listed were considered. The sources provided by the US Energy Information Administration for its estimates of coal reserves (EIA, 2021) were then consulted to identify individual coal mines above the carbon bomb threshold. Government and company reports, and in the absence of these, industry news reports were used to identify the latest available reserve figures. Sources are given in column L of the Coal sheet of the dataset (Appendix 2). In a final step, the resulting list was compared with Global Energy Monitor's Global Coal Mine Tracker (Global Energy Monitor, 2021) to identify further mines or more up-to-date information.

Coal reserves are defined in this dataset as "recoverable reserves": the amount of coal at a mine that is considered economically mineable with the highest degree of confidence. Recoverable reserves include measured resources that are sufficiently "proved" and indicated/measured resources that are "probable." This approach enabled us to estimate carbon bombs at the mine-level, where extraction is ongoing or proposed. The use of recoverable reserves also provides a more consistent approach to global reserve figures, which can vary based on local standards of measurement and reporting, although currently national reserve estimates are being unified into a single framework by the Committee for Mineral Reserves

International Reporting Standards (Expert Group on Resource Classification, 2015). When recoverable reserve figures were unavailable, we collected data on coal resources and indicated those in the dataset in column H “Reserve category.” Those mines likely have smaller recoverable reserve sizes than indicated, but without data on drilled and sampled measurements, this is the best available information for our analysis.

3.2. Production data

Production data stem from Rystad (Rystad Energy, 2020) in the case of oil and gas and the German Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Institute for Geosciences and Natural Resources, 2021) in the case of coal.

3.3. Emissions factors

For estimating the average emissions of different fossil fuel reserves, we build on the work of the Production Gap Report (SEI et al., 2019) which uses adjustments for fugitive emissions and non-energy uses of coal, oil and gas for their projections. In our approach, we have not included those adjustments which work in opposite directions. Our numbers are therefore labeled as *potential emissions* - the emissions that would result if all reserves were burnt. By excluding methane leakage, we slightly underestimate the global warming potential, particularly of the gas carbon bombs. By excluding non-energy uses (e.g. plastics, fertilizer, etc.) where the products are not burnt and the carbon may not reach the atmosphere in the form of CO2 - we slightly overestimate the emissions in a real-life use case. The emissions factors used are described in the tab “Emissions Factors” of Appendix 2. We opted for such a simplified approach towards emissions factors, because we are concerned with giving a global picture of the biggest fossil fuel projects, and establishing the identity of those projects. A more precise accounting of potential emissions would change the overall position of a carbon bomb on the list only in a small number of cases and only in border cases where adapting the formula pushes individual projects above or below the limit, the composition of the list would be modified at all through such methodological fine-tuning. SEI et al. (2019, Annex B3) have also shown that the difference between a top-down approach with just one global emissions factor vs. a bottom-up approach using individual country data tends to be relatively small. We therefore opted for the top-down approach. Additionally, comparability and future efforts to update the carbon bomb inventory will be facilitated by a simpler methodology. Our aim is to contribute to the "defusing" of carbon bombs. If successful, emissions will be zero for projects that have not started yet or much lower for those already in operation. Therefore a very precise quantification of emissions defeats the purpose of our work.

3.4. Harvest mode analysis

To explore the potential results of a policy of stopping further investments into carbon bombs, we ran a scenario of putting all existing carbon bombs into “harvest mode”. This means naturally declining output of producing oil and gas fields, a scenario that is described by the International Energy Agency as a “no new investment” scenario (International Energy Agency, 2020a Figure 7.3, 2018, p. 158). As a proxy, we used an 8% annual decline in output from existing fields for oil and gas. We did not differentiate between conventional and fracked wells, although the second have much higher decline rates (Peters, 2021), because they account for a minor portion of global oil and gas supply. This is a simplification of the picture, because there are big differences in decline rates between different unconventional and conventional oil and gas fields and also between ramp-up, legacy and post-peak fields (International Energy Agency, 2018, pp. 159–160).

For coal, we performed a simpler harvest mode analysis, based on the assumption that once coal mines have reached an annual extraction capacity they can run at that level with limited further investments. We simply assumed that all existing mines continued extraction at 2019 levels until 2050. For 13 of 137 operating mines this meant they would exhaust their resources. The rest of them still had reserves remaining at 2050. To establish the validity of our harvest mode analysis, we compared it with two IEA scenarios from the 2019 World Energy Outlook (International Energy Agency, 2019, fig. 5.13): A "strict" scenario without new investment, which shows a global roughly linear decline of 4% of current global extraction capacity going offline each year, resulting in zero coal extraction in the year 2043.[1] A "softer" scenario with a 2% annual linear decline was derived from the IEA estimate for production going forward under continued "brownfield investment", but no investment in new “greenfield” mines. Note that the IEA figures are for all global coal extraction, and our figures only for the 137 biggest projects globally.

[1] The graph ends in 2040. Continuing the trend from 2018 in a linear fashion meets zero in 2043.

4. Results and Discussion

We have identified 425 carbon bombs. 195 oil and gas projects fall into this category, 76 of which are new projects that had not started production in 2020. We identified 230 coal mines with over 1 gigaton of potential CO_2 emissions, 93 of which had not been producing yet in 2020. Table 2 gives an overview of the numbers of projects in the different categories and their potential emissions.

Category	**Coal total**	**Oil & Gas total**	**Carbon bombs total**	***Coal new***	***Oil & Gas new***	***New Carbon bombs total***
# of projects	230	195	425	*93*	*76*	*169*
Potential emissions (Gt CO_2)	536.2	646.0	1182.3	*225.2*	*193.8*	*419.0*

Table 2. Number of total and new carbon bombs and their potential emissions.

Figure 1 shows the global map of carbon bombs with combined potential emissions given for each country. The complete list with all project names, ordered by country, can be found in Appendix 1.

There are only 10 countries with more than 10 carbon bombs: China (141), Russia (41), United States (28), Iran (24), Saudi Arabia (23.5)[2], Australia (23), India (18), Qatar (13), Canada (12) and Iraq (11). Together, they account for three quarters of the emissions potential of all carbon bombs.

Potential CO_2-Emissions

Country	Potential Emissions
China	332.9
United States	151.1
Russian Federation	117.0
Saudi-Arabia	107.1
Australia	46.3
Qatar	43.3
Canada	39.0
Iraq	27.6
India	27.0
Brazil	25.9
Iran	23.9
United Arab Emirates	23.0
Indonesia	21.9
Kazakhstan	20.3
South Africa	18.2
Kuwait	17.1
Mongolia	16.0
Turkmenistan	13.3
Mozambique	11.8
Mexico	10.3
Colombia	8.8
Venezuela	7.8
Algeria	5.8
Poland	5.6
Argentina	5.2
Pakistan	4.7
Turkey	4.1
North Korea	3.2
Germany	3.0
Norway	2.8
Libya	2.7
Serbia	2.5
Bulgaria	2.5
Uzbekistan	2.4
Denmark	2.2
Botswana	2.2
Greece	2.2
Guyana	2.1
Ukraine	1.7
Azerbaijan	1.7
United Kingdom	1.5
Bahrain	1.4
Bangladesh	1.4
Syria	1.4
Israel	1.1
Nigeria	1.0
Tanzania	1.0
Zimbabwe	1.0

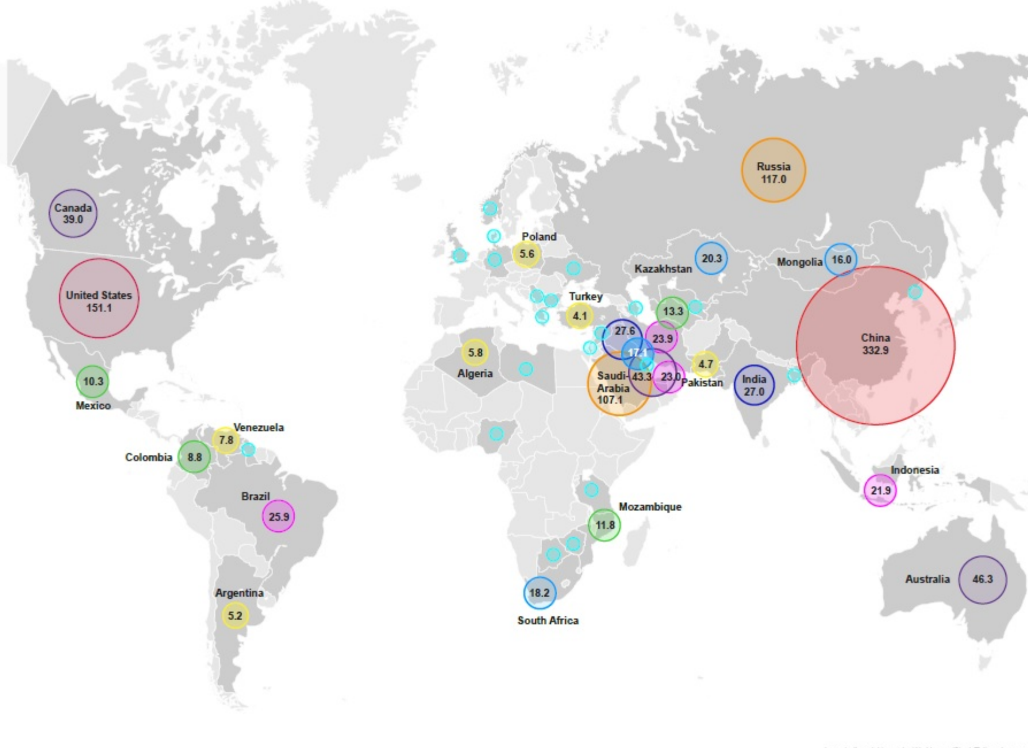

Figure 1. Potential CO_2 emissions from carbon bombs per country Source: Own data

In terms of current production, carbon bomb projects in operation were responsible for 45% of global oil and gas production and 25% of global coal production in 2019 (see Appendix 2, “production share”). A focus on these projects thus has the potential to address a significant portion of global fossil fuel emissions.

[2] The Khafji project in the Neutral Zone between Saudi Arabia and Kuwait that is operated jointly by both countries has been assigned to 50% to each country in our list.

The potential emissions of the sum of all carbon bombs are roughly double the remaining 1.5°C budget (IPCC, 2018, p. 12)(see Figure 2), an important climate policy benchmark.

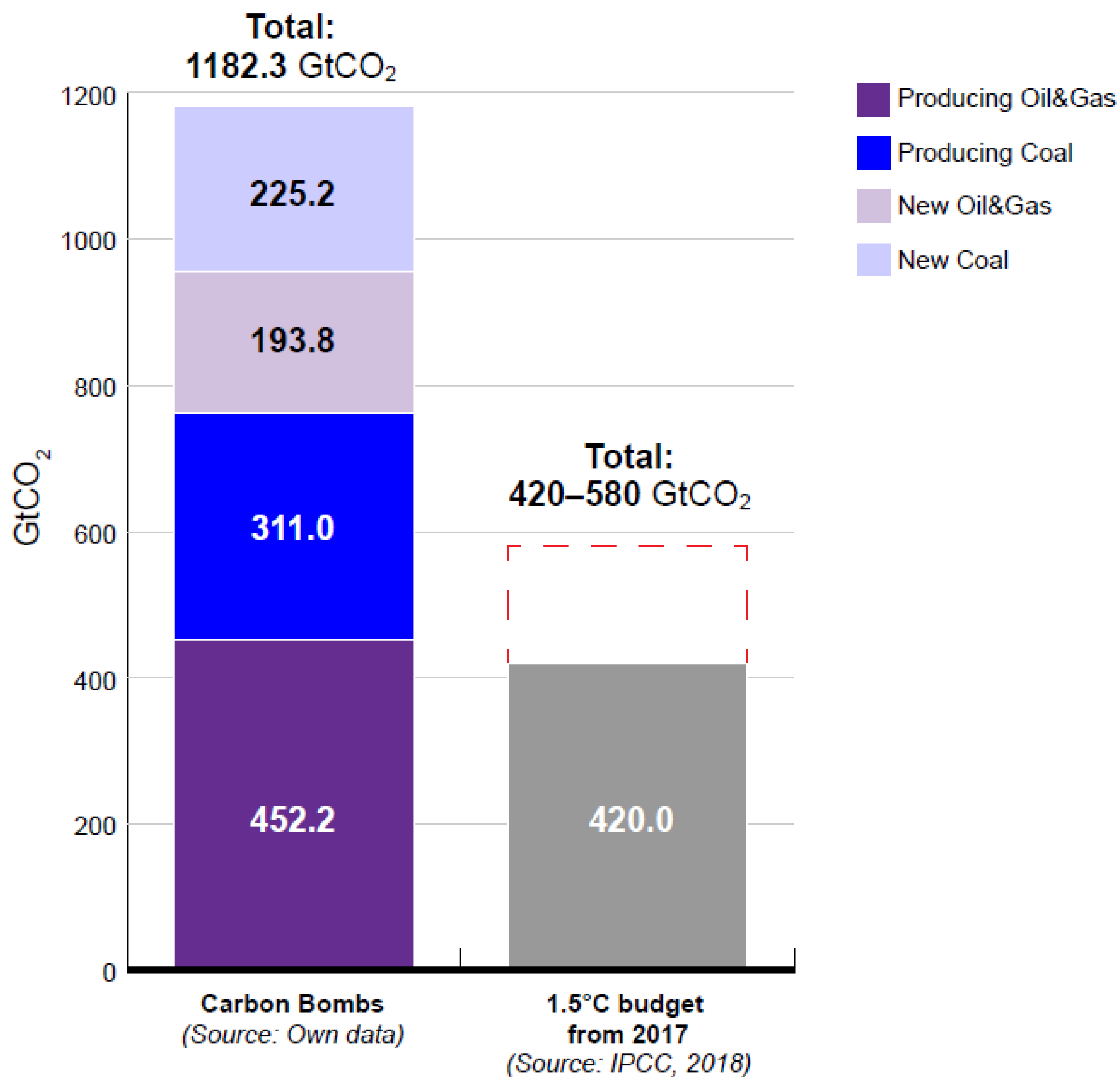

Figure 2. Combined potential emissions of all carbon bombs versus 1.5°C carbon budget

Sources: Own data, based on Rystad, 2020, Global Energy Monitor, 2021 (Carbon bombs), and IPCC, 2018 (1.5° carbon budget)

A number of carbon bombs have not started extraction yet. In some cases, the required infrastructure has not yet been built. The combined potential emissions of new carbon bombs are 419 Gt CO_2 (225 Gt from coal, 194 Gt from oil & gas).

Our harvest mode analysis leads to a combined production until 2050 of 318 billion barrels of oil equivalent (113 Gt CO_2) and 64.2 billion tons of coal (128 Gt CO_2), resulting in a combined 241 Gt CO_2 over the period 2019-2050 - a figure much more compatible with a 1.5°C carbon budget. Our simple harvest mode model only offers a very limited view of global fossil fuel markets. More detailed models with refined assumptions are needed to give a better picture on potentially stranded assets among carbon bombs.

When comparing our results with findings of previous research, a few reference points are helpful.

The Production Gap report has pointed to the difference between governments' climate pledges and supply side energy policies (SEI et al., 2019), resulting in a gap that is 50% as wide as permissible production under a 2°C pathway and 120% as wide under a 1.5°C pathway in 2030. Our perspective on carbon bombs coincides in identifying a large overhang of potential emissions coming from the supply side, and helps refine this production gap picture by naming the biggest projects that would be responsible for a significant part of this excess production.

The Sky's limit report (Muttitt, 2016) identified the potential emissions from existing oil and gas fields and coal mines and compared them with 1.5° and 2° carbon budgets, arriving at the conclusion that existing infrastructure would be enough to take us past those thresholds. Again, our findings are consistent with this, in that existing carbon bombs have more reserves than would be compatible with 1.5° and no new fossil fuel infrastructure is admissible from a climate perspective.

A third line of work looks at the lock-in of emissions from demand-side fossil fuel infrastructure, such as power plants, internal combustion engine cars (Smith et al., 2019; Tong et al., 2019). This research indicates that with near-term action in the sense of ceasing to build new fossil fuel infrastructure, the 1.5° and 2° C targets would be reachable. Our research focuses on the supply side and thus complements this demand-side picture with some new insights from the supply side of fossil fuels and priorities for bringing it in line with the global climate targets.

As discussed in the literature review section, we provide a more detailed perspective on previous regional overviews of unburnable carbon (McGlade and Ekins, 2015; Welsby et al., 2021).

Our results furthermore agree with authors that have pointed out the importance of climate change mitigation efforts to focus on fossil fuel extracting countries (Johnsson et al., 2019). These countries must be part of an ambitious conversation, else mitigation efforts might fail to reach their global objective.

Taken together, two thirds of carbon bombs are located either in China, Russia or the Middle East and North Africa regions. These regions have so far received very limited attention in terms of efforts to stop fossil fuel extraction. A closer look at Chinese coal (130 projects, including 48 new ones) and Middle Eastern oil & gas projects (82 projects, including 24 new ones) are urgently needed to avoid locking in an overshoot of the Paris targets. Other hotspots of carbon bombs are in the United States, Australia, India and Canada. These countries will have to be more actively engaged in searching for ways to meet the Paris targets, and the likely path leads via defusing some of their carbon bombs.

China interestingly has a history of striving to close small coal mines, leaving only major, more efficient ones (Cao, 2017). The average mine capacity is now over 1 million tons per annum (Fitch Ratings, 2020). The Chinese coal mining sector deserves more focussed attention from the climate policy community because it makes up the largest number of carbon bombs globally and more studies such as Shi et al.'s (2018) examination of the Chinese capacity cut policy would be useful.

Some existing carbon bombs may have escaped our method where exploration activities are still taking place. Reserve numbers also see changes when prices change and the oil price depression in 2020 may have made the extraction of some carbon bombs unviable, leaving fewer carbon bombs to defuse. On the other hand, a rebound in fossil fuel prices could add more projects to the carbon bombs list by increasing the reserves in individual projects beyond the threshold.

5. Conclusions and Policy Implications

We have mapped the biggest fossil fuel projects worldwide, 425 carbon bombs, with a CO_2 emissions potential exceeding 1 Gigaton in each project. The potential emissions from these projects exceed the 1.5°C carbon budget by a factor of two. We showed that there is a high concentration of these projects in countries that have so far received little attention by those looking at the supply side of climate change mitigation: China, Middle Eastern countries and Russia. This is a major gap in mitigation policy and urgently needs to be addressed. There are over a hundred new carbon bombs currently being planned. As a direction for dealing with carbon bombs, in the following we discuss some strategic options.

5.1. No new projects

Our results on “new” carbon bombs indicate that a moratorium on new carbon bombs could avoid about a third of potential emissions from carbon bombs.

Coal mines and oil & gas fields, especially of the size considered in this article, have long lead times and require years for planning, regulatory approvals and acquiring financial backing in the billions of US dollars. The time until a project recovers its initial investment (“breakeven”), tends to be over ten years for such big projects (Muttitt, 2016, p. 35 Figure 12). Because investments in fossil fuel projects need to compete with other alternative uses of the capital, the return on investment is critical. Companies internally often apply so-called hurdle rates, where an investment will not go forward if it does not meet the hurdle rate, typically 10% as an internal rate of return (Erickson et al., 2020). Erickson et al. (2017) have analyzed how many fossil fuel projects in the US are pushed over the hurdle rate through fossil fuel subsidies. Implementing the long-standing G20 commitment to eliminate fossil fuel subsidies could thus result in a shortening of the list of carbon bombs.

In today's energy context, with an ongoing energy transition towards renewables and ambitious climate policy targets adopted at the global level by all countries through the UNFCCC and on a national level in a stepwise fashion, there are strong question marks over the reliability of decades-long forecasts of revenue for fossil fuel projects (Atanasova and Schwartz, 2019; Krane, 2017). The least risky strategy under these circumstances is to forego the investment. A strictly economic analysis (such as Welsby et al., 2021) does not adequately capture the dynamics of a market with a significant percentage of actors not mainly driven by economic incentives, but rather responding to a range of political factors. If further carbon bomb projects are started, the relevant actors must seriously consider the danger of generating a stranded asset. Failing to act accordingly and exercising prudence can often be explained by misaligned incentives and political economy analyses have been used to shine light on these dynamics (e.g. Brauers and Oei, 2020).

The recent IEA roadmap for net zero by 2050 which arrived at the conclusion that no new oil and gas fields nor coal mines are needed (Bouckaert et al., 2021) aligns well with the argument. Increasingly, oil and gas exploration is also questioned in courts on the grounds of its incompatibility with global climate change mitigation (Médici Colombo, 2020). Therefore, further inquiry into the potential emissions impacts of carbon bombs projects and their compatibility with global climate change mitigation pathways, both on an aggregate and a project level are needed, especially where investments are still considered. The UN Secretary General has stated in August 2021 that countries should not explore for more fossil fuels nor start new extraction projects (United Nations Secretary-General, 2021). Our analysis points in the same direction and outlines a priority list of projects that could be questioned.

5.2. Harvest mode

During the COVID-19 pandemic, most oil and gas companies found themselves in a situation of low oil prices and little capital for investments and exploration. Some privately-owned companies ceased to pay dividends. In 2021, prices were on the increase again, and these same companies were under pressure to reestablish dividends and align their plans with the Paris Agreement, rather than withholding the money from their shareholders and investing in further extraction which is incompatible with the Paris Agreement. Applying a “harvest mode” strategy, which consists of continuing extraction without new investments, is one possible response to the challenge. It could be combined with a shift in focus of a business towards other sectors within or beyond energy (see Harries and Annex, 2018 for a successful example; and Harrigan and Porter, 1989 for general strategies). Applying a harvest mode strategy can stabilize a fossil fuel business and reduce its risks, because it continues to provide returns, as no investment needs to be made while fossil fuels are still harvested. This property of a harvest mode strategy might make it a useful ingredient of the conversation about a “managed decline” of fossil fuels (Erickson et al., 2018). It provides a potential alignment of different interests: firstly, central banks focused on stability of the financial system, which would be threatened by the collapse of big companies (Baer, 2020); secondly, governments focused on a strong economy and stable jobs; thirdly, investors focused on financial returns; and lastly climate-vulnerable countries and young generations focused on a swift reduction in fossil fuel emissions.

Different fossil fuel sectors have different decline rates when applying a harvest mode strategy, with unconventional oil and gas extracted through fracking having much steeper declines than conventional oil and gas or coal. Our analysis indicates that this strategy might make a contribution to aligning fossil fuel supply with climate goals. On the demand side, the work of Millward-Hopkins et al. (2020) indicates that there is also potential for a bigger alignment, while meeting the basic needs of the global population.

5.3. Early closure

The major part of coal globally today is used for electricity (International Energy Agency, 2020b). Levelized cost of electricity analyses show that renewables are replacing coal as the cheapest source of electricity in most major countries (Ram et al., 2018). However, coal-fired electricity is often shielded from market competition, meaning that it can persist even when it is effectively more expensive than cleaner energy sources (Bodnar et al., 2020). This situation, where consumers pay more for coal power which is not only high in emissions, but also highly polluting, may change soon. Finance mechanisms have been proposed that could unlock benefits of cost, emissions and health (Bodnar et al., 2020; Kanak, 2020). The necessity of early closure due to climate constraints has already been examined for coal power plants (Kefford et al., 2018), and for coal mines (Auger et al., 2021; Caldecott et al., 2016; Lucas, 2016).

China dominates the global coal picture, and a wave of coal mine retirements expected in the mid-2020s (International Energy Agency, 2019, p. 244) provide an opportunity for a shift. Opening new coal mines as replacements may increase the need for early closure of existing coal mines. If and how the list of 48 new Chinese coal carbon bombs we have identified is being planned to start operations in this decade is an urgent question to be tackled, in order to identify alternatives.

What early closure would mean for oil and gas carbon bombs needs to be investigated. Today, only when operating costs fall below revenue levels, projects tend to close down. However, this creates the issue of "stranded liabilities" when clean-up obligations are not sufficiently covered through guarantees during the operational phase (Schuwerk and Rogers, 2020). When bankruptcies occur, as has been the case in the coal sector in recent years, these liabilities are absorbed by the public. Several scenarios are possible in this "fossil endgame": a big crash, destabilizing financial markets, or intervention through central banks which absorb potentially stranded assets and liabilities in a proactive manner and allow a managed decline (Kroll, 2018).

5.4. Defusing carbon bombs

As shown, there are too many carbon bombs being activated, so an obvious question raised by our analysis is: how can carbon bombs be defused?

In theory, some policies, such as a “No New Coal Mines” policy (Denniss, 2015) or a “Coal Elimination Treaty” (Burke and Fishel, 2020) propose to automatically eliminate a significant number of them. A global fracking ban, as called for by a coalition of NGOs, or an offshore drilling ban could eliminate an additional amount. While outright banning fossil fuels (Green, 2018) seems appropriate in the face of the climate emergency, the list of countries with a large number of carbon bombs indicates the challenge of a rather entrenched fossil fuel model with governments and corporations with very tangible interests in pushing the projects forward - a situation that has been called carbon entanglement (Gurría, 2013).

Therefore, in practical terms, political economy concerns (Zhao and Alexandroff, 2019) are key for achieving a swift phase-out, and poorer countries who are especially vulnerable (Cust et al., 2017) might require some dedicated support.

In the absence of government action to limit fossil fuel supply, a growing number of social movement actors have taken to blocking fossil fuel infrastructure, such as pipelines, coal mines or ports through actions of civil disobedience over the past years (Gaulin and Le Billon, 2020; Piggot, 2018). While they are illegal in many cases, they have increasingly been justified in court as based on the necessity to avoid greater harm (McGraw, 2018).

Some important regions and their extractive sectors however are currently almost unattended by the climate movement, namely the Middle East, China and Russia. Given the size of the carbon bombs' potential emissions, this is a gap that needs to be closed urgently by the climate movement, because without defusing a sufficient number of carbon bombs, meeting the Paris targets will be impossible.

While some non-governmental actors are already engaged in trying to defuse a small subset of carbon bombs, official climate change mitigation policy must not ignore the issue either. In order to defuse a significant amount of carbon bombs, a serious supply-side discussion among big fossil fuel producer states is needed. Especially China, Russia and Middle Eastern countries, along with the United States urgently need to start exploring non-extraction options. The discussion could start with identifying global principles for a managed decline and create a priority list of carbon bombs that can easily be defused. Reverse auctions have also been proposed (Pellegrini et al., 2021). Coal carbon bombs would likely be the first to be pledged by countries to be defused, followed by marginal oil & gas projects (see Collier and Venables, 2014 for a proposal of a similarly staged approach). With the proposal of a Fossil Fuel Non-Proliferation Treaty (Newell and Simms, 2020) some detailed thinking is already available on how this process could be structured, using the successful process in nuclear arms control as point of departure.

A dialogue on limiting fossil fuel extraction would not only be useful for avoiding carbon lock-in and a very volatile market situation for fossil fuel exporting countries - as has been the case in the early 2020s, but it would also be a way to minimize the amount of additional stranded assets being created. Managing the transition away from fossil fuels in coordination could be a stabilizing force in a world in energy transition and reduce the risk of emissions leakage which reduces the attractivity of unilateral action.

5.5. The way forward

The carbon bombs framing translates the rather abstract and intractable challenge of mitigating climate change to a very concrete and specific task of defusing a number of carbon bombs in each country. As an example, in Germany there are two carbon bombs, both lignite mines. Shutting them down should be a priority for climate change mitigation. However, to consider defusing those 425 projects as a new or different mitigation agenda would be too simplistic. The size of potential emissions is just one of many perspectives under which a fossil fuel project can be viewed. Some other factors that influence the views of political, economic and social movement decision makers are cost, location, emissions intensity (as opposed to overall size), available alternatives, fiscal revenue, jobs, and whether it is an existing or a new project.

Studying and understanding the individual carbon bombs of our list will be essential for developing useful approaches tailored to each context. Some defusing may be negotiated internationally, some may be tackled mainly at a national policy level, some may be struggles of movements with lawsuits and blockades. The concentration of two thirds of potential emissions of carbon bombs in just ten countries potentially makes the targeting of multilateral efforts easier, as only a limited number of governments need to participate in an initial dialogue. The lack of an effective civil society pursuing climate ambition in several of these countries means that such government-focused efforts are even more important. Defusing carbon bombs will be essential for keeping temperatures below 1.5° warming and new strategies are needed for designing effective measures that will result in their non-extraction - an area so far neglected by mainstream mitigation policy (Verkuijl et al., 2019).

Identifying coal carbon bombs to a common standard has proven challenging (see the Methods section), and for oil and gas we had to resort to a commercial, paid service (Rystad) to get reliable data with global coverage. This illustrates the need for more transparency in the sector, and the global fossil fuel registry (Byrnes, 2020) could be a step forward in bringing it about. The list of carbon bombs can also be used as an *indicator of progress* of global mitigation efforts. If demand-side mitigation measures are effective towards the ultimate UNFCCC goal of avoiding dangerous anthropogenic interference with the climate system, they will have an impact on the list of carbon bombs, limiting their full exploitation.

In this article, we have introduced a new methodology to identify the world's biggest potential fossil fuel emissions sources. Our list of carbon bombs brings much clarity to the question of where the climate crisis can be addressed from the supply side. The list can assist activists and policymakers alike in setting priorities and preparing the next step of defusing carbon bombs. A number of jurisdictions have recently declared climate emergencies. Defusing carbon bombs could be a priority in response to the emergency, to meet the Paris targets and avoid planetary run-away climate change.

6. References

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7. Addendum

On page 102, the term "optimistic" refers to an optimistic estimate in terms of the size of potential resources that could be extracted.

In the harvest mode analysis (section 3.4.), the 8% decline rate for oil and gas fields is the rate which the IEA estimates to be the minimum decline rate without further capital expenditure (International Energy Agency, 2018, p. 158). Calculating a single decline rate for the global oil and gas industry is obviously a strong simplification of the picture which hides a wide diversity of geological, technological, economic and political situations under which oil and gas is extracted. If the decline rate was lower, the total amount of oil and gas extracted under the scenario would be higher and hence emissions as well. If the decline rate was higher - as the IEA notes it could be (International Energy Agency, 2018, p. 158) - it would result in lower amounts of oil and gas extracted under the scenario and lower CO_2 emissions.

For the comparisons with other research made in the results and discussion section (4.), it is important to keep in mind, that we are only looking at a selection of fossil fuel projects - the biggest ones above our gigaton threshold - and that on top of the potential emissions contained in the carbon bombs, there are even more - and which we have not quantified - from smaller projects. Combined, the emissions from these smaller projects could exceed those in the carbon bombs, given that carbon bombs account for less than half of global oil and gas extraction and a quarter of coal.

IV. Defusing a carbon bomb: Stopping fracking in Mexico

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Abstract

Bending the curve on greenhouse gas emissions is one of the big challenges of our times and the "keep it in the ground" (KING) approach has received increasing attention from activists, academics and policymakers over the last decade. In this case study based on stakeholder interviews we study the key strategies of Mexican KING activists and the effectiveness of their efforts to stop fracking. We show how they have used the strategies of sharing information, linking with the frontlines and seeking a legal fracking ban to varying degrees of success. A new conceptual lens, that of economic windows of opportunity, is applied to add to the understanding of the context for KING efforts, and their prospects of success.

Keywords

Fracking; Keep it in the ground movement; Mexico; carbon bomb; political opportunities; activist strategies

1. Introduction

The world faces a climate emergency. With the Paris Agreement, governments have set ambitious temperature targets to address this emergency in 2015, but effective policies to reach those targets are lagging behind, and after a dip in global greenhouse gas emissions due to Covid in 2020, they are on the rise again. Governments have only recently started to embrace the solution of keeping fossil fuels in the ground, also termed supply-side mitigation - the "next big step in climate policy" (Erickson, Lazarus, and Piggot 2018). However, the mitigation challenge is not only confronted by governments, a vibrant global climate movement also participates in the search for effective ways to bring down emissions, and supply-side approaches that cut fossil fuel extraction[1] have received increasing attention over the past years (Gaulin and Le Billon 2020). While local grievances and resistance to fossil fuel extraction are almost as old as the fossil fuel industry, a global "Keep it in the ground (KING) movement" which aims at stopping fossil fuel extraction which exacerbates the climate emergency (Kühne 2021), has arisen only over the past decades and unites these local concerns with global climate concerns. It stands against a still-powerful fossil fuel industry and over 400 gigaton-size "carbon bombs" on a global level (Kühne et al. 2022) many of which must be defused to maintain climatic stability.

The current paper aims to contribute to the understanding of the KING movement and its strategies. We want to gain a better understanding of relevant factors for its pathways to success - defined as stopping fossil fuel extraction - and, to that end, use a case study from the (understudied) Global South, focusing on a KING movement actor in Mexico. Our research questions are to determine which strategies Mexican fracking opponents have used to deactivate a Mexican carbon bomb; how effective these strategies have been; and what key factors for success were. In answering these questions in the results section, we adapt existing concepts to better capture the conditions for KING success.

Our case study encountered a complex situation with several contradictions, including a pro-fossil fuel president adopting an anti-fracking discourse, and halting some of its practice, but then not instituting anti-fracking laws, nor halting preparations for future large-scale fracking. In

[1] We do not use the term "production", still commonly used, because it clouds the understanding of fossil fuels as non-renewable resources and evokes an erroneous notion of a steady supply, while "production levels" are in reality just the "speed of depletion" of non-renewable resources.

order to resolve the puzzle, we propose a new conceptual lens, which we call “economic windows of opportunity”. It draws on environmental and social movement literature and in particular political opportunity theory (Kingdon 1984). We thus examine the ‘windows of opportunity’ landscape (economic and political) of Mexican fracking and go on to argue that the new concept can not only help make sense of the situation, but the KING movement build winning strategies by bringing the stop-and-go nature of the development of fossil fuel projects into sharper focus.

2. Conceptual framework

We start with the challenge that the KING movement faces anywhere in the world: transforming, and ultimately stopping, a landscape of material and social configurations that enable the extraction and burning of fossil fuels - which Haarstad and Wanvik (2017) have called carbonscapes. We focus on the *agency* of the KING movement in investigating what strategies activists have used to achieve their goal. We inquire about the key target of activist strategies, using Kingdon’s multiple streams model (1984) to understand the efforts of Mexican anti-fracking activists. However, the success or failure of their efforts does not emerge clearly when using this framework which is focused on political opportunities. We therefore introduce a new concept, loosely inspired by Kingdon, which asks about the combination of political and economic windows of opportunity as essential conditions for fossil fuel projects to move forward.

2.1. Carbonscapes and defusing carbon bombs

Haarstad and Wanvik define *carbonscapes* as: “the spaces created by material expressions of carbon-based energy systems and the institutional and cultural practices attached to them” (Haarstad and Wanvik 2017:433). Their idea draws from assemblage theory (De Landa 2006) and iIt is a useful concept for those aiming to facilitate the swift transition from a fossil fuel based energy system to a fully decarbonized one, because the concept makes the potential for systemic change explicit. Haarstad and Wanvik suggest identifying *converters* which expose *instabilities* in these carbonscapes and have the power to reshuffle the assemblage. They give the Fukushima accident as an example, which pushed the German *Energiewende* forward by accelerating the nuclear phase-out, realising some potential in the German energy assemblage that was formerly present as *relations of exteriority* but only materialised once the converter activated it. Through Fukushima, the potential of a swift phase-out of nuclear power turned from a possibility into a reality. This conceptual tool focuses the mind on where a whole supply chain can be disrupted, a whole industry halted or a question mark put behind a full project, rather than just some of its details.

In this paper, we further sharpen the focus from unintentional (via external events) to intentional transformation of carbonscapes (via activist strategies), and thus add an *agency* dimension to the "instabilities of carbonscapes" concept, hopefully making it even more useful for the KING movement. By closing at least one window of two that must both be open for fossil fuel projects to go forward, the political *and* the economic (see section 2.4. below), activists can make a project unviable and thereby profoundly transform a carbonscape, eliminating whole segments of it on the supply side and sending a ripple effect downstream. In our case study, we explore the strategies with which activists have accomplished this.

2.2. Activist strategies of the Keep it in the ground (KING) movement

The KING movement is opposing what Naomi Klein terms the "arsonists": fossil fuel interests and projects (Klein 2019). Their continued exploitation and burning of fossil fuels for a profit is, through climate impacts such as rising temperatures and forest fires quite literally setting the planet on fire. The instance we examine is the Mexican resistance against oil and gas extraction through fracking, a technology used to extract previously inaccessible hydrocarbons. In particular, we focus on the Mexican Alliance against Fracking (*Alianza Mexicana contra el Fracking,* "the Alliance"), the key player in the resistance against fracking in Mexico.

Some parts of the KING movement have been discussed, e.g. the anti-fracking movement in the UK (Kirk, Nyberg, and Wright 2021) or the Ende Gelände alliance opposing coal in Germany (Sander 2017) and general overviews have been attempted (Cheon and Urpelainen 2018; Piggot 2018), but the movement is very dynamic and warrants more attention, given that we urgently need to bend the curve on emissions to avoid run-away climate change. Especially in the Global South, the KING movement is understudied, and we hope to make a useful contribution here to understanding it better.

In order to analyse the strategies of Mexican KING activists, we have an abundant literature on environmental movements to draw inspiration from (see Rootes 2014 for an overview). The diverse body of literature, academic and other, covering activist strategies relevant for the KING movement includes the Democracy Center's "Beating Goliath" (Arquiñego et al. 2011) which analyses cases of successful campaigns against corporations, Bill Moyer's Movement Action

Plan (Moyer, MacAllister, and Soifer 2001) which charts the progression of movements through different stages and towards success, Naomi Klein's "This changes everything" (Klein 2014) which describes a range of activist interventions from what she terms "Blockadia", Fusco and Carter's anti-fracking toolkit (Fusco and Carter 2017) that provides 10 lessons learnt in the successful campaign against fracking in Newfoundland, Canada, the SmartMeme Collective's work on framing (Reinsborough and Canning 2010) and Routledge's exploration of spatial strategies (Routledge 2017).

Conceptual academic debates on activist strategies have focused on questions of radicalization versus institutionalisation (Coglianese 2001; Giugni and Grasso 2015; Seel 2000; Thörn and Svenberg 2016), local versus transnational emphasis (Beck 2002; Escobar 2001; Hawken 2007; Smith, Chatfield, and Pagnucco 1998), and environmental justice versus mainstream environmentalism (Mohai, Pellow, and Roberts 2009; Walker 2012) among others. These debates reflect tensions that occur to varying degrees in real-life organising.

While these debates are important and especially the works summarising lessons learnt are very valuable and constitute recommended reading for any aspiring KING activist, in practice, such previous study is not a common activity among KING activists. Therefore, the strategies we encounter frequently differ slightly or greatly from those already described in the literature, making it even more worthwhile to describe them, to inspire others to replicate or build on them. Where strategies are unique or new - as may potentially be the case with the "linking with the frontlines" strategy described in section 4.1.2. - we are making a contribution to the literature on social movement strategies.

2.3. Understanding activist strategies - the multiple streams model

When looking for ways how activists exploit instabilities in carbonscapes, we have taken inspiration from a common approach in the social movements literature, which focuses on political opportunities and in particular Kingdon's multiple streams model (Kingdon 1984).

In this model, three streams, the *problem*, *policy* and *politics* stream need to combine, to open a window of opportunity for policy solutions to be moved forward. As long as any of the three is missing, the desired change will not take place. This framework has been one of the dominant approaches in social movement studies in the past decades and many environmental movements have been examined through this conceptual lens (e.g. Almeida and Stearns 1998 in Japan; Marks and McAdam 1996 in Western Europe; McLaughlin and Khawaja 2000 in the US; and Van Der Heijden 1997, 1999, and 2006 internationally).

Carter and Jacobs (2014) have used it to analyse radical changes in climate and energy policy in the UK in the 2000s. Hoberg used it to explore the strategies of resistance to pipelines carrying oil from the Canadian tar-sands (Hoberg, Rivers, and Salomons 2012). He pointed to accessing *veto points* for new infrastructures (Hoberg 2013) and taking the battle to the constitutional court as activist strategies (Hoberg 2018).

In the school of social movement research that focuses on political opportunities and how social movements use them (e.g. Kitschelt 1986), a dominant conceptualization has been that political opportunities give rise to social movements. However, as Tarrow (1996) has pointed out, a more dynamic understanding, where social movements *create* political opportunities, manages to cover a wider range of empirical cases, and this applies also to the one reported here.

In section 4.2., we evaluate the evidence from our case study through the lens of the multiple streams model. However, the result is an unsatisfactory one, a sort of stalemate where the outcome of the case remains ambiguous. Therefore, we go on to use an additional, bespoke tool to further analyse the situation. This tool focuses on the economic dimension and is described in detail in the next section.

We are not the first to cross economic factors with questions about political opportunities. A focus on resource mobilisation is a separate approach in social movement studies (see e.g. Oberschall 1973; McCarthy and Zald 1977; Jenkins 1983), while it does not limit itself to material resources, but also looks at moral, cultural, social-organisational and human resources (Edwards and McCarthy 2011), it focuses on economic and other resources from a particular perspective: how movements acquire and use them.

Schurman and Munro (2009) discuss how British activists have successfully disrupted Global Commodity Chains and stopped genetically engineered food from entering the UK market. They speak of "economic opportunity structures" which are weak points in the supply chain that activists can attack. Spar and La Mure (2003) analyse several campaigns, including one against oil company Unocal which was doing business in Burma and ask the question why some firms respond to activist pressure and others don't. They come to the conclusion that the response depends on the costs and benefits of complying with or resisting activist demands. Luders (2006) also speaks of economic opportunity structures. In his case, these are conceived of as the perceived costs of economic actors, in particular disruption costs, with regards to their responses to movement demands. Wahlström and Peterson (2006) have expanded Kingdon's model by dividing the political further into state, cultural and economic opportunity structures in their analysis of the Swedish animal rights movement. In this case, the economic opportunity structure was such that it outweighed the state and cultural opportunities that were successfully used by the movement.

In an example that has certain similarities with our case study, Broadbent (1988) gives an account of a struggle over a landfill in Japan. He argues that even antagonistic political institutions can be understood as processes. This opens up the possibility of opportune moments for forcefully entering the process, as is shown in his case study. The movement in Japan ultimately won the fight against the project by delaying it, because by the time it was approved, there was an economic crisis and no money to go forward with the project. The KING movement can also win by delaying, as fossil fuel projects are effectively in a race against time which exposes them to oil and gas market cycles, political cycles, advancing climate concerns and stronger renewable competition. Our case study pointed us to windows of opportunity, not for opponents, but rather for commercial projects themselves as we explain in the following section.

2.4. A new conceptual tool: Economic windows of opportunity

While these different approaches point to the importance of understanding the economic contexts of social movements and activist strategies, we believe that they fall short of giving useful guidance to the KING movement. We have therefore modified the approach taken by the multiple streams model to better fit the context of the KING struggle we analyse.

While the existing literature mainly focuses on opportunities *for movements*, we use it instead to make reference to the possibilities *for fossil fuel projects* to move forward. We do not just look at the political sphere as is commonly the case, but extend this concept and identify what we call "*economic windows of opportunity*". We argue that these constitute an important spatial and temporal landscape within which the struggle between the fossil fuel industry and its opponents unfolds. In the new conceptualization we propose, an economic window of opportunity is to be understood as the moment when a fossil fuel project can move forward because economic conditions are right and it is expected to generate a profit. In Figure 1 we show a schematic depiction of the concept.

While it may be argued that current oil prices have only a relatively modest influence on the profitability of decades-long extraction projects, low prices usually lead to a tight capital situation in oil companies, leaving them less leeway for new undertakings. When prices are high, much money is available to put into new projects. Thus price cycles do determine largely when the industry can advance or must slow down or freeze expansion efforts. In addition, in particular the fracking industry operates on much shorter time scales than “conventional” oil and gas extraction, making it more responsive to oil and gas prices.

In Kingdon’s (1984) multiple streams model, problem, policy and politics streams must coincide to open the window for a particular policy solution. In our analogous proposal, both the political window in the form of government support and the economic window of opportunity must be open for a fossil fuel project to move forward. Antagonistic governments, or even a burdensome legal framework left behind by a previous administration, and low prices constitute significant obstacles. Thus, even when an economic window of opportunity (shown in green in Figure 1) is open, a government that does not fully support extraction may still deny or delay permits and effectively stop the project from moving forward.

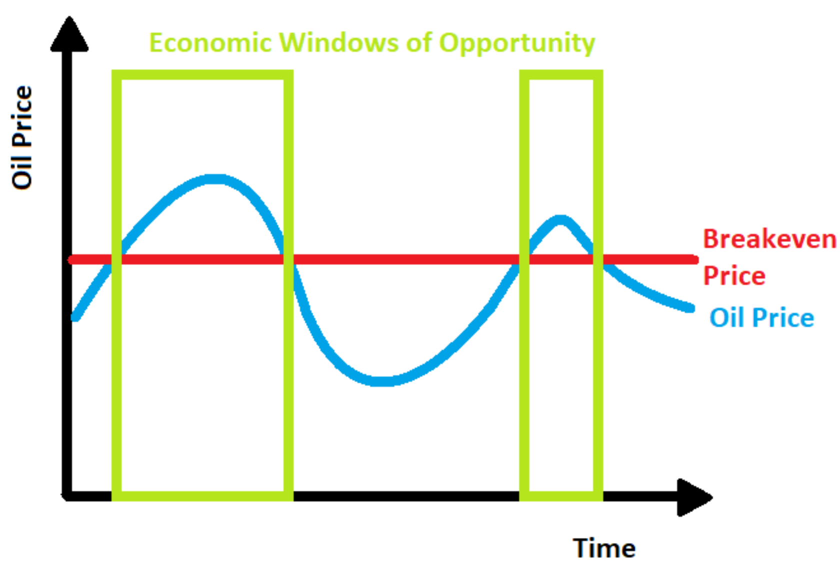

Figure 1. Economic windows of opportunity for oil projects

Economic windows of opportunity open and close for fossil fuel projects with the ups and downs of market prices. To illustrate this further with an example relevant for our case study: the economic window for most high-cost fossil gas projects is starting to close permanently on a global scale, due to competition in its key market electricity. Cheaper renewables are competing with gas for baseload, and storage technologies compete with gas for peak loads. While gas proponents stress that these technologies do not yet cover all of the moments when gas electricity is competitive today, they are nevertheless reducing the profitability of gas power plants. When used only as a back-up for the moments when renewables or storage are unavailable, overall gas use will be minimal, compared to today. The economic window for high-cost gas projects is thus slowly closing.

3. Case study: Stopping fracking in Mexico

In this section, we will introduce the historic, geological and social context of fracking in Mexico.

3.1. The setting

According to the US Energy Information Administration (EIA 2015), Mexico has potential shale gas reserves of 545 trillion cubic feet, the sixth biggest in the world. High-volume hydraulic fracturing in shale formations ("fracking") was invented, based on existing fracking methods, in the early 2000s in Texas and started to be applied on a significant commercial scale around 2006. High oil prices in 2008 sparked a fracking boom in the United States. This, and the fact that several shale plays in Texas extend beyond the Mexican border, awakened interest for shale fracking in Mexico, where hydraulic fracturing in sandstone formations had already been practised since the 1980s. The administration under Mexican President Peña Nieto (2012-18) tried to move the industry forward, including through a major energy sector reform. In parallel, a coalition of NGOs, the Mexican Alliance against Fracking ("the Alliance") formed in 2013 and has since then been working to stop fracking. The following president, Andrés Manuel López Obrador (abbreviated AMLO, 2018-2024) has made a commitment to not allow fracking due to its impacts on water and nature (Lopezobrador.org.mx 2019). However, permits continue in force and some public budget has been assigned to projects that will require fracking in the future. Table 1 shows a timeline of events relevant for fracking in Mexico.

Year	Event
1980s	Vertical low-volume fracking starts in Veracruz.
1994	A programme is initiated in the Burgos Basin in Northern Mexico to improve recovery from tight gas deposits, including low-volume fracking.
2004	High-volume fracking for shale formations is invented in Texas.
2008/09	The US gas export price to Mexico drops from ~8 to ~4 USD/thousand cubic feet, closing the economic window for shale gas in Mexico (see Figure 3).

2011-13	Fracking “hype” in Mexico, hopes are expressed to repeat the US “fracking revolution”.
2012	A research budget of 3 billion USD is approved for the Mexican Energy Ministry and National Council for Science and Technology to study Mexico’s shale oil and gas potential.
2013	The US Geological Service publishes an estimate of Mexico’s shale gas potential at 545 trillion cubic feet.
2013	A major energy reform opens the Mexican oil and gas sector to private companies. Enabling fracking is used as an argument in favour by its proponents.
2013	The Mexican Alliance against Fracking (*Alianza Mexicana contra el Fracking)* forms.
2014	A study, publicly financed with 250 million USD, is conducted on potential fracking “sweet spots” (Galaxia and Limonaria).
2014	The oil price drops from ~100 to ~60 USD/bbl, making shale oil in Mexico more expensive than market prices (compare Figure 2).
2014-17	Regulations for fracking in Mexico are developed, accompanied by resistance against fracking in the relevant states.
2018	AMLO gets elected and says No to fracking.

Table 1. Timeline of relevant events for fracking in Mexico

The Mexican shale oil and gas potential is divided over six basins in the Northeastern states of Chihuahua, Coahuila, Nuevo León, Tamaulipas, Veracruz and Puebla. Most basins hold almost exclusively shale gas, the only basin with large oil reserves (up to 30 billion barrels) is called Tampico-Misantla and is located in the states of Veracruz and Puebla. Veracruz already has a century-long history of oil extraction. It is also home to the *Paleocanal de Chicontepec*, a geological formation which has been the target of high investments with low results, due to its complicated geology. Here, hydraulic fracturing has been used for several decades already, however with a lower volume of water, high-volume fracking in shale deposits being a more recent invention. Some of the shale formations in Mexico are continuations of formations in the US that have successfully been exploited there, most notably the Eagle Ford. The Mexican section of the Eagle Ford Shale is considered a “carbon bomb” in Kühne et al. (2022) with potential CO_2 emissions of 5.1 gigatons CO_2.

Several factors modify the prospects of extraction in Mexico, most of them in the direction of making extraction less economic, attractive or easy than in the United States, most notably a lack of infrastructure, land and resource ownership and administrative rules for extraction. Local opposition to oil and gas extraction has traditionally been very limited in Mexico, and local movements have tended to focus on getting a “bigger piece of the cake” rather than stopping extraction.[2] The Alliance however is focused on stopping fracking altogether and identifies clearly with the demand of keeping it in the ground. It has about 40 member organisations, both national (e.g. Greenpeace, Fundar, Cartocrítica) and regional ones in Veracruz, Nuevo León, Coahuila, Puebla, San Luis Potosí and Chiapas. The Alliance, its strategies and their success are the object of this case study.

3.2. Methods

The current article is the result of a scholar activist undertaking (Routledge 1996) which combines participant observation, interviews and desk-based research. Academia and activism constitute fluid fields of social action that are interwoven with other activity spaces (Routledge 1996: 400). We understand critical thought as action-oriented and engaged with the claims, goals, and actions of social movements. The first author participates in the Mexican Alliance against Fracking via his organisation which has been an Alliance member since 2015. His activism in the Alliance both contributes to, and draws from key concepts such as carbon bombs, windows of economic opportunity and supply-side mitigation. Activities included participation in assemblies which saw strategic analyses of activities of the Alliance, feedback on project proposals and policy documents and information sharing of news from the sector. As an additional outcome of this research, a presentation with key learnings was shared with the

[2] *“Both social and environmental mobilisation against hydrocarbon projects in general had always been very, very limited (...) the vast majority of the time what the local population sees is the villain who is doing them direct harm (...) and that villain is asked to share more of the cake, not to stop extracting, because they see it as inevitable.” (Interview National Activist Claudia Campero)* This and all following quotes are from the interviews of our case study. They were translated from Spanish. See the next section on methods for more details. We provide textual quotes only in instructive cases and where respondents have indicated consent.

members of the Alliance to sharpen the understanding of different aspects of the fracking panorama in Mexico.

In order to establish the strategies applied by the Alliance and explore their impact, as perceived by other stakeholders in the field, 20 semi-structured interviews were conducted in the period from November 2020 to September 2021 with stakeholders from activism on a national (3) and local/regional level (5), from government (5), industry (3) and academia (4). The different categories were chosen to give a more balanced picture than just a view "from the inside" of activist groups and included several persons who held positive views about fracking.

Participants were recruited through personal networks of the author and snowballed by asking interviewees for further recommendations. The active participation of the first author in the Alliance had already established a basis of trust that made it simple to ask colleagues for an interview. The interviews were semi-structured, held in Spanish, took around 60 minutes, were recorded and subsequently analysed and focused on 1) the history of fracking in Mexico, 2) its prospects for the future, 3) the Alliance and 4) the impact of activist strategies.

A document review based on desktop research and key documents mentioned by interview partners was used to complement and substantiate the information from the interviews. The outputs were a detailed timeline, a summary of which is reproduced in Table 1, the list of strategies described below and a description of the economic context of fracking in Mexico which forms the basis of the section on the economic windows of opportunity.

The combination of participant observation in movement spaces where strategic discussions were being held with interviews of actors inside and outside of the movement and the corroboration of facts and issues from written sources helped us gain a multi-perspective picture of the issue of fracking in Mexico.

4. Results

We will present the results of our research in an integrated fashion (combining the evidence from the three methods just described), starting with a simple description of three key activist strategies. We will then examine how these strategies fit within Kingdon's multiple streams model. Because we cannot resolve the puzzle mentioned in the introduction with this framework alone, we then use the new conceptual lens of economic windows of opportunity to examine the evidence.

4.1. Key activist strategies

The most important strategies that emerged from the interviews are summarised in this section.

4.1.1. Information

The first strategy used by the Mexican Alliance against Fracking is based on information. Fracking is a technically complex undertaking that is used at different scales for different geological formations deep underground. As such, it is not easily understood by outsiders. Gathering, processing and sharing of information about fracking and its impacts as a technology, and about the plans of the government and other actors for fracking in Mexico has been the starting point of the Alliance activities. Activists did so by seeking out industry and academic experts and translating relevant materials from English to Spanish.[3] This is one of the few ways how the transnational embeddedness of the movement came into focus. Two more have been exchange meetings with anti-fracking activists in other countries and a visit from US-based group Earthworks who filmed invisible methane leaks with infrared cameras. However, these international linkages have been relatively limited and most of the efforts have concentrated on the national or subnational levels.

Cartocritica, one of the Alliance members, has been using access to information requests to identify the scope of the government and industry plans, including the inglorious fact that fracking has been happening during AMLO's administration in spite of AMLOs commitment to not do it.[4]

They then translated the gathered information for the public through mapping work, materials, sharing them in workshops with frontline groups (see next section), and feeding it to journalists who have published a continuous stream of news about the revelations of the Alliance and the dangers of fracking in Mexico over the years. When alerting the public about it, the Alliance obviously adopted a highly critical stance on the environmental and social impacts that the activity would bring to local communities, as well as on its global emissions impacts. This

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[3] *"the work was to begin to understand ourselves what it [fracking] was about, what the implications were, to read a lot of what was out there, especially in English, to summarise and translate it (...) and also a pedagogical process of taking this information in a digestible way to the organisations in the affected States" (Interview National Activist Claudia Campero)*

[4] *"Following this route of the permits, we found that in effect - and despite the fact that the president has this supposed commitment that fracking will not be used - Pemex had used it, it did have the permits and the budget and it had already drilled and fractured during this administration." (Interview National Activist)*

strategy has been very successful: starting from an unknown concept, even to environmentalists, in 2013, today, fracking is considered controversial and unwanted in Mexico by big parts of the population[5] - testified by continued interest from media, government and legislators showing a public anti-fracking stance (see also the section on legislation below). In fact, the current administration's no to fracking is considered by many as AMLO's riding a wave of popular anti-fracking sentiment.[6] Without the work of the Alliance, the issue of fracking would not have received this level of attention.

4.1.2. Linking with the frontlines

An innovative strategy used by the Alliance was its outreach to potentially affected communities and states, activating and empowering these stakeholders to take on a role of active agency in the matter. Even before the formation of the Alliance, and more regularly since its establishment in 2013, Alliance member organisations went to a number of Mexican states to inform local environmentalists and communities about the dangers of fracking which was being considered or planned for their regions. Subsequently, new organisations joined the Alliance, including from San Luis Potosí, Veracruz, Chiapas, Nuevo León and Coahuila.[7] The Alliance organised workshops with technical and legal information, and members from the new organisations joined the communication channels and meetings of the Alliance, over time building a closely-knit network that links frontline communities to actors in Mexico City where national policy decisions are taken and national media located. Subsequently, in some regions, local communities declared themselves "extraction-free",[8] in others they used legal means to challenge fracking,[9] in yet others, mass mobilizations were organised to express rejection of the industry,[10] eventually leading to AMLO's No to fracking (see section 4.4.2. below on successful strategies). There is a strong sense of solidarity within the Alliance, a strong focus on human rights and a respect for the moral leadership of affected communities, often indigenous.

[5] *"if we take into account that in 2013 the Mexican environmentalists themselves did not know what fracking was and that in 2018 part of the president's political campaign was to say that it was not going to be allowed, well I think it was very successful, to lift a conversation that was totally absent in the public sphere to this level, that was really a great success" (Interview National Activist Claudia Campero)*
[6] *(Interview Local Activist)*
[7] *(Interviews National Activist, Local Activists)*
[8] *(Interview Local Activist)*
[9] *(Interview Local Activist)*
[10] *(Interview Local Activist, National Activist)*

4.1.3. Seeking a legal fracking ban

The Alliance has actively supported proposals of laws to prohibit fracking. A total of 8 of such laws and one to prohibit water use for fracking have been tabled over the years in Mexico by several political parties, including the ruling party of Morena under AMLO.[11] The Alliance has collaborated with legislators and their staff to provide technical input into the draft laws and help spread the word about them. In addition, the Alliance has held conversations with the Ministry of Environment on prohibiting fracking. None of these initiatives prospered and none of the draft laws was ever passed even to a vote within senate or congress committees. Even two consecutive environment ministers, Víctor Toledo (Notimex 2019) and María Luisa Albores (Enciso 2021) have said their administration would legally prohibit fracking and thus materialise AMLO's commitment, but this has not happened, raising questions over the seriousness of said commitment.

The overall dynamic seems to be that legislators aim to improve their reputation by introducing this kind of legislation as "defenders of the environment". The reputation will stay with them, even if the proposal has no chances of being passed. Thus it is an indicator of the solidity of the results of the information strategy detailed above which allows politicians to increase their political capital by being seen as opposing fracking.

4.2. Mexican fracking through the multiple streams lens

According to Kingdon (1984), three streams need to combine for policy change to happen: the problem, policy and politics stream.

The *problem stream* has seen a continuous engagement by the Alliance. It can be said that the Alliance made fracking a problem. Recurrent critical media reports and a petition signed by almost 100,000 people to prohibit fracking speak of a problem that is at least costly to ignore. Both the information strategy and linking with the frontlines managed to firmly establish the issue of fracking as problematic on a local, regional and national scale.

In the *policy stream*, two aspects can be noted. Firstly, due to the opposition organised by the Alliance, the process of lawmaking *for* fracking was slowed down. During the Peña administration, the group developing the rules that were to govern fracking in Mexico took a long time to make sure that the rules were sound and the best they could be. They felt pressured by

[11] *(Interview National Activist)*

public opinion and decided to develop the rules first and then start licensing. This extended the process in time and delayed the licensing rounds for “unconventionals” (i.e. fracking prospects). Secondly, a number of prohibition proposals were developed. Even though they did not prosper, the policy solution can be considered well developed. Ultimately, the current administration’s no to fracking took the format of an inclusion in AMLO’s 100 commitments for his term, which has no legal status, but with a president with high popularity, his word stands against more institutional mechanisms, and a large number of supporters believe in his word, maybe more than they believe in the institutions.

In the *politics stream*, the government change from the Peña to the AMLO administration was what brought the change in course. AMLO’s No to fracking arose from work against fracking in the *Sierra Norte de Puebla* and the organisation *Tosepan*[12] with which some of AMLO’s close allies are associated and which had been positioning itself against fracking. Mass mobilizations against fracking had taken place recently in San Luis Potosí at the time of AMLO’s campaign visit in October 2018, which lay in the period between his election victory and his assuming office. During his visit, he announced that “we won’t do fracking” (Tristan 2018). This was a “popular” choice that resonated with people and certainly brought him more political capital ahead of his presidency which started in December 2018. When AMLO entered office, he included the No to fracking as commitment #75 in a programme of 100 commitments for his term (Lopezobrador.org.mx 2019).

From the multiple streams perspective, all streams were combined. The Alliance did everything right, by turning fracking into a problem, preparing policy solutions and pushing political actors and thus creating the political will. However, a reversal of AMLO’s current position is quite thinkable because he has not changed any law with regards to fracking. Furthermore, PEMEX, the national oil company which is controlled by the government, continues to explore shale formations, frack conventional wells and prepare for the case that the fracking ban gets dropped. Thus, the Alliance is not celebrating. In fact, it is torn between supporting AMLO’s stance and calling his bluff.[13] This seemingly confusing situation becomes clearer when analysing the *economic windows of opportunity* landscape which we will do in the next section.

[12] *(Interview Local Activist)*

[13] “*The strategy has revolved around "Here is a promise from the president, right?" Until now it has been a collective decision not to directly confront the president. We have not come out with "The president is a liar. It [fracking]'s not forbidden." It is something that we keep in stock.” (Interview National Activist)*

4.3. Mexican fracking through the economic windows of opportunity lens

As laid out in section 2.4., a fossil fuel project depends on both the political *and* the economic window of opportunity to be open, to move forward. The Alliance, as we could establish in our case study, concentrated on closing the political window. It largely ignored the economic window, maybe not surprisingly, since it is beyond its scope of influence. However, as we will see, it is a very important context factor, and keeping it in mind can help craft winning strategies. The administration of Peña Nieto (2012-2018) was seen as a key promoter of fracking in Mexico, and one of its major projects, the 2013 energy reform was partly motivated by the urge to create the legal basis for private companies to enter hydrocarbon extraction. The legal changes contain provisions that allow the industry to occupy lands without the possibility for local landowners to effectively stop this.[14] In spite of the organising efforts by the Alliance, the political window of opportunity for fracking was open until late 2018.

Then, on the surface, the Alliance succeeded: after years of efforts of alerting the public on the dangers of fracking, AMLO, a president who actually has a strong inclination *against* renewable energy, climate action and environmental protection more generally, made an express commitment that fracking will not be used in Mexico. But in spite of the explicit presidential support for the anti-fracking agenda, several proposed laws - including by AMLO's own party - that have aimed to ban fracking have not prospered, and fracking has even been continuing to some degree during AMLO's administration. This puzzling situation has had movement participants scratching their heads.

For understanding the prospects for fracking in Mexico, and the context under which the anti-fracking movement operates, we must examine the economic landscape, particularly oil and gas prices which can act as a converter of the carbonscape, especially for high-price undertakings like fracking. As we shall see, economic windows of opportunity for both shale oil and gas have temporarily or permanently been closed by low prices.[15]

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[14] *(Interviews National Activists)*

[15] *"They announced the unconventional bidding round three times and postponed it, and I think the only reason is that while the price of oil dropped to forty-fifty dollars a barrel, at that price it's not business. So that's what has saved us from fracking: low prices. That would be a very important context factor to take into account for how the issue is moving or stopping in the country. I always told the Mexican Alliance against Fracking: look, it's an economic issue." (Interview Researcher)*

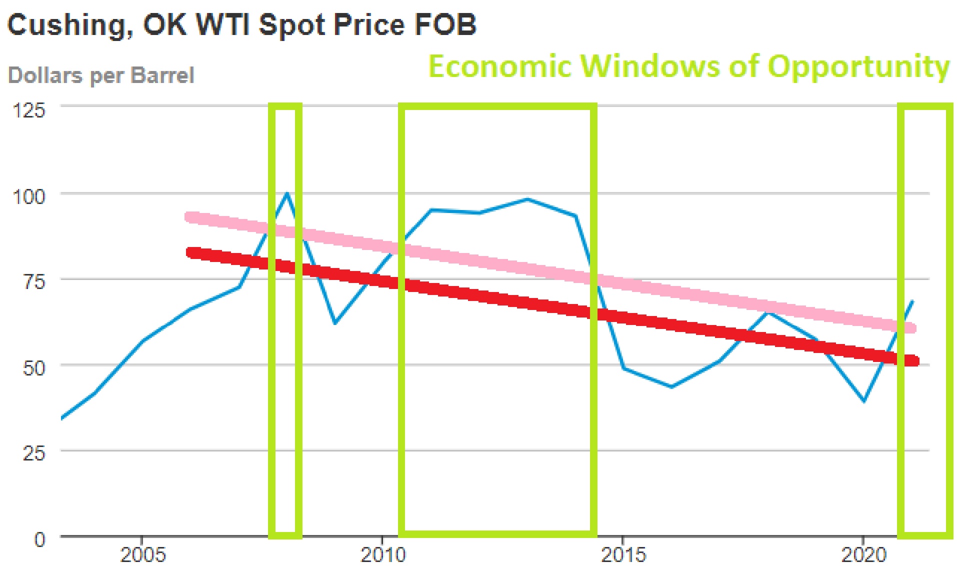

Figure 2. Economic windows of opportunity for fracking for shale oil in Mexico. Blue line: average annual US Oil prices (EIA 2022a); Red line US shale oil average breakeven prices (2006: ~80$/bbl, 2021:~50$/bbl); Pink line: hypothetical Mexican shale oil breakeven prices (2006: ~90$/bbl, 2021:~60$/bbl); Green squares: Economic windows of opportunity.

Shale oil and gas are relatively high-cost. When comparing them to conventional wells, the productivity of fracked shale wells is relatively low, and costs are up to ten times higher.[16] Breakeven prices for shale oil in the US have been estimated to lie between 48 and 69 USD/bbl (Federal Reserve Bank of Dallas 2022), even though they have shown a slight downward trend (Mistré, Crénes, and Hafner 2018) (Figure 2). Countries with lower extraction costs such as Saudi-Arabia have been accused of deliberately depressing oil prices, in an effort to squeeze high-cost US shale operations out of a market with lower prices.

Extraction costs for both fracked oil and gas are expected to be much higher in Mexico than in the US, due to a number of factors. The minimum oil price for fracked oil from Mexico to cover extraction cost ("breakeven") has been estimated at 70-80 USD/bbl by some[17] while others say that the breakeven has not yet been discovered, because the shale fracking industry has not yet started to operate on a commercial scale in Mexico and only then will the actual costs be discovered. In any case, costs are expected by all actors to be higher than in the United States

[16] *(Interview Researcher)*
[17] *(Interview Researcher)*

for several reasons, including less pre-existing infrastructure,[18] property rights, government support for research and development, deregulation, a favourable geology in the US (de la Vega Navarro and Ramírez Villegas 2015) and foreign technology that needs to be bought (see also Bazán Navarrete and Ortiz Muñíz 2014:38 for a list of potential obstacles). Fry et al. (2020) describe these challenges in detail for the Burgos basin. In Figure 2, we show the economic window of opportunity for Mexican shale oil for an average breakeven price declining over the years from ~90 to ~60 USD/bbl, which roughly corresponds to the information we gathered.

While potential breakeven prices of 4-6 USD/mmbtu have been estimated for shale gas in Mexico (de la Vega Navarro and Ramírez Villegas 2015:94–95), these numbers need to be taken with caution, because they emanated from an energy ministry which was promoting fracking at the time, and from a global study without much national level information on assumptions. Extracting costs (a subset of total costs) of 3-4 USD/mmbtu have been named for the Emergente-1 well in Coahuila (Suárez y Farías 2012:26). 6-8 USD/mmbtu may be a more realistic estimate.[19] In Figure 3, we show the economic window of opportunity for Mexican shale gas for an average price of 6 USD/mmbtu.

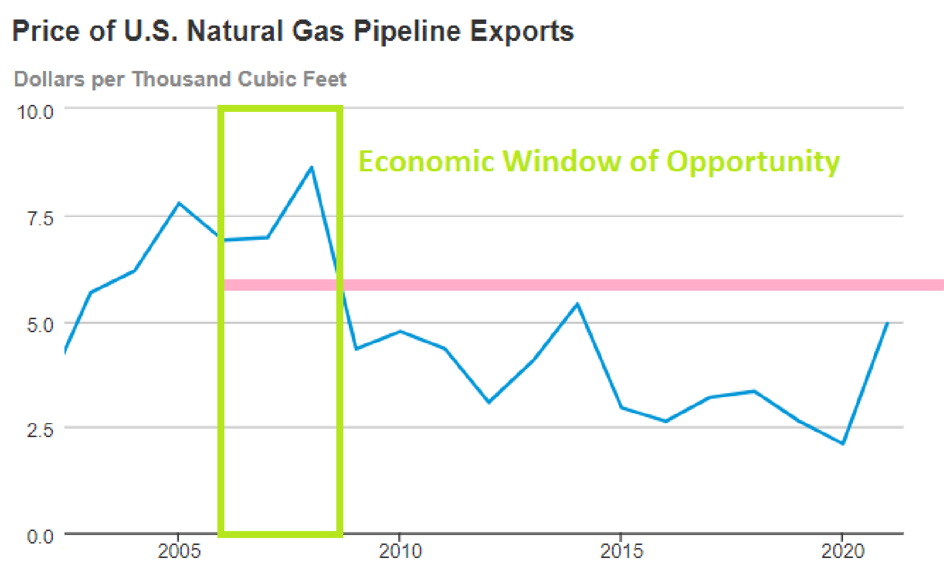

Figure 3. Economic window of opportunity for fracking for shale gas in Mexico. Blue line: average annual US pipeline export gas prices (EIA 2022b); Pink line: hypothetical Mexican shale gas breakeven price (~6$/Mcf); Green square: Economic window of opportunity.

[18] *(Interview Researcher)*

[19] *"The truth is that I don't know, but for a "guesstimate" I think it would be around six, seven, eight dollars per unit. All the infrastructure, of logistics that it needs, and that is infrastructure that if the project doesn't work out, is already buried there. And a pipeline can cost a million dollars per kilometre." (Interview Government)*

Shale gas is often associated with oil, which is the higher priced product, extracted along with it, and put on the market. The fact that gas is often a by-product of oil or the other way around, and natural gas liquids can improve the project economics to the point of making them viable, makes for a complicated relationship between oil and gas prices and shale projects (Rathbone and Bass 2012:24). In Texas, so much shale gas has been extracted since 2008 that the market has been flooded and prices have been consistently low, even briefly negative in 2020. Due to constantly low prices, the economic window of opportunity for pure gas plays such as the Mexican Burgos basin, an extension of the Eagle Ford in Texas, has remained closed since then and hopes of developing an industry based on it have remained hopes, due to the inability to compete with Texan gas prices. Ironically, high oil prices may lead to low gas prices, because they incentivize more fracking for oil and more associated gas in Texas. Mexican plans for fracking have consequently concentrated on the two basins that have shale oil (Sabinas/Burro-Picachos and Tampico-Misantla) which however have much less potential than its shale gas. De la Vega et al. (2015) also note that PEMEX has concentrated on oil due to its higher price. Only one company besides PEMEX went to the pains of prequalifying for the “Round 3.3” for non-conventionals in 2018 indicating a relatively low industry interest in the areas on offer - which contained mostly shale gas.

These factors help understand the landscape of economic opportunity for Mexican fracking. Only if oil and gas prices are high enough for an extended period of time can the industry move forward and develop. In 2007/08 and from 2011 to 2015, oil prices were high enough to warrant fracking for oil in Mexico (Figure 2). Gas prices have been too low since 2008 to warrant fracking for gas in Mexico (Figure 3). This also explains the focus of attention on oil plays.

Given that the industry was not yet ready for shale fracking in Mexico in 2007/08, the windows of opportunity for oil were only open economically from 2011 to 2015 and remain basically closed since 2015. In the face of resistance, a regulatory framework for the industry was needed. This was already developed during the Peña Nieto administration (2012-18). However, the development took so long that the economic window that was still open for Mexican shale oil in 2012, closed in the meantime (in late 2014). With higher oil prices since 2021, the economic window for fracking seems to be opening again, as attested by increasing fracking activity in Texas and renewed calls for fracking in Mexico (Flores 2022). But since the political window is now closed, these calls have remained unanswered so far.

An additional point was raised by respondents and may explain the split-tongue approach of AMLO towards saying no to fracking while not legally prohibiting it and assigning a budget for further exploration. It is linked to the fact that PEMEX has debt exceeding 100 billion USD. The Mexican government's credit rating is closely linked to PEMEX's, due to the important role that PEMEX plays in government finances. Valuation agencies pay close attention to reserve figures, when evaluating fossil fuel companies. Because Mexico passed the peak of oil extraction in 2004 and extraction has been in steady decline since then, whether non-conventional, i.e. shale reserves, which are abundant but more difficult to extract, are included in its long-term projections makes a significant difference. The reasoning by some respondents is that a legal prohibition of fracking would take those non-conventional reserves off PEMEX's books and automatically result in a lower credit rating for PEMEX and in consequence lead to a higher borrowing cost for both PEMEX and the Mexican government.

While low gas prices in the US in the last 15 years have made gas of Burgos uncompetitive, exporting it to Asia might still be viable in the future[20] and proposed LNG export terminals on Mexico's Pacific coast could be fed by it.

At the beginning of AMLO's 6-year term in 2018, both oil and gas prices were low, so coming out against fracking was an easy choice in the face of closed economic windows of opportunity. In spite of spikes such as in February 2021 due to the cold spell and more recently due to disruption of gas flows from Russia in the wake of the invasion of Ukraine, gas prices can be expected to remain relatively low in North America over the foreseeable future (McKinsey 2018:7) in the absence of a significant US policy change. Developing fracking for oil to a significant scale would have taken several years and would probably not have made a notable difference during AMLO's own term (2018-2024). In that context, fracking was not going to make a major contribution to national energy provision in Mexico, so the decision to halt it was justifiable. These strategic considerations are based on our interviews, rather than on public declarations. The valuation issue mentioned previously further complicates the picture and may in itself explain why AMLO has been reluctant to effectively ban fracking, as this might jeopardise the financial dimension of his project of strengthening PEMEX.

[20] *(Interview Industry)*

Identifying and analysing the economic dimension as an important ingredient of the “landscape” in which the struggle between fossil fuel projects and the KING movement unfolds, can thus lend further usefulness and rigour to the Kingdon model and allows to better pinpoint the reasons for success or failure of activist efforts.

4.4. Evaluating the success of activist strategies

After a look at the current situation in Mexico, we will establish what constitutes success for a KING movement struggle, and then, based on these parameters, we will answer the question of which strategies were successful.

4.4.1. Current state of affairs

Firstly, we need to clarify that the Alliance formed in response to the threat of the new technology of shale fracking. Our evaluation of success is thus based on the situation for this specific technique. As the Alliance itself discovered in the course of its search for information, fracking had already been practised in Mexico for decades (Cartocrítica 2019), and communities affected by that activity are also members of the Alliance. Due to intra-movement solidarity and a focus on human rights which fracking threatens, the Alliance calls for an end to all fracking, including “conventional” fracking of wells that do not target shale formations and do not require the high volumes of water that have made fracking notorious. For the purposes of this analysis however, we exclude those fracking activities, and there are some indicators that the AMLO administration is following a similar line of limiting shale fracking while allowing conventional fracking to continue (see below).

From 2010 to 2016, at least 28 wells were drilled into shale formations and fracked in Mexico (de la Fuente and Olivera 2016). In spite of the presidential commitment to not use fracking, since December 2018, every year congress has approved government budgets which include several billion Mexican pesos for PEMEX programmes that include fracking (Alianza Mexicana contra el Fracking 2021). Exploration activities have continued and PEMEX has even fracked some wells in the first months under AMLO. The Alliance has called this out (Alianza Mexicana contra el Fracking 2020) and taken it as a note of caution against the seriousness of AMLO’s commitment against fracking. Under AMLO, fracking has not been banned, in spite of several laws having been modified under AMLO, such as the Hydrocarbon Law, which would have been an opportunity to give the fracking ban legal status and implement his electoral promise. This means that fracking is still legal, and in fact some companies are required under their approved development plan to undertake fracking, and the regulatory authority could give them the green light, based on the legal situation.

In 2024, presidential elections will take place in Mexico and the following administration could theoretically resume fracking without major delay, due to the fact that no laws were changed. The success of halting fracking on a national scale in Mexico must therefore be considered a temporary one, until more solid guarantees of non-extraction are in place. It must also be noted that Mexico generates much of its electricity with gas and a high percentage of that is fracked gas imported from the US (Sarmiento et al. 2021).

4.4.2. Which strategies were successful?

The key ingredient of KING movement success is the absence of fossil fuel extraction. Additionally, several dimensions can be characterised:

1. Whether the absence is temporary/reversible or permanent. (delay vs. cancellation)
2. The geographical scale. (e.g. community, company, project, basin, state, country)
3. Who guarantees non-extraction.

Firstly, the information sharing strategy was one of the key success factors for the Alliance's KING efforts, because it has won the framing battle via information and media work. Through several years of information and education work, the Alliance managed to turn fracking from something that even environmentalists didn't know, into something that the president has used to increase his popularity, and frequently mentions as something that is evidently bad for the environment.

Secondly, in an innovative strategy which we call "linking with the frontlines", the Alliance activated and empowered new allies in potentially affected regions. Mass mobilizations in Chiapas and San Luis Potosí raised the political cost for fracking proponents and in the Round 3.3 where unconventional areas were offered for the last time, only one of the Mexican states (Tamaulipas) participated. While this was negotiated behind closed doors and we do not know why the states with more promising shale potential did not participate, the Alliance's presence and activities in Veracruz, Puebla, Coahuila and Nuevo León may have played a role. On a territorial level, the Alliance has active members in 8 states, of which Chiapas and San Luis Potosí have seen mass mobilisations, and Veracruz and Puebla have frack-free municipalities and communities. In the case of Chiapas, mass mobilisation came early enough to cause the government to pull back from hydrocarbon exploration plans.[21] The popular support for the anti-fracking resistance has tipped the balance towards AMLO publicly assuming an anti-fracking stance.

Thirdly, efforts towards a legal ban have not led to an effective outcome. But they have exposed the unwillingness by AMLO to legally prohibit fracking in Mexico. This also contributed to the puzzle that led us to examine the economic context more closely. The failure of this strategy when even AMLO's own party, Morena, which has a majority in both chambers, has proposed laws that would ban fracking, and members of AMLO's cabinet support a ban, is notable.

On a superficial level, the information and linking with frontlines strategies worked out in Mexico.

But the suspicion that AMLO is trying to increase his popularity while not giving up any hydrocarbon prospects persists. AMLO's energy policy is led by concerns about energy sovereignty. Increasing oil extraction to cover the national gasoline supply can be considered the cornerstone of his energy policy. He has also repeatedly been criticised for not caring about the environment or the global climate. Then why would he shut the door to fracking? Fracking proponents like to point out that fracking would mean more energy sovereignty for Mexico, and blackouts in Northern Mexico in early 2021 due to a cold spell in Texas that shut off gas imports to Mexico have revived this argument.

[21] Even though unconventional fracking was not on the table in Chiapas, the information shared with the frontlines by the Alliance eventually led to the exploration plans getting stopped.

5. Discussion and conclusions

Keeping fossil fuels in the ground must be multiplied manifold, if we are to meet the Paris targets. The KING movement is currently the foremost actor of such efforts and its successes are key to bending the curve of emissions. In our case study, we looked at the economic and political windows of opportunity landscape for fracking in Mexico and showed the strategies by which the anti-fracking movement in Mexico has for now successfully managed to tip things towards “no fracking”, and at least temporarily defused a carbon bomb.

We have identified three key strategies used by activists and evaluated their success. The successful information strategy connects with a perspective taken by Meadows, who has identified leverage points in systems (Meadows 1999). She identified “modifying the flow of information in the system” as one powerful leverage point, and this has been skillfully used, not only in the media, but also in combination with the second strategy of empowering current or future frontlines of fracking to play an active role.

Other strategies are absent from our case study, such as a focus on chokepoints - which would seem a good fit for an explicit converter role of the movement in the carbonscape - or any reference to non-violent direct action. The former was asked for in the interviews, but respondents tended towards seeing it as an interesting new way to look at the Alliance strategy.[22] As for non-violent direct action, this is a movement tactic that certainly exists in a similar form, but tends to be called “resistance against megaprojects” in Mexico and in a context of violence and criminalization of environmental defenders it is usually done in response to an imminent threat to people’s lives or livelihoods, rather than proactively as is often the case in Global North direct actions. (See Martinez-Alier 2014 for an in-depth discussion of the differences in approach between Global North and Global South environmentalism.)

The unfavourable economic context for fracking in Mexico in the last years is a crucial factor that should be taken into account as we have shown. We have explained this with reference to the concept of “windows of opportunity for fossil fuel projects”, showing how both political and economic windows need to be open for projects to move forward. Understanding that landscape

[22] *(Interviews National & Local Activists)*

is key for KING activists. The concept is inspired by Kingdon's multiple streams model (1984) and gives the framing a twist.

We did not explore in detail how the fossil fuel industry manages to put their interests on the political agenda. It seems that the political window of opportunity is normally always open for them by default, reflecting that norms have not yet turned sufficiently against fossil fuels (Green 2018). In future work, looking at the legal context and the social licence of fossil fuels could allow identifying where and how the space for fossil fuel projects is being closed most effectively. We also did not explore the role of technology in much detail, because in our case, there was no fracking of shale formations before the technology was invented, and since then, technological change has only caused incremental changes to the overall picture. However, on a longer timescale, the question of how new technologies transform carbonscapes could provide a good field of study.

With our analysis of a KING movement actor which did stop fracking in Mexico for now, we have put the spotlight on the agency performed by activists in transforming a carbonscape. The Mexican Alliance against Fracking operated a very successful information campaign that swayed public opinion against fracking, carrying many politicians - including current president AMLO - along, and linked with the frontlines, recruiting new actors for the opposition against fracking in relevant territories. Even though attempts to legally ban fracking, were ineffective so far, the fuse to the Mexican fracking carbon bomb has so far been kept from being lit.

We hope that such purposeful transformation will become more commonplace and that others feel inspired to engage in similar undertakings.

Our work also underlines the necessity of understanding the particular role of state-owned enterprises in stabilising carbonscapes better - as exemplified by the connection between PEMEX debt and AMLO's split-tongue on fracking. State-owned enterprises control the bigger part of global fossil fuel reserves (Heede and Oreskes 2016), but have not been studied - and campaigned on - as thoroughly as private companies.

The following lessons can be drawn from our case study for the KING movement in Mexico and elsewhere.

Firstly, both economic and political windows of opportunity must be open to move fossil fuel projects forward. An understanding of the market environment in addition to the political environment is very helpful for the KING movement. We thus propose that future studies on the KING movement address both the political and economic context of the projects being opposed. Our conceptualization of windows of opportunity for fossil fuel projects may provide a useful frame for analysis.

Secondly, *delaying* can be as useful for defusing carbon bombs as cancelling, when it is long enough for one of the windows to close again. In addition to the direct stimulation of industry activity by prices, typical lead times for projects must be factored into the time equation. In advance it is hard to tell which “delay” will be the definite one for a given project, but in a context of increasing competition from other energy sources, any delay could be the winner. Understanding economic windows of opportunity can help build better KING strategies, because it widens the range of options to include delay tactics.

Thirdly, *locking in* KING movement successes is necessary. Else the threat of a policy or market reversal hangs over that success, as shown by Donald Trump opening up nature reserves to the oil industry, after President Obama had protected them. The cyclical nature of oil and gas markets means that the KING movement would do well to use moments of low oil and gas prices to lock in non-extraction rather than to wait for the next wave of industry expansion when prices recover. An important question then becomes how such successes can be locked in.

Fourthly, *linking with the frontlines* and by this means bringing new actors into the movement can be a successful strategy as shown by our case where the *compañer@s* in San Luis Potosí were instrumental in securing the presidential No to fracking on a national scale. This turns the question usually asked about how local struggles manage to get onto the national policy agenda (Rootes 2013) on its head: activation can also flow from the centre to the frontlines.

Fifthly, early on in a project, chances of stopping it are higher. In combination, these two findings may hold a key for a stronger and more successful KING movement, because local mobilizations tend to happen when the threat is already tangible - and when it is too late to win. In the age of the internet, where maps and plans are often available online, movement resources on analysing upcoming threats and “early warning” of those communities that appear in fossil fuel expansion plans, may be well spent. The successful mobilisation in Chiapas we mentioned was such a case. Shale fracking in Mexico is an industry not yet in existence (or only in very initial forms and in this early stage of a struggle, framing has an important role to play. The Alliance has managed to "brand" fracking as something bad, and most of the Mexican population now rejects it.

Sixthly, we often only come to know after the fact which strategy actually worked. In Mexico, a legal prohibition seemed to be an ideal way to stop fracking, but in spite of a number of proposed laws to ban fracking, this strategy has not (yet) prospered.

An open question we would like to mention and that we have not examined is the relationship between sites of extraction and those consuming the fossil fuels being extracted. As an example, a recent campaign (Stand.earth no date) has linked resistance to oil extraction in the Amazon basin to the consumers in California. The power of the consumer has shone through in moments such as during the conflict around the disposal of Shell's Brent Spar platform, but we have not yet harnessed that power systematically to bring fracking to an end or defuse carbon bombs. Linking activists on the supply and the demand side could provide potential for further impact of the KING movement in the future.

As mentioned at the outset, the KING movement faces the challenge of having to find ways to defuse many further carbon bombs. We have provided some suggestions on what to pay attention to and hope that this will be a contribution to the learning of the KING movement and enable further successes.

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V. Discussion and conclusions

As detailed in the introduction, I find myself in a particular position at the intersection of the academic and the climate movement worlds where I am confronted with the opportunities and shortcomings of each sphere on a daily basis. In this final section, I will discuss the results of my research against this background. I start with a discussion of the significance of the work with an emphasis on the conceptual or theoretical, on the methodological and empirical perspective, even though these different strands often intermingle - and I consider it a sign of the quality of my work that they do. This is followed by a section that discusses current developments in relation to my area of work that provide a backdrop for my research - or a wave to ride on, that I hope will reinforce in the reader the sense of opportunity arising from my work. I conclude with a collection of suggestions of future work that have emerged in this process.

1. Significance of this research

Let me turn to the question where the research has made contributions to the academic conversation.

1.1. Conceptual

1.1.1. Carbon bombs as frame

The importance of framing an issue for social movements is well known (Benford and Snow, 2000). Over decades, the fossil fuel industry had a tight grip on the mainstream narrative about fossil fuels, including framing the climate challenge as one of “reducing emissions”, a very disempowering, unspecific and hard to implement challenge. Citizens were called upon to reduce their “carbon footprint” and “many small actions” done by many small people in many small places would at some unspecified moment in the future add up to something great. This recipe for climate inaction has worked out so far. In the fossil fuel industry narrative, fossil fuel dependency equals energy security, as long as we manage to keep it coming. When there is a problem, the security has to be sought with other providers, fossil fuel providers of course. Fossil gas is called “natural gas”. This narrative is starting to break down. And carbon bombs offer a framing that is much more empowering. The key contribution with the article on carbon bombs (section III of this thesis) is to provide a frame that works at the same time as a diagnostic frame (these projects will burn us past climate limits), a prognostic frame (we must defuse these projects) and a motivational one (we can attack and win against these projects on many fronts, such as stopping the finance, filing lawsuits against their permits, questioning their legitimacy in the media or even physically blocking their operations). The problem is clear, the enemy is clear and it is clear what there is to do. I am hopeful that the carbon bombs framing will help galvanise more KING movement action, increasing the number of fighters against fossil fuels. I have already been approached by a number of people offering their help as volunteers for defusing carbon bombs in the past months. Both media and KING movement allies have shown great interest in the carbon bombs and their implications in the months following a front-page story on the research published in the Guardian in May 2022 (Carrington and Taylor, 2022). In the case of the activists, the excitement stems from the evaluation that with this framing, we can win any communications battle against the fossil fuel industry, because as one colleague put it “who wants to defend setting off a bomb?”

1.1.2. Agency in carbonscapes

The idea of carbonscapes (Haarstad and Wanvik, 2017) is helpful in understanding the relevant parts of the fossil fuel system, and the idea of instabilities in these carbonscapes leads our thinking to the potential for change in these configurations. An element that previous work that uses this concept has not yet clearly integrated, and which we worked out as a key component, is that of *agency*. With the KING movement, and in the specific case of Mexico, with the Alliance, we find agents, who purposefully set out to transform the carbonscape in an effort to profoundly change it - ending the extraction of fossil fuels. If we compare a carbonscape with a landscape, such a willful engagement with the carbonscape could almost be likened to the work of a landscape architect - one that is strongly in favour of rewilding, maybe. Although to be fair, many KING movement colleagues take upon themselves the responsibility of an orderly transition with retraining for the workforce, under the banner of a “just transition”.

1.1.3. Categories of KING effort impacts

I consider it a milestone of my thinking to have identified a “clean” way of conceptually breaking up the efforts of the KING movement against fossil fuel projects into different categories that are used in the KING metrics article. My mind was guided by the search for a quantification of impact, and the categories, reserves kept in the ground, fossil fuel projects delayed or stopped, and temporary stoppage allow to quantify the potential emissions precisely - with related but different methods. The clarity that these methods bring, and their ease of application are a conceptual novelty that has helped me think through the impacts of KING movement efforts. Repeated requests for related calculations which I have received from colleagues in the following months make me hopeful that this might be the same for others. The carbon bombs research also builds on one of the categories of the KING metrics article, the one using reserves in the ground.

1.1.4. Thinking in projects

Framing efforts in terms of individual fossil fuel projects, whether to make them happen or to stop them, is of course common in the fossil fuel industry, and in the KING movement, but, and that is another conceptual contribution, it is uncommon in the climate policy community. Thinking in terms of countries, and sometimes companies, prevails. In the carbon bombs article we suggested that the list of carbon bombs could be used as an indicator of the success of more mainstream mitigation efforts such as demand reduction policies. If they are effective, they will show in a reduction of the list: projects will be dropped from it. The initial positive response has been much more around “toxifying” individual projects, rather than carbon bombs as a measure of climate policy success. Whether thinking in projects carries over into climate policy making is to be seen. By painting a project-based picture of the supply-side mitigation landscape, we have made a contribution that has the potential to bring a different, more tangible perspective to the table.

1.1.5. The KING movement as an entity

During the literature review phase of this project it dawned upon me that there is a growing movement against fossil fuels that did not have a name, but whose common denominator is the aim to keep fossil fuels in the ground. I have given this movement a name, argued for its distinct nature which is not properly captured by the names other authors have been using so far, and used the term “KING movement” in my academic and activist work since then. An important element of a movement is a *collective identity* (Polletta and Jasper, 2001). Giving the movement a catchy name is just one step towards such a collective identity. Another can be shared practices, such as potentially the quantification of its successes in tons (or gigatons) of CO2 kept in the ground. By developing the methods for KING metrics to a high level of usability for non-experts, I hope to give KING movement colleagues practical help for “speaking the emissions language” of the climate policy expert community, making our efforts more compatible and normalise supply-side thinking. Since the development of the methods, which preceded the publication of the peer-reviewed article, they have already been used in at least two reports (Bingler, 2020; Choksey and Richter, 2021) and one lawsuit (Sabin Center for Climate Change Law, 2021). The name and the metrics methods are two small contributions that hopefully solidify the sense of coherence in the movement and collaboration among its members.

1.1.6. Harvest mode

The concept of harvest mode we introduced in the carbon bombs paper is a conceptual contribution to the field, and in times of the need to rapidly unravel fossil fuel institutions, it could become an important concept alongside stranded assets and divestment, because it provides an avenue to fossil fuel companies that is not as aggressive as building new projects or expanding existing ones on the one hand, and also not as aggressive as early closure of existing fossil fuel infrastructure on the other, offering a compromise between the interests of maintaining fossil fuel based stability, including in cash flow, and the need to close down fossil fuel infrastructures as quickly as possible driven by climate concerns.

1.1.7. Economic “windows of opportunity”

In the Mexico case study, we built on the “windows of opportunity” concept in an innovative way. Not only did we expand from the political realm to the economic, we also turned the framing on its head: usually social movements are seen as the underdogs so to say, with their issue *not* being taken on as the default value of the situation. Only when several conditions are given, when the different streams of the multiple streams model (Kingdon, 1984) combine, is there a window of opportunity for change as envisioned by the movement. In our new conceptualization, rather than painting the KING movement into the underdog role, we assign this place to the fossil fuel industry, which is trying, against the odds, to make a fossil fuel project happen. In the current context of what I call the “fossil endgame” (Kühne, 2020), with a climate emergency unfolding, renewable energy technologies on a rapid conquest of formerly fossil fuel dominated markets and a growing KING movement against its operations, the characterization seems appropriate, maybe not from a perspective of looking back, but from one looking towards the next few years.

1.2. Methodological

1.2.1. KING metrics

In order to achieve my first research objective (*establishing a method to quantify the impacts of KING activism*), I surveyed and analysed existing emissions accounting methods and there was no appropriate existing method that would have been applicable in the limited timeframe of a PhD project. This led me to create a new method, the one described in the KING metrics article. As mentioned previously, I tried to strike a balance between keeping the emissions calculations to be performed by the user as simple as possible, fit for the movement to be used, while at the same time providing a robustness that would allow for the resulting figures to be used in contexts of mutual questioning as is normally the case when KING activists try to stop a project, or even in court. It is also a contribution to the field of social movement impact studies with a method for evaluation that is very much quantitative. The field tends more towards qualitative evaluations of movement outcomes, because these tend to be very diverse, and a possibility of arranging them along a single numerical dimension, as is possible for the KING movement with the central metric of avoided CO2 emissions, is a rather rare instance.

1.2.2. Reflections on the process of a *practitioner's PhD*

There might be some slight differences between my PhD project and a typical PhD research, which could provide some insights into a more seamless integration of academic work with the "real world". Five aspects are worth highlighting, since they can influence different logistical and content aspects of such an undertaking.

Firstly, I already came into the doctorate with a long list of topics that to my practitioner's mind, needed to be researched. With the help of my supervisors, I chose some of them and worked them out. The interest of movement colleagues and the media in my results speaks to the benefits and potential high impact of such an integrated approach. Having been a climate activist for close to a decade at the start of my PhD is likely to be a relatively exceptional situation for a doctoral candidate. It might make sense to pair PhD students up with practitioners at the beginning of their project, or even before, in order to arrive at practice-relevant research objectives.

Secondly, I saw my task as using the research time to dive into complexity and process the contributions that academics have made to questions relevant to the KING movement, in order to establish clarity on the other end of it and come out with an easy to understand output that I could bring back to the movement. I hope to have achieved this, but from my experience of reading doctoral theses, and academic papers more generally, many scholars stall after diving into the complexity and never come back out of the rabbit hole with anything valuable for outsiders. A more guided approach to translating research questions and findings back into normal people's language, particularly for PhD students who are at the beginning of their academic career, could contribute to a more fluid interaction between science and society.

Thirdly, a cautionary tale about dismissing a concept too early: the concept of *carbon bombs* had already been used by KING movement colleagues for years. They tried with the media, but it didn't catch on (Rafalowicz, personal communication). My evaluation was that carbon bombs were a useful concept but they had not been standardised, and work on them was not systematic. My own work consisted of creating the definition of 1 gigaton of potential CO2 emissions, and assembling the global list in a systematic way through standardised databases, rather than as a more free-form collection among movement allies as had been done for previous reports (Voorhar and Myllyvirta, 2013; Cimons, 2016; Bingler, 2020). It could be seen as a rather small and incremental variation on existing work that had tried and failed to mainstream the concept. However, this time it worked, making front page news of one of the major international newspapers (Carrington and Taylor, 2022), followed by a reception of media in a number of other countries, and great interest from the KING movement community. The point is that sometimes time is not ripe, or a framing might just need a little tweak to turn into something attractive and useful.

Fourthly, as an activist scholar, I found myself dedicating much more time than before to the Mexican Alliance against Fracking, following its agenda and contributing to its shared tasks. While some of these had a degree of overlap with the questions in my case study, such as trying to foster self-reflection among the members about the strategies we use and which of them have worked and why, others were utterly unrelated, such as helping with fundraising, which is an area that I happen to have experience in. This is in line with Derickson and Routledge's suggestion to put resources and skills at the service of the movement (Derickson and Routledge, 2015).

Lastly, in the engagement with the Alliance, I started with the assumption that activists would frame their strategies as "choking fracking". However, in the course of the interviews it became clear that while some were able to frame some activities as such in response to my question, it wasn't a framing prevalent in their own thinking. The first strategy I identified (described in more detail in section IV) - looking for and disseminating information - could be understood as a first step of looking for instabilities/choke points. The Alliance regularly holds assemblies, strategy conversations and retreats which analyse the political context and opportunities and dynamics of the moment and could also be seen as a search for choke points. However, these opportunities apparently did not get translated into activities that attacked specific choke points. Activities such as media work, a petition, linking with frontline groups and communities and helping legislators with their proposals to prohibit fracking are all understandable as generally "opposing" fracking and "mobilising" against fracking, but not attacking specific choke points. While activists did not use the framing themselves, several of them expressed interest in using it in the future. Even though from an academic perspective, the time chasing after non-existing choke point thinking was probably not well spent, because I could not find what I was searching for, for movement colleagues it was still useful and interesting to be asked such strategic questions. Another interesting outcome of this questioning were comments on two potential "choke *moments*": in the planning stage, when not much capital has been invested into a fossil fuel project yet, and in the wake of accidents (Interview National Activist 1). In the case of one

Alliance member organisation in Chiapas, an early mobilisation, which happened while oil and gas industry plans were still being drawn up, turned out successful, leading the government to cancel plans in the region (Interview National Activist 1). While I had to drop the whole idea of choke points from my Mexico case study, because the activists were not attacking them, the idea of *choke moments* will accompany me in my activist future. Unfortunately, this will rely exclusively on my good memory and on my ability to recognize situations where this framing fits and to apply it. Additional tools and mechanisms to record and share not-quite-publishable learnings from a research project could be a useful innovation that captures more of the intellectual value-added generated during such a long and typically intense effort.

1.3. Empirical

1.3.1. Movement blind spots

The carbon bombs analysis pointed to three regions with clusters of a large number of projects that could be considered “blind spots” of the KING movement: China, the Middle East and North Africa (MENA) and Russia. While there may have been a vague awareness that there are “a lot” of fossil fuels in these regions, the carbon bombs picture makes it very clear: there are 141 carbon bombs in China (including 48 new coal mines), 82 projects in the MENA region and 41 in Russia, while the whole European continent (excluding Russia) for example, only has 11 such projects. The results quite naturally invite reflections on how the strong European climate movement could engage with this picture. This reflection process has already started and we are starting work with colleagues from different organisations to identify supply chains of carbon bombs that lead to Europe, involvement of European companies in carbon bombs overseas (see Jehanno, 2022 on French TotalEnergies, which is involved in more than 20 carbon bombs), or financing of European and US investors in Russian carbon bombs (Carrington, 2022).

1.3.2. Mexico fracking

I would like to point to four results of the case study in Mexico that I find particularly interesting.

Firstly, the research facilitated what I would call *self-reflection* of the Alliance. Some of the questions I asked in my interview were rather big picture, inquiring into the effectiveness of our efforts and thus helped my interlocutors to develop or reinforce a sense of where our strengths lie and where our impact is biggest.

Secondly, it became clear that oil and gas prices are a key ingredient of the opportunity landscape for fossil fuel projects and have great explanatory power for the opening and closing of the “economic window of opportunity” for fossil fuel projects. Their price cycles are key shapers of the dynamics of the industry, and in response to it, of our movement. From my experience in the KING movement beyond Mexico I can say that beyond a few very knowledgeable people who monitor the industry closely, there is not much strategic awareness of these dynamics. This economic factor is not much monitored by movement actors, even though it could be a key strategic guidepost for our efforts and could help design more winnable campaigns through smart timing that “rides the waves” of price cycles, as I have tried to outline before (Kühne, 2015a).

Thirdly, the case study made it very clear that defusing is not the only game in town - delaying fossil fuel projects might also win the day, as political and economic windows of opportunity might be closing on fossil fuel projects. This is a significant finding for the movement, because it widens the playbook of useful interventions by a whole range of delay tactics - anything that can buy us time and slows down a project is in fact useful for the goals of the KING movement, and might even result in the complete cancelation of a project.

Lastly, the gloomy prospect of a “policy reversal” is still very much present in Mexico, it reminds us of the need, so far largely unmet, of the KING movement to identify *lock-in mechanisms* of its successes. We need to find ways to make sure that once we have fought off extraction, it is not going to come back in the next upward swing of the market. This is true not only in Mexico, but internationally, as the dash for gas in the wake of the Russian invasion of Ukraine has shown, which reactivated the calls for fracking in a number of countries where we thought we had won.

It would be desirable to replicate my case study for other carbon bombs, in order to collect further insights from struggles in other places.

2. Current context for the results

In addition to the individual discussions of my research findings in the three articles, I would like to point to a number of discussions and developments that are relevant for understanding where my results fit.

2.1. Supply-side mitigation gathering momentum

2021 was the third year that UNEP and partners published a Production Gap Report to highlight the disconnect between climate targets and fossil fuel extraction policies (SEI et al., 2019b; SEI et al., 2020; SEI et al., 2021). While the UNFCCC has still not moved much on the issue, and COP26 in Glasgow only timidly mentioned the need to "phase down" coal in its outcome text, supply-side climate action is gathering momentum on several fronts.

A civil society led campaign has rallied a large number of civil society organisations, Nobel laureates and cities behind the call for a Fossil Fuel Non-Proliferation Treaty (Newell and Simms, 2020). The Beyond Oil and Gas Alliance was launched in Glasgow at COP26, bringing together a number of countries and subnational jurisdictions in a group that is determined to phase out these fossil fuels, and mirroring the Powering Past Coal Alliance that already follows the same goal for coal. Besides this new international coalition, there have been a number of "first movers" announcing targets to phase out fossil fuel extraction or exploration, such as California, Greenland, Ireland, Spain (SEI et al., 2019a). While most of the first movers are located in the Global North, our case study is significant, because it unpacks the dynamics of a movement in the Global South that calls for non-extraction of fossil fuels and does so without the call for compensation that has been put forward in the case of the Ecuadorian Yasuní-ITT initiative or by Kenya in its Nationally Determined Contribution that mentions non-extraction as a possibility, conditional on external financial support (Ministry of Environment and Forestry, Republic of Kenya, 2020). This compensation for non-extraction is a problematic demand, because it shares an assumption with the fossil fuel industry, namely that fossil fuels are a force of good so to speak, requiring an equally attractive compensation if you forgo that benefit. The Mexican Alliance against Fracking is one, but not the only actor taking a more critical stance against fossil fuels. The same has been taken for many years by coalitions such as Oilwatch or the Asian People's Movement on Debt and Development. After elections in July 2022, Colombia aspires for a leadership role in the race beyond fossil fuels. What is still missing is the dialogue among governments about fossil fuels and climate change that would finally turn the negotiations about climate targets into a more realistic conversation with a perspective of achieving the goals that are set out, because the most relevant building blocks in the form of fossil fuel emissions are being addressed. The carbon bombs framing might make it more attractive for a political leader to step forward and make history by facilitating such a dialogue, which would only need a small number of countries, due to the high concentration of carbon bombs in a short list of countries.

As supply-side mitigation gathers momentum, the question of effectiveness of policies in that category will become more important, including to compare them with demand-side policies, the mainstay of climate change mitigation so far. My method for quantification of fossil fuel projects can inform efforts to understand the impact of supply-side measures and make such conversations easier to engage in for a wider set of people, beyond the usual experts.

A topic that will likely receive more attention at that point, and which I only briefly discussed in the paper on KING metrics is that of carbon leakage. While much of the literature focuses on carbon leakage on the demand side, the picture on the supply side has its own dynamics and challenges. Firstly, leakage needs to be differentiated by fuel. While there is a fairly liquid market for oil with often - but not always - interchangeable sources, for gas, the picture is already much more static, with much of global fossil gas extraction needing expensive infrastructures such as pipelines to be brought to market, and such expensive infrastructures tend to get financed via long-term contracts. Even the global market for liquefied fossil gas (still successfully branded as liquefied “natural” gas (LNG) by its merchants) requires many long-term decisions, and the spot market for LNG makes up for less than 10% of global fossil gas market (International Energy Agency, 2021; Shiryaevskaya, 2022). Coal is much more consumed domestically and less traded internationally. It is also mostly used for electricity generation, which means that relevant leakage effects are not only happening through international trade - where coal actually does cross borders, but also via the electricity market. A question for all three fuels is that of effective “swing producers” that will actually increase or decrease output in response to market prices. In the absence of those, rather than pushing the market equilibrium up or down a straight curve as witnessed in economic models, supply-side action would rather deepen or flatten a curve of a price cycle, which is a very different outcome that may be much more challenging to quantify than the simple calculations undertaken in current carbon leakage models.

2.2. No new projects

Only a few months after the Paris Agreement was signed, NGOs started pointing to the situation that existing fossil fuel extraction infrastructure is sufficient to break its temperature goals in *The Sky's Limits* report (Muttitt, 2016). It took the International Energy Agency five years to catch up with that realism, and in 2021 it finally released a first publication that stated that no new projects are needed under a net-zero by 2050 scenario (IEA, 2021). Trout et al. (2022) recently updated the analysis to indicate that 40% of "developed" reserves need to be left in the ground, indicating the need not only for an end to new fossil fuel projects, but also a very significant need for early closure of existing fossil fuel extraction infrastructure. This academic and institutional backing for the line of "no new projects" that we suggested in our carbon bombs paper is also matched by much starker language from the UN Secretary General against new fossil fuel projects in recent statements (United Nations Secretary-General, 2021). All of this indicates that the time for defusing new carbon bombs - 40% of our list - is now.

However, the seemingly simple demand "don't build new fossil fuel projects" clashes quite fundamentally with the interests of political and economic elites that drive and stand to personally benefit from new carbon bomb projects, often as part of a neocolonial export economy. Questioning them involves facing deeply rooted structures of injustice and oppression. It also clashes with the growth imperative of corporations in a capitalist economy. Fossil fuel companies have not yet come up with proper strategies for the inevitable decline in the second part of the extraction trajectory - after the peak. This seems to indicate that in early 21st century economies, degrowth is still not an option being seriously considered in fossil fuel companies.

2.3. Fossil gas - up or down?

In 2022, in the wake of the Russian invasion of Ukraine, we witnessed a renewed "dash for gas", because in the short run, Europe struggles to replace or eliminate the demand for cheap gas which it has been importing from Russia - now an uncertain and undesirable source. Even though the threat is a short-term one, with plans for replacing Russian gas in its major markets such as Germany ranging in time from immediately to five years (Brown et al., 2022; Buck et al., 2022; Stuckmann et al., 2022), the gas industry somehow managed to create a buzz around the theme of supposed energy security where any gas project - even if it needs many years to build, as is the case for new LNG terminals or to activate, as is the case for ramping up fracking, seems to be a welcome contribution. I have previously argued that energy security in the 21st century should not rely on fossil fuels (Kühne, 2015b). This would achieve a more solid energy security and better alignment with the Paris Agreement targets.

On the other hand, there is increasing recognition that emissions of methane, the main component of fossil gas, need to be reduced. In fact, action on methane provides an opportunity to curb the rise in temperatures due to the short atmospheric half-life of the gas. The Global Methane Pledge which aims to reduce methane emissions by 30 percent by 2030 signed at COP26 in Glasgow points in that direction. The FIFA World Cup in Qatar at the end of 2022 was held in a country that hosts 6 new (to-be-developed) gas carbon bombs with combined potential emissions of over 30 gigatons of CO2 (see the carbon bombs article). The tournament had to be shifted to the winter months due to the unbearable heat in Qatar in summer - and methane is responsible for one third of the man-made global heating (IPCC, 2021, fig. SPM.2, Panel (c)). Being able to quickly identify fossil gas expansion projects such as these as carbon bombs on our list may help make a contribution to leading the discussion on fossil gas in the direction of a faster phase-out.

3. Future work

In processing the academic literature on the climate movement, I found some concepts that inform my own thinking to be absent from the literature, such as the categorization of activists into *activists by choice* vs. *activists by necessity*, the *duty-bound* frame of KING activists, and the understanding of the climate movement as gravitating towards two poles, the “North Pole” of the UN climate negotiations and the “South Pole” of grassroots direct action against fossil fuel projects. Due to the necessary choice of a limited set of research objectives for a PhD project, I did not explore these other concepts and their implications in greater detail. But I believe that they could prove useful for understanding the phenomena at hand. It may therefore be useful to expand on them in future research. To close, let me mention some further promising areas for future work related to the KING movement and to carbon bombs.

3.1. KING movement

Because the KING movement is a concept that I have introduced and so far I have only been able to briefly characterise it in the articles, a more detailed description of the movement is warranted and could benefit the spread of the framing.

Another piece of useful work would be a mapping and a quantification of KING movement successes on a global scale, similar to what Goldtooth et al. (2021) have done for indigenous resistance to fossil fuel projects in the US and Canada. A list of KING movement successes could be created drawing upon previous mappings (Gaulin and Le Billon, 2020; Temper et al., 2020) with basic information for each success case. My quantification method can be used to quantify the amount of unburned carbon, where data to produce an estimate is available and thus put us in a position to assess the impact of the KING movement on the global carbonscape. This will make it comparable to other climate change mitigation approaches.

The finding that the success against fracking has not been “locked in” in Mexico and thus may easily be reversed by future administrations, or in a worst case scenario even the current one, points to a research need for the wider KING movement: how to lock in non-extraction successes? In the US, president Trump opened up areas protected under president Obama for drilling, and internationally there are so many countries around the world where protected area status has been attacked for various reasons that the acronym PADDD - protected areas downsizing, downgrading and degazettement was coined for the phenomenon (Mascia and Pailler, 2011). Therefore, we need to find and spread existing mechanisms to lock in non-extraction, and if they don't exist, we need to create them.

In a similar fashion, my research has pointed to price cycles of oil and gas, and presumably also coal, translating into opening and closing economic windows of opportunity for fossil fuel projects, and thus changing the relative vigour with which companies may pursue their projects or oppose KING movement efforts at achieving non-extraction concessions. It would be very useful to translate this into movement strategies, and in a similar vein as Naomi Klein has described the advancing of neoliberal policies in moments of crisis in *The Shock Doctrine* (Klein, 2008), being prepared for the next market up- or downturn, whatever comes next, can be of great strategic value to the KING movement.

The KING movement will eventually win. The stone age didn't end because of a lack of stones, and the same can be assumed to apply for the fossil fuel age. The biggest challenge for the movement is speed. We are currently winning too slowly. Emissions are still going up, despite all the resistance we have put up. We need to be multiplying the successes of the KING movement on a huge scale in order to stand a chance of limiting the amount of fossil carbon pumped into the atmosphere so swiftly that we stop short of triggering run-away climate change of catastrophic proportions, landing us in a hothouse Earth (Steffen et al., 2018).

3.2. Carbon bombs

Quite a few colleagues have been congratulating me on the carbon bombs paper and the reporting in the Guardian and other media (France, Germany, Canada, Ireland, India, etc.). I usually shrug my shoulders and say "now the *real* work starts: defusing them". Finding answers to the question on how to most effectively and quickly defuse carbon bombs is a big piece of work that now lies before us. A number of angles offer themselves: stopping new projects, going for coal first, stopping the most economically marginal projects and stopping unconventional projects. All of these approaches will take research to clarify the picture, and a coming together of players with the capacity to make an impact, at the very least by throwing some spanners into the works of those projects to delay them (see my discussion of delays above).

A useful piece of work could be a prioritisation of carbon bombs into three categories:

1.) those that are already operating, sometimes for decades, have robust economics and strong political backing
2.) those that are speculative, have low chances of ever going forward and are more “paper tigers” than real threats
3.) those in between.

The third category should become the key focus of our efforts. This categorization will likely reduce the number of priority projects to address further from the current number of 425. But to be honest, I do not see a reason why a global climate movement that manages to bring millions of people onto the streets shouldn’t be able to create small task forces of a handful of people, including lawyers, investigative journalists, communicators, researchers and friends of direct action for every single one of those 425 projects. The prioritisation can guide us on where to start creating such task forces.

An area also warranting further research is the question of *early closure*. As mentioned in the paper on carbon bombs, coal is increasingly uncompetitive in comparison with other sources of energy (Bodnar et al., 2020). But the standard way of ending the story has been bankruptcies - allowing corporations to offload environmental and social liabilities onto the public. This story is prone to repeating itself for existing coal carbon bombs, but also for oil and gas projects, unless we find ways to frontload the costs of closing down. This would have the additional benefit that marginal projects would not be started up in the first place, thus likely shortening the list of carbon bombs. Mechanisms to achieve this need to be investigated and fed into energy policy discussions. Good mechanisms for early closure, such as a proposed “climate bailout” (Kroll, 2018) could accelerate an orderly end to the fossil fuel age, rather than a fight that delays the end which then still involves bankruptcies and strong social injustices.

In the carbon bombs paper, we point to the fact that civil society in general and the KING movement in particular is not very strong in three important regions with clusters of carbon bombs: China, MENA and Russia. Let me share some thoughts about ways to start tackling their carbon bombs anyway.

China is the country with the most carbon bombs (141), and most of them (130) are coal mines, including 48 new ones. This squarely puts China in the first place of concern over carbon bombs. But China has severely restricted NGO operations, and especially those of foreign NGOs since Xi Jinping came to power (Han, 2018). Confrontational campaigning which many

KING movement constituents are used to in their home countries in Europe and North America, is much less of an option in China. Engagement with the government seems to be essential. And there are precedents of successful interventions of civil society, such as the Coal Consumption Cap Programme of the Natural Resources Defense Council (NRDC) China office which accompanied government institutions in researching the benefits of capping coal consumption. The proposal was subsequently turned into official government policy when the 13th Five-Year Plan (2016-2020) established a cap on coal output and when the National Development and Reform Commission set a cap for the total installed capacity of coal-fired power plants nationally. An acceleration of the end of coal in China (He et al., 2020) is an urgent area for further research.

The MENA region, and in particular the Gulf countries are also known for a lack of political freedom. Together with a strong dependency on oil and gas exports, it makes them another carbon bomb hotspot with 82 projects that is not a likely target for Western-style confrontational campaigning. In 2022, Egypt hosted COP27 and in 2023, the United Arab Emirates will play host to COP28. Maybe in the wake of these conferences, some new angles for a rapid transition that includes defusing carbon bombs may emerge. Qatar, which has 13 carbon bombs, 7 of which are new projects, is signing up many international partners to undertake those projects. This might provide an opportunity of confronting foreign companies in the courts in their home countries for the evident incompatibility of these undertakings with the Paris Agreement. Another front where these projects could be confronted is on the buyer side. Supply-chain campaigning is helped by information technologies that allow to track sources of oil and gas from the well all the way to the end consumer (Boyle, 2021). The caveat for consumer-side action is that while some places may stop buying problematic oil or gas, other places may buy this oil at a discount, as has happened during Russia’s invasion of Ukraine in 2022 where its discounted oil found willing buyers in countries uninvolved in the conflict.

Russia, similar to China and the MENA region, is not an easy place for defenders of the environment. Also there, the last years have seen an increase of repression and criminalisation of environmental organisations (Plantan, 2022). However, the Russian invasion of Ukraine in February 2022 has kindled the motivation of foreign players to stop supporting Russian fossil fuel projects and thus “filling Putin’s war chest”. Several companies have written down their investments and others have announced that they would not engage in new projects in Russia. At my organisation, we have published the list of foreign investors in Russian carbon bombs, with the aim to convince them to pull out. A significant development for the “defusing carbon bombs” agenda is that countries who support Ukraine have suddenly found a range of new tools to stop Russian fossil fuel profits, from economic sanctions, to seizing assets, nationalising companies, reducing or stopping purchases to accelerating the build-out of renewables and efficiency measures. This portfolio of responses to the situation shows that there is much one can do if one really wants to. It is certainly appropriate in the face of the situation in Ukraine, and is equally appropriate in responding to the climate emergency. My hope is that we will continue to wield the tools from that toolbox in the next years to stop other carbon bombs and dissuade the “arsonists” who still plan to set off new carbon bombs.

The carbon bombs framing naturally awakens associations of war and “normal” bombs. While estimating the death toll of CO_2 emissions is a methodical challenge (see e.g. Kharecha and Hansen, 2013), we believe the comparison holds. The *mortality cost of carbon* has been estimated at 1 death per 4,434 tons of CO2 over the rest of the 21st century (Bressler, 2021). This puts climate-change related deaths for a gigaton of CO2 at 225,530. Before Bressler’s paper was published, I already made my own, simpler calculations: global annual climate change related deaths were estimated at 166,000 per year in 2000 (McMichael et al., 2004 Table 20.16), while historical fossil fuel emissions to that point had been 1041 Gt CO_2 (Oak Ridge National Laboratory Environmental Sciences Division, 2010), putting the annual killing power of a gigaton of anthropogenic CO_2 emissions at over 100 human lives and thus in the same order of magnitude as other bombs (Quillen, 2002). Over a century, this translates into over 10,000 deaths, for any single project on our list, and many more for the bigger ones. I believe that calculating and spreading such figures can help stress the urgency of defusing carbon bombs. For that purpose, it would be useful to standardise the methodology and apply it to specific projects, maybe in connection with lawsuits that question governments and companies that try to greenlight such projects. Ultimately, however, the value of successfully defusing carbon bombs cannot be measured in a linear fashion, because we are dealing with a non-linear climate system on the verge of tipping into run-away climate change. The difference between a “Hothouse Earth” (Steffen et al. 2018) and a stabilised climate is a question of life and death for many millions of humans and hundreds of thousands of other species. When the cumulative effect of defusing carbon bombs is one of safeguarding a significant portion of life on Earth, the mentioned quantifications of the death toll of one project seem very small in comparison.

While the upsides of the framing apply to many campaigning and other contexts in Western societies, the militaristic carbon bombs framing can also be perceived as disempowering. In places like the Middle East, Russia, India and China which have both a more limited space for civil society opposition to government policies (including on fossil fuel extraction) and their own history of violent conflict and terrorism, it could even backfire. The concept may well stay mostly confined to Western societies and campaigning contexts.

A related line of argument that can also strengthen the case for defusing carbon bombs is that of climate-related economic damages. The international *social cost of carbon* has been put at 417 USD/ton of CO2 (Ricke et al., 2018). This means that each carbon bomb will be causing at least 0.4 trillion USD of climate damage. Another way of looking at it is that each barrel of oil burnt causes 175 USD of damages. The benefits derived from these fossil fuels are almost certainly smaller. When Nicholas Stern called climate change the greatest market failure we have ever seen (Stern, 2007), economists and governments took notice. But little has been done to correct this dysfunctional situation since then. Specifying the climate damages of carbon bombs (and other fossil fuel projects) more consistently could help remind us of how exceptionally damaging our current fossil fuel based economy is and how urgent it is to correct this. At LINGO, we have already published “death & damage” figures for all carbon bombs (Leave it in the Ground Initiative, 2022).

The strongest response to the carbon bombs paper has come from the media and from KING movement colleagues so far. Two additional constituencies that should get involved, but haven’t so far are academia and politics. I hope to carry the results of my work into those spaces as well, to spark interest and responses, and work building on the framing. Particularly politicians are a group that could benefit from adopting the framing. There is currently a lack of political leadership in effectively addressing the climate emergency and organising the move beyond the fossil fuel age. There are calls from the academic community to address fossil fuels and create a supply-side treaty or even a fossil fuel non-proliferation treaty (Asheim et al., 2019; Newell and Simms, 2020), but a champion to take up this call and bring it into high-level government conversations has not stepped up yet. It is a good time for somebody with courage and vision to do so and put defusing carbon bombs on the agenda of governments.

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VI. Appendices

1. List of carbon bombs
2. Carbon bomb calculations
3. Interview guide - Mexico case study
4. KING metrics emissions factors

Appendix 1

List of Carbon Bombs

Name (* new project)	Fuel	GtCO2
Algeria		
*Tannezuft Shale	Oil&Gas	2.3
Hassi R'Mel (Domestic)	Oil&Gas	2.3
Hassi Messaoud	Oil&Gas	1.2
Argentina		
Vaca Muerta Shale	Oil&Gas	5.2
Australia		
*Red Hill Coal Project	Coal	4.6
*Goldwyer Shale	Oil&Gas	4.5
Loy Yang Coal Mine	Coal	3.1
*Wards Well Coal Mine	Coal	2.7
*Alpha North Coal Mine	Coal	2.5
Peak Downs Coal Mine	Coal	2.3
Goonyella-Riverside Coal Mine	Coal	2.2
*Carmichael Coal Project	Coal	2.1
*Valeria Coal Mine	Coal	2.0
*Wilton and Fairhill Coal Projects	Coal	1.9
Gorgon LNG T1-T3	Oil&Gas	1.9
Byerwen Coal Mine	Coal	1.8
*Galilee Coal Mine	Coal	1.8
Hunter Valley North Coal Mine	Coal	1.7
*Hutton Coal Mine	Coal	1.7
*Olive Downs Coal Mine	Coal	1.4
*Saraji East Coal Mine	Coal	1.3
Ensham Coal Mine	Coal	1.3
Hunter Valley South Coal Mine	Coal	1.2
*Velkerri Shale	Oil&Gas	1.1
Yallourn	Coal	1.1
Mount Pleasant Coal Mine	Coal	1.1
Blackwater Coal Mine	Coal	1.0
Azerbaijan		
ACG (Azeri-Chirag-Guneshli Deep Water)	Oil&Gas	1.7
Bahrain		
*Central Arabian Offshore	Oil&Gas	1.4
Bangladesh		
*Phulbari Coal Mine	Coal	1.4
Botswana		
*Project Motheo	Coal	2.2
Brazil		
*Santos Offshore	Oil&Gas	4.3
*Llandovery Shale	Oil&Gas	4.3
Buzios (x-Franco)	Oil&Gas	3.6
*Irati Shale	Oil&Gas	2.7
Lula (X-Tupi)	Oil&Gas	2.5
*Parnaiba Onshore	Oil&Gas	2.0
*Libra	Oil&Gas	1.9
*Candeias Shale	Oil&Gas	1.6
*Campos Offshore	Oil&Gas	1.6
Mero (Libra NW)	Oil&Gas	1.3
Bulgaria		
Maritsa Coal Mines	Coal	2.5
Canada		
Montney Play	Oil&Gas	13.7
Murray River Coal Mine	Coal	8.5
Spirit River (Notikewin, Falher, Wilrich)	Oil&Gas	3.0
Gething Coal Mine	Coal	2.1
Horizon Oil Sands Project	Oil&Gas	2.0
Kearl	Oil&Gas	1.9
Duvernay	Oil&Gas	1.9
Athabasca Oil Sands Project	Oil&Gas	1.4
Christina Lake	Oil&Gas	1.2
Liard Shale	Oil&Gas	1.2
Syncrude Mildred Lake/Aurora	Oil&Gas	1.2
Fording River	Coal	1.0
China		
Tashan Coal Mine	Coal	9.0
Hongshaquan No.1 Coal Mine	Coal	9.0
*Dahaize Coal Mine	Coal	8.0
*Jiangjun Gebi No.2 Coal Mine	Coal	7.8
Dananhu No.1 Coal Mine	Coal	7.2
*Balasu Coal Mine	Coal	6.4
Hongqinghe Coal Mine	Coal	5.7
Longmaxi Shale	Oil&Gas	5.7
*Baijia Haizi Coal Mine	Coal	5.0
Changqing	Oil&Gas	4.9
Xiaojihan Coal Mine	Coal	4.6
Shengli East No.2 Coal Mine	Coal	4.6
Buertai Coal Mine	Coal	4.5
*Xinwen Ili No.1 Coal Mine	Coal	4.5
Chahasu Coal Mine	Coal	4.2
Ningtiaota Coal Mine	Coal	4.0
Hulusu Coal Mine	Coal	4.0
*Shilawusu Coal Mine	Coal	3.9
Jinjie Coal Mine	Coal	3.9
Xiaobaodang No.1 Coal Mine	Coal	3.8
*Yingpanhao Coal Mine	Coal	3.8
Menkeqing Coal Mine	Coal	3.7
*Dananhu No. 7 Coal Mine	Coal	3.6
*Zhundong Surface Mine	Coal	3.5
Meihuajing Coal Mine	Coal	3.5
*Qinghua No.7 Coal Mine	Coal	3.4
*Shaanxi Caojiatan Coal Mine	Coal	3.3
*Wucaiwan No.1 Coal Mine	Coal	3.3
Majialiang Coal Mine	Coal	3.2
Hongliulin Coal Mine	Coal	3.1
*Hetaoyu Coal Mine	Coal	3.0
*Taran Gaole Coal Mine	Coal	2.9
Ningxia Hongliu Coal Mine	Coal	2.9
*Dalaihushuo Coal Mine	Coal	2.9
Yushuwan Coal Mine	Coal	2.8
*Dananhu West No.2 Coal Mine	Coal	2.7
Wangjialing Coal Mine	Coal	2.7
Shenhua Heidaigou Surface Coal Mine	Coal	2.7
Pingshuo East Coal Mine	Coal	2.6
Yili No.4 Coal Mine	Coal	2.6
Daqing	Oil&Gas	2.6
*Shitoumei No.1 Coal Mine	Coal	2.4
*Cambrian/Silurian Marine Shale	Oil&Gas	2.4
*Xinzhuang Coal Mine	Coal	2.3
Sandaogou Coal Mine	Coal	2.3
Huangyuchuan Coal Mine	Coal	2.3
*Inner Mongolia Erlintu Coal Mine	Coal	2.2
Shenhua Bulianta Coal Mine	Coal	2.2
Zhangji Coal Mine	Coal	2.2
*Jinjitan Coal Mine	Coal	2.2
*Pangpangta Coal Mine	Coal	2.2
*Guojiatan Coal Mine	Coal	2.2
Dongzhouyao Coal Mine	Coal	2.2
Longmaxi Shale (Sichuan/Changyu)	Oil&Gas	2.2
Haerwusu Surface Mine	Coal	2.1
Suancigou Coal Mine	Coal	2.1
Yimin Surface Coal Mine	Coal	2.0
Guqiao Coal Mine	Coal	2.0
*Boli Coal Mine	Coal	2.0
Gaojialiang No.1 Coal Mine	Coal	2.0
Hongqingliang Coal Mine	Coal	2.0
Tarim (CNPC)	Oil&Gas	2.0
*Xiaobaodang No.2 Coal Mine	Coal	1.9
*Zhaoshipan Coal Mine	Coal	1.9
Longwanggou Coal Mine	Coal	1.9
Guojiawan Coal Mine	Coal	1.9
Gaotouyao Coal Mine	Coal	1.9
*Madaotou Coal Mine	Coal	1.8
Qingshuiying Coal Mine	Coal	1.8
Buliangou Coal Mine	Coal	1.8
Shanxi Lu'an Gucheng Coal Mine	Coal	1.8
Shangwan Coal Mine	Coal	1.8
Hanglaiwan Coal Mine	Coal	1.8
Xiaojiawa Coal Mine	Coal	1.8
*Southeast Uplift Onshore Heilongjiang Province	Oil&Gas	1.8
*Chagannur No.1 Coal Mine	Coal	1.7
*Muduchaideng Coal Mine	Coal	1.7
*Qiyuan Coal Mine	Coal	1.7
Weijiamao Open Pit Mine	Coal	1.7
*Nalin River No.2 Coal Mine	Coal	1.7
Dingji Coal Mine	Coal	1.7
Baode Coal Mine	Coal	1.7
Wangjiata Coal Mine	Coal	1.6
Wudong Coal Mine	Coal	1.6
*Shengli No.1 Open-Pit Coal Mine	Coal	1.6
Baiyinhua No.3 Surface Mine	Coal	1.6
Tongxin Coal Mine	Coal	1.6
Shenhua Baorixile Surface Coal Mine	Coal	1.6
Sijiazhuang Coal Mine	Coal	1.6
Gaohe Coal Mine	Coal	1.5
Xiwan Surface Coal Mine	Coal	1.5
Liuzhuang Coal Mine	Coal	1.5
*Yadian Coal Mine	Coal	1.5
Lijiahao Coal Mine	Coal	1.5
Shicaocun Coal Mine	Coal	1.5
Shengli	Oil&Gas	1.5
Shangyuquan Coal Mine	Coal	1.4
Qingchunta Coal Mine	Coal	1.4
*Taohe Coal Mine	Coal	1.4
Xiaozhuang Coal Mine	Coal	1.4
Wucaiwan No.1 Surface Mine	Coal	1.4
Shaqu No.1 Coal Mine	Coal	1.4
*Sanjiao No.1 Coal Mine	Coal	1.4
*Zhong Yu Coal Mine	Coal	1.4
*Mengcun Coal Mine	Coal	1.4
Huangling No.2 Coal Mine	Coal	1.4
Dafosi Coal Mine	Coal	1.4
Oil shale China	Oil&Gas	1.4
Xinjiang (CNPC)	Oil&Gas	1.4
Zhangjiamao Coal Mine	Coal	1.3
Talahao Coal Mine	Coal	1.3
Baishihu Surface Mine	Coal	1.3
Halagou Coal Mine	Coal	1.3
*Wenjiazhuang Coal Mine	Coal	1.3
*Yuwang No.1 Coal Mine	Coal	1.3
*Baiyanghe Coal Mine	Coal	1.2
Yangquan No.1 Coal Mine	Coal	1.2
Daliuta Coal Mine	Coal	1.2
*Xinjiang Hongshan Coal Mine	Coal	1.2
Antaibao Surface Mine	Coal	1.2
Shahaiji No.1 Coal Mine	Coal	1.2
Shigetai Coal Mine	Coal	1.2
Fengjiata Coal Mine	Coal	1.2
Gaojiabao Coal Mine	Coal	1.1
Shajihai No.2 Coal Mine	Coal	1.1
*Talike District No. 2 Coal Mine	Coal	1.1

Huojitu Well Of Daliuta Coal Mine Coal 1.1
*Changcheng No.3 Coal Mine Coal 1.1
Yangjiacun Coal Mine Coal 1.1
Yangchangwan No.1 Well Coal Mine Coal 1.1
*Wangwa Coal Mine Coal 1.1
*Ba Leng Coal Mine Coal 1.1
Zaoquan Coal MineCoal 1.1
Anjialing Open-Pit Mine Coal 1.0
*Longwan Coal Mine Coal 1.0
*Shanxi Dongda Coal Mine Coal 1.0
Kouzi East Coal Mine Coal 1.0
*Hongshuliang Coal Mine Coal 1.0
*West Well of Faer Second Coal Mine Coal 1.0
Sihe Coal Mine Coal 1.0
*Central Uplift Onshore Xinjiang Uygur Autonomous Region Oil&Gas 1.0

Colombia
El Descanso Coal Mine Coal 4.1
Cerrejón Coal Mine Coal 2.4
*La Luna Shale Oil&Gas 1.6
*San Juan Coal Mine Coal 1.6
Pribbenow Coal Mine Coal 1.4

Denmark
*Kronprins Christian Offshore Oil&Gas 2.2

Germany
Hambach Coal Mine Coal 1.7
Garzweiler Coal Mine Coal 1.3

Greece
West Macedonia Lignite Centre (WMLC) Coal 2.2

Guyana
*Greater Turbot (Stabroek) Oil&Gas 1.1
Greater Liza (Liza) Oil&Gas 1.0

India
Rajmahal Coal Mine Coal 5.8
Gevra Coal Mine Coal 2.4
*Barail Shale Oil&Gas 2.1
*Siarmal Coal Mine Coal 1.9
*Kerandari BC Coal 1.8
Talaipalli Coal Mine Coal 1.5
Lakhanpur Coal Mine Coal 1.5
*Integrated Belpahar, Lakhanpur, Lilari Coal Mine Coal 1.5
*Bankui Coal 1.6
*Balaram Coal Mine Coal 1.4
*Gare Pelma Sector II Coal 1.3
*Mandakini B Coal 1.3
Kaniha Coal Mine Coal 1.2
Dipka Coal Mine Coal 1.2
Kusmunda Coal Mine Coal 1.2
*Banhardih Coal 1.1
*Saharpur Jamarpani Coal 1.0
Moher Amlohri Coal Mine Coal 1.0

Indonesia
PTBA Coal Mines Coal 8.9
KPC Operation Coal Mine Coal 3.1
*East Natuna (x-Natuna D-Alpha) Oil&Gas 2.2
*GAM Coal Mine Coal 1.3
Indexim Coalindo Coal Mine Coal 1.1
*Pakar North Coal Mine Coal 1.1
Tutupan Coal Mine Coal 1.1
MHU Coal Mine Coal 1.1
BIB Coal Mine Coal 1.1
Pasir Coal Mine Coal 1.0

Israel
*Leviathan Oil&Gas 1.1

Iraq
Rumaila North & South Oil&Gas 7.8
Qurna West Oil&Gas 4.0
Baghdad East Oil&Gas 2.7
*Central Arabian Onshore Oil&Gas 2.6
Majnoon Oil&Gas 2.5
Zubair Oil&Gas 1.7
Qurna West-2 Oil&Gas 1.6
Halfayah Oil&Gas 1.4
Nahr bin Umar Oil&Gas 1.3
Ratawi Oil&Gas 1.1
Basrah Gas project Oil&Gas 1.0

Iran
Marun Oil&Gas 2.4
Azadegan Oil&Gas 2.3
Ahwaz Asmari Oil&Gas 2.2
*Central Arabian Offshore Oil&Gas 2.1
Gachsaran Oil&Gas 1.7
Agha Jari Oil&Gas 1.6
Ahwaz Bangestan Oil&Gas 1.4
Pazanan Oil&Gas 1.4
South Pars (Phases 9-10) dry gas Oil&Gas 1.3
*Kish Gas Project Oil&Gas 1.2
*Pars Southwest Oil&Gas 1.1
South Pars (Phases 4-5) dry gas Oil&Gas 1.1
Mansouri Bangestan Oil&Gas 1.0
South Pars (Phases 22-24) Oil&Gas 1.0
South Pars (Phases 20-21) Oil&Gas 1.0
South Pars (Phases 2-3) dry gas Oil&Gas 1.0

Kazakhstan
Bogatyr Coal Mine Coal 7.3
Kashagan Oil&Gas 5.1
Tengiz Oil&Gas 3.4
*Carboniferous Shale Oil&Gas 1.3
Karachaganak Oil&Gas 1.2
Borly Coal Mines Coal 1.0
Shubarkol Coal Mine Coal 1.0

Kuwait
Greater Burgan Oil&Gas 8.3
Project Kuwait Oil&Gas 4.4
*Central Arabian Onshore Oil&Gas 3.6
*Khafji Oil&Gas 1.4[1]

Libya
*Sirte Shale Oil&Gas 1.7
El Sharara Oil&Gas 1.0

Mexico
*Eagle Ford Shale Oil&Gas 5.1
*Gulf Deepwater Offshore Oil&Gas 2.2
Ku-Maloob-Zaap Project Oil&Gas 2.0
*Yucatan Platform Offshore Oil&Gas 1.0

Mongolia
*Tavan Tolgoi Coal Mine Coal 16.0

Mozambique
*Zambezi Coal Mine Coal 4.1
*Chirodzi Coal Mine Coal 2.9
*Revuboe Coal Mine Coal 1.4
*MZLNG Joint Development (T1-T2) Oil&Gas 1.3
*Area-1 Future Phases Oil&Gas 1.0
*Area 1 LNG (T1&T2) Oil&Gas 1.0

Nigeria
NLNG Base Project Oil&Gas 1.0

North Korea
Saebyol Coal Mining Complex Coal 3.2

Norway
Troll Oil&Gas 1.8
Johan Sverdrup Oil&Gas 1.1

Pakistan
*Sembar Shale Oil&Gas 2.8
Thar Coal Mine Coal 1.9

Poland
*Lublin Basin Silurian Shale Oil&Gas 5.6

Qatar
*North Field Oil&Gas 11.6
*North Field C LNG Oil&Gas 7.8
*North Field E Oil&Gas 4.6
*QatarGas LNG T8-T11 (NFE-East) Oil&Gas 3.4
*Barzan Oil&Gas 3.1
*Central Arabian Onshore Oil&Gas 2.2
Qatargas 2 LNG T4-T5 Oil&Gas 1.8
*QatarGas LNG T12-T13(NFE-South) Oil&Gas 1.8
Dolphin Oil&Gas 1.6
Rasgas 2 LNG T3-T5 Oil&Gas 1.5
Rasgas 3 LNG T6-T7 Oil&Gas 1.5
QatarGas 1 LNG T1-T3 Oil&Gas 1.3
Al Khaleej Gas project Oil&Gas 1.1

Russia
Bovanenkovo Zone (Yamal Megaproject) Oil&Gas 11.2
Gazprom dobycha Yamburg Oil&Gas 8.9
*Tunguska Basin CBM Oil&Gas 8.8
*Shtokman Oil&Gas 6.1
Urengoyskoye Oil&Gas 5.2
*Kuznetsk Depression (Kuzbass) CBM Oil&Gas 4.9
*Elga Coal Mine Coal 4.5
Yuganskneftegaz Oil&Gas 4.3
Eastern Gas Program Oil&Gas 4.3
Stepnoy Coal Mine Coal 3.6
*West Siberia Offshore Oil&Gas 2.9
*Lensky Basin CBM Oil&Gas 2.7
*Timan - Pechora Basin Offshore Oil&Gas 2.5
*Tambey Zone (Yamal Megaproject) Oil&Gas 2.5
*Timan - Pechora Basin Onshore Oil&Gas 2.4
*Beisky-Zapadniy Coal Mine Coal 2.4
Raspadskaya Coal Mine Coal 2.4
Listvianskaya Coal Mine Coal 2.4
Elegest Coal Mine Coal 2.3
Taldinsky Coal Mine Coal 2.2
*Ulug-Khem Project Coal 2.2
Samotlorneftegaz (TNK-BP) Oil&Gas 1.9
*Sugodinsk-Ogodzhinsky Coal Mine Coal 1.8
*Leningradskoye (Kara Sea) Oil&Gas 1.8
Arshanovsky Coal Mine Coal 1.7
*Usinsk-1 Coal Mine Coal 1.7
Pereyaslovskiy Coal Mine Coal 1.6
Gazprom dobycha Orenburg Oil&Gas 1.6
*Arctic LNG 2 T1-3 Oil&Gas 1.5
*Pervomaisky Coal Mine Coal 1.5
*Volga - Urals Onshore Oil&Gas 1.4
Romashkino Oil&Gas 1.3
*Rusanovskoye (Kara Sea) Oil&Gas 1.3
Gazprom dobycha Nadym Oil&Gas 1.3
*Inaglinskaya-2 Mine Coal 1.3
*Taymyr Basin CBM Oil&Gas 1.2
*North Kara Sea Offshore Oil&Gas 1.2
*West Siberia Onshore Oil&Gas 1.2

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[1] This project is located in the Neutral Zone between Saudi-Arabia & Kuwait and is included in both country lists.

SeverEnergia Project	Oil&Gas	1.1
Erkovetskiy Coal Mine	Coal	1.0
*Shurapskaya Coal Mine	Coal	1.0

Saudi Arabia

Ghawar Uthmaniyah	Oil&Gas	19.2
Safaniya	Oil&Gas	11.9
Khurais project	Oil&Gas	7.6
Ghawar Haradh	Oil&Gas	7.0
*Central Arabian Offshore	Oil&Gas	6.9
Ghawar Shedgum	Oil&Gas	5.7
Qatif project	Oil&Gas	5.1
Manifa (redevelop)	Oil&Gas	5.0
Ghawar Hawiyah	Oil&Gas	4.6
*Central Arabian Onshore	Oil&Gas	4.4
Shaybah	Oil&Gas	4.3
Berri	Oil&Gas	3.6
*Zuluf (CR in field)	Oil&Gas	3.5
Zuluf	Oil&Gas	2.4
Khursaniyah	Oil&Gas	2.4
Ghawar Ain Dar N	Oil&Gas	2.1
Marjan	Oil&Gas	1.9
*Safaniya YTF Concession	Oil&Gas	1.8
*Zuluf (expansion)	Oil&Gas	1.8
Abqaiq	Oil&Gas	1.6
Ghawar Ain Dar S	Oil&Gas	1.4
*Khafji	Oil&Gas	1.4[2]
*Sudair Shale	Oil&Gas	1.0
Harmaliyah	Oil&Gas	1.0

Serbia

Kolubara	Coal	2.5

South Africa

Grootegeluk Mine	Coal	6.9
*Greater Soutpansberg Coal Project	Coal	2.8
*Boikarabelo Coal Mine	Coal	2.4
*Collingham Shale	Oil&Gas	1.8
*Paardekop Coal Mine	Coal	1.7
*New Largo Coal Mine	Coal	1.4
*Bernice-Cygnus Coal Mine	Coal	1.1

Syria

*Tanf Shale	Oil&Gas	1.4

Turkey

Afşin-Elbistan Coal Mine	Coal	4.1

Turkmenistan

Yolotan (Iolotan) South	Oil&Gas	9.5
*Yashlar Vostochnyy (East)	Oil&Gas	2.1
Dovletabad-Donmez	Oil&Gas	1.6

[2] See footnote 1.

Tanzania

*Tanzanian Coastal Offshore	Oil&Gas	1.0

Ukraine

*Menilite Shale	Oil&Gas	1.7

United Arab Emirates

Upper Zakum	Oil&Gas	6.4
Bu Hasa	Oil&Gas	4.9
Bab	Oil&Gas	4.2
Lower Zakum	Oil&Gas	2.4
Umm Shaif/Nasr	Oil&Gas	1.9
Bab (Gasco)	Oil&Gas	1.7
Asab	Oil&Gas	1.4

United Kingdom

*Bowland Shale	Oil&Gas	1.5

United States

Permian Delaware Tight	Oil&Gas	27.8
Marcellus Shale	Oil&Gas	26.7
Permian Midland Tight	Oil&Gas	16.6
Haynesville/Bossier Shale	Oil&Gas	13.2
Utica Shale	Oil&Gas	7.7
Bakken Shale	Oil&Gas	5.9
Eagle Ford Shale	Oil&Gas	5.9
DJ Basin Tight Oil	Oil&Gas	5.9
Western Gulf Province_Texas	Oil&Gas	5.1
Woodford Shale	Oil&Gas	3.4
North Antelope Rochelle Coal Mine	Coal	2.9
MC #1 Coal Mine	Coal	2.9
PRB Tight Oil	Oil&Gas	2.8
*Chukchi Sea Offshore	Oil&Gas	2.5
Meramec Shale	Oil&Gas	2.4
Permian Conventional_Texas	Oil&Gas	2.1
*North Slope Onshore	Oil&Gas	2.0
Cumberland Coal Mine	Coal	1.9
Anadarko Shelf_Oklahoma	Oil&Gas	1.8
*Baltimore Canyon Offshore	Oil&Gas	1.6
Austin Chalk Tight	Oil&Gas	1.4
Barnett Shale	Oil&Gas	1.4
Black Thunder Coal Mine	Coal	1.4
*Beaufort Sea Offshore	Oil&Gas	1.3
Hamilton County No. 1 Mine	Coal	1.2
*Gulf Coast Centre Offshore	Oil&Gas	1.1
*West Florida Offshore	Oil&Gas	1.1
*Youngs Creek Coal Mine	Coal	1.1

Uzbekistan

*Angren Coal Mine	Coal	2.4

Venezuela

Orinoco Joint Ventures	Oil&Gas	6.7
*La Luna Shale	Oil&Gas	1.1

Zimbabwe

Sengwe Colliery	Coal	1.0

Source: Kühne et al. 2022

			Potentia	Total (mboe)		Oil (mbbl)			NGLs (mbbl)							Gas		
Ne	Project	Country	Gt CO2	Productior	Resources	Production	Resources	Emissions factor	Condensate Production	Condensate Resources	NGL Production	NGL Resources	Sum Production	Sum Resources	Emissions factor	Production (mboe)	Resources (bcm)	Emissions factor
	Upper Zakum	United Ar	6.4404	272.3	18255.9	272.3	17759.7	0.00035464					0.0	0.0	0.00023745		84.3	0.0016848
	Bu Hasa	United Ar	4.9158	186.4	13861.3	186.4	13861.3	0.00035464					0.0	0.0	0.00023745			0.0016848
	Bab	United Ar	4.1970	149.7	12879.9	149.7	7450.3	0.00035464					0.0	0.0	0.00023745		922.9	0.0016848
	Lower Zakum	United Ar	2.4344	146.2	6864.5	146.2	6864.5	0.00035464					0.0	0.0	0.00023745			0.0016848
	Umm Shaif/Nasr	United Ar	1.9393	96.2	5468.2	96.2	5468.2	0.00035464					0.0	0.0	0.00023745			0.0016848
	Bab (Gasco)	United Ar	1.6744	241.7	6298.4			0.00035464	65.7	1676.0	56.0	966.7	121.7	2642.7	0.00023745	120.0	621.4	0.0016848
	Asab	United Ar	1.3732	72.4	3872.2	72.4	3872.2	0.00035464					0.0	0.0	0.00023745			0.0016848
	Vaca Muerta Shale	Argentina	5.1778	102.6	16380.7	32.2	7804.3	0.00035464	0.6	111.3	5.3	827.6	6.0	938.9	0.00023745	64.4	1298.2	0.0016848
*	Goldwyer Shale	Australia	4.4688	0.0	14073.6		8440.3	0.00035464				2814.1	0.0	2814.1	0.00023745		479.2	0.0016848
	Gorgon LNG T1-T3	Australia	1.9310	137.7	6801.8			0.00035464	5.8	211.0		132.9	5.8	343.9	0.00023745	131.9	1097.7	0.0016848
*	Velkerri Shale	Australia	1.0580	0.0	3688.5		164.9	0.00035464				194.1	0.0	194.1	0.00023745		565.9	0.0016848
	ACG (Azeri-Chirag-Guneshli I	Azerbaija	1.6603	207.5	4970.5	195.1	3469.5	0.00035464					0.0	0.0	0.00023745	12.4	255.1	0.0016848
*	Central Arabian Offshore	Bahrain	1.4114	0.0	4248.5		2853.6	0.00035464					0.0	0.0	0.00023745		237.1	0.0016848
*	Santos Offshore	Brazil	4.3398	0.0	13049.2		8831.9	0.00035464					0.0	0.0	0.00023745		716.8	0.0016848
*	Llandovery Shale	Brazil	4.2735	0.0	15051.5			0.00035464				752.6	0.0	752.6	0.00023745		2430.4	0.0016848
	Buzios (x-Franco)	Brazil	3.6382	92.2	10568.9	92.2	9138.5	0.00035464				250.6	0.0	250.6	0.00023745		200.5	0.0016848
*	Irati Shale	Brazil	2.6953	0.0	9493.0			0.00035464				474.7	0.0	474.7	0.00023745		1532.9	0.0016848
	Lula (X-Tupi)	Brazil	2.5458	415.8	7363.4	363.3	6403.0	0.00035464					0.0	0.0	0.00023745	52.5	163.2	0.0016848
*	Parnaiba Onshore	Brazil	1.9986	0.0	6603.0		1577.2	0.00035464					0.0	0.0	0.00023745		854.2	0.0016848
*	Libra	Brazil	1.8917	0.0	5556.2		4479.4	0.00035464		16.7		89.6	0.0	106.3	0.00023745		165.0	0.0016848
*	Candeias Shale	Brazil	1.6418	0.0	4835.8		4110.5	0.00035464				483.6	0.0	483.6	0.00023745		41.1	0.0016848
*	Campos Offshore	Brazil	1.5610	0.0	4686.8		3204.9	0.00035464					0.0	0.0	0.00023745		251.9	0.0016848
	Mero (Libra NW)	Brazil	1.2870	13.1	3757.7	13.1	3089.7	0.00035464					0.0	0.0	0.00023745		113.5	0.0016848
	Montney Play	Canada	13.6885	616.9	48822.0	24.6	2659.7	0.00035464	51.5	2782.5	106.8	6910.2	158.4	9692.7	0.00023745	434.0	6198.8	0.0016848
	Spirit River (Notikewin, Falhe	Canada	2.9762	160.3	10651.5	1.2	33.5	0.00035464	0.1	48.5	21.8	1512.1	21.9	1560.6	0.00023745	137.2	1539.5	0.0016848
	Horizon Oil Sands Project	Canada	1.9898	72.7	5610.7	72.7	5610.7	0.00035464					0.0	0.0	0.00023745			0.0016848
	Kearl	Canada	1.9012	74.8	5360.9	74.8	5360.9	0.00035464					0.0	0.0	0.00023745			0.0016848
	Duvernay	Canada	1.8714	63.8	6568.7	6.8	1454.0	0.00035464	9.1	1220.6	15.8	1006.8	24.9	2227.5	0.00023745	32.1	490.8	0.0016848
	Athabasca Oil Sands Project	Canada	1.3559	102.2	3823.2	102.2	3823.2	0.00035464					0.0	0.0	0.00023745			0.0016848
	Christina Lake	Canada	1.2321	71.1	3474.3	71.1	3474.3	0.00035464					0.0	0.0	0.00023745			0.0016848
	Liard Shale	Canada	1.2018	0.3	4196.8			0.00035464					0.0	0.0	0.00023745	0.3	713.3	0.0016848
	Syncrude Mildred Lake/Auro	Canada	1.1841	107.1	3338.7	107.1	3338.7	0.00035464					0.0	0.0	0.00023745			0.0016848
	Longmaxi Shale	China	5.6917	59.8	18742.7		5223.1	0.00035464	1.1	296.0	1.1	362.2	2.1	658.2	0.00023745	57.7	2186.1	0.0016848
	Changqing	China	4.9399	411.6	15751.4	178.4	6303.1	0.00035464		0.0	0.6	22.4	0.6	22.4	0.00023745	232.5	1602.1	0.0016848
	Daqing	China	2.6018	237.3	7530.1	222.2	6525.0	0.00035464		0.4	0.0	0.6	0.0	1.0	0.00023745	15.1	170.7	0.0016848
*	Cambrian/Silurian Marine Sh	China	2.3675	0.0	7640.5		3537.3	0.00035464		1179.1		87.3	0.0	1266.4	0.00023745		482.2	0.0016848
	Longmaxi Shale (Sichuan/Ch	China	2.2099	19.4	7851.1			0.00035464	1.0	392.6	1.0	392.6	1.9	785.1	0.00023745	17.5	1201.0	0.0016848
	Tarim (CNPC)	China	1.9599	214.0	6718.2	39.2	715.6	0.00035464	9.9	140.2	5.3	122.6	15.2	262.8	0.00023745	159.5	975.6	0.0016848
*	Southeast Uplift Onshore He	China	1.7505	0.0	5512.7		3307.6	0.00035464		1102.5			0.0	1102.5	0.00023745		187.4	0.0016848
	Shengli	China	1.5058	170.2	4265.8	167.6	4162.7	0.00035464		0.0		0.0	0.0	0.0	0.00023745	2.6	17.5	0.0016848
	Oil shale China	China	1.3855	3.3	3906.7	3.3	3906.7	0.00035464					0.0	0.0	0.00023745			0.0016848
	Xinjiang (CNPC)	China	1.3564	103.8	3982.4	90.2	3242.4	0.00035464	1.7	83.8	0.9	26.4	2.6	110.2	0.00023745	10.9	107.0	0.0016848
*	Central Uplift Onshore Xinjia	China	1.0443	0.0	3062.7		2450.1	0.00035464					0.0	0.0	0.00023745		104.1	0.0016848
*	La Luna Shale	Colombia	1.6168	0.0	5492.2		1430.5	0.00035464	0.0	17.5	0.0	1079.3	0.0	1096.8	0.00023745	0.0	503.9	0.0016848
*	Tannezuft Shale	Algeria	2.3479	0.0	7536.0		3754.1	0.00035464				1359.5	0.0	1359.5	0.00023745		411.7	0.0016848
	Hassi R'Mel (Domestic)	Algeria	2.2715	177.0	8021.5			0.00035464			30.0	522.3	30.0	522.3	0.00023745	147.0	1274.6	0.0016848
	Hassi Messaoud	Algeria	1.2159	155.3	3457.0	155.0	3368.2	0.00035464	0.0	45.0	0.3	36.7	0.3	81.7	0.00023745		1.2	0.0016848
*	Bowland Shale	United Ki	1.4761	0.0	5222.2		194.5	0.00035464		121.5		546.5	0.0	668.0	0.00023745		741.0	0.0016848
*	Kronprins Christian Offshore	Denmark	2.2324	0.0	6722.1		4503.3	0.00035464					0.0	0.0	0.00023745		377.1	0.0016848
*	Greater Turbot (Stabroek)	Guyana	1.1144	0.0	3230.2		2774.0	0.00035464					0.0	0.0	0.00023745		77.5	0.0016848
	Greater Liza (Liza)	Guyana	1.0028	0.1	2884.2	0.1	2590.2	0.00035464					0.0	0.0	0.00023745		50.0	0.0016848
*	East Natuna (x-Natuna D-Alp	Indonesia	2.1585	0.0	7668.5			0.00035464				766.3	0.0	766.3	0.00023745		1173.2	0.0016848
	Leviathan	Israel	1.0602	0.1	3711.9			0.00035464	0.0	55.6		0.0	0.0	55.6	0.00023745	0.1	621.5	0.0016848
*	Barail Shale	India	2.1416	0.0	7542.8			0.00035464				377.1	0.0	377.1	0.00023745		1218.0	0.0016848
	Rumaila North & South	Iraq	7.7616	530.7	22061.6	530.7	21148.9	0.00035464					0.0	0.0	0.00023745		155.1	0.0016848
	Qurna West	Iraq	3.9828	164.2	11230.9	164.2	11229.6	0.00035464					0.0	0.0	0.00023745		0.2	0.0016848
	Baghdad East	Iraq	2.7425	2.6	7771.6	2.6	7571.4	0.00035464					0.0	0.0	0.00023745		34.0	0.0016848
*	Central Arabian Onshore	Iraq	2.6074	0.0	7879.6		5140.4	0.00035464					0.0	0.0	0.00023745		465.6	0.0016848
	Majnoon	Iraq	2.4683	44.6	7185.1	44.6	6016.7	0.00035464					0.0	0.0	0.00023745		198.6	0.0016848

			Potentia	Total (mboe)		Oil (mbbl)			NGLs (mbbl)							Gas		
Ne	Project	Country	Gt CO2	Productior	Resources	Production	Resources	Emissions factor	Condensate Production	Condensate Resources	NGL Production	NGL Resources	Sum Production	Sum Resources	Emissions factor	Production (mboe)	Resources (bcm)	Emissions factor
	Zubair	Iraq	1.6793	175.9	4813.6	175.9	4406.4	0.00035464					0.0	0.0	0.00023745		69.2	0.0016848
	Qurna West-2	Iraq	1.5987	142.5	4525.0	142.5	4436.8	0.00035464					0.0	0.0	0.00023745		15.0	0.0016848
	Halfayah	Iraq	1.4090	135.3	3994.7	135.3	3882.7	0.00035464					0.0	0.0	0.00023745		19.0	0.0016848
	Nahr bin Umar	Iraq	1.2776	9.2	3610.9	9.2	3568.2	0.00035464					0.0	0.0	0.00023745		7.3	0.0016848
	Ratawi	Iraq	1.0651	6.7	3044.6	6.7	2830.6	0.00035464					0.0	0.0	0.00023745		36.4	0.0016848
	Basrah Gas project	Iraq	1.0412	73.1	3733.7			0.00035464	5.7	306.4	15.8	267.2	21.4	573.6	0.00023745	51.7	537.1	0.0016848
	Marun	Iran	2.4085	71.8	7492.7	47.5	4994.1	0.00035464	7.7	826.6	0.7	769.6	8.3	1596.2	0.00023745	16.0	153.4	0.0016848
	Azadegan	Iran	2.2780	75.0	6480.4	65.0	6185.1	0.00035464			0.1	0.7	0.1	0.7	0.00023745	9.9	50.1	0.0016848
	Ahwaz Asmari	Iran	2.2383	114.9	6859.9	99.0	4570.5	0.00035464	4.4	673.3	0.5	107.8	4.9	781.2	0.00023745	11.0	256.4	0.0016848
*	Central Arabian Offshore	Iran	2.1221	0.0	6388.1		4288.8	0.00035464					0.0	0.0	0.00023745		356.8	0.0016848
	Gachsaran	Iran	1.7393	36.0	4983.2	36.0	4573.9	0.00035464					0.0	0.0	0.00023745		69.6	0.0016848
	Agha Jari	Iran	1.5631	14.7	4504.1	14.6	4167.3	0.00035464	0.0	106.2	0.1	123.5	0.1	229.7	0.00023745		18.2	0.0016848
	Ahwaz Bangestan	Iran	1.4339	27.0	4159.2	17.8	3564.8	0.00035464			0.1	10.6	0.1	10.6	0.00023745	9.1	99.2	0.0016848
	Pazanan	Iran	1.3584	13.0	4721.2	11.9	598.1	0.00035464	1.0	703.0	0.1	0.7	1.1	703.7	0.00023745		581.2	0.0016848
	South Pars (Phases 9-10) dry	Iran	1.2650	108.9	4417.4			0.00035464					0.0	0.0	0.00023745	108.9	750.8	0.0016848
*	Kish Gas Project	Iran	1.1936	0.0	4215.5			0.00035464	0.0	277.2			0.0	277.2	0.00023745	0.0	669.4	0.0016848
*	Pars Southwest	Iran	1.1093	0.0	4011.2			0.00035464		449.9		355.8	0.0	805.7	0.00023745		544.8	0.0016848
	South Pars (Phases 4-5) dry g	Iran	1.1010	113.1	3844.6			0.00035464					0.0	0.0	0.00023745	113.1	653.5	0.0016848
	Mansouri Bangestan	Iran	1.0458	24.8	3006.5	22.5	2708.0	0.00035464					0.0	0.0	0.00023745	2.3	50.7	0.0016848
	South Pars (Phases 22-24)	Iran	1.0427	34.7	3812.0			0.00035464	2.2	639.1	2.7	360.9	4.9	1000.0	0.00023745	29.8	478.0	0.0016848
	South Pars (Phases 20-21)	Iran	1.0172	123.6	3713.3			0.00035464	13.7	600.4	11.9	343.8	25.7	944.2	0.00023745	97.9	470.7	0.0016848
	South Pars (Phases 2-3) dry g	Iran	1.0163	109.4	3548.8			0.00035464					0.0	0.0	0.00023745	109.4	603.2	0.0016848
	Greater Burgan	Kuwait	8.3419	483.0	23537.0	483.0	23460.4	0.00035464					0.0	0.0	0.00023745	0.0	13.0	0.0016848
	Project Kuwait	Kuwait	4.4095	346.6	12644.2	346.6	11550.8	0.00035464					0.0	0.0	0.00023745		185.8	0.0016848
*	Central Arabian Onshore	Kuwait	3.5975	0.0	10860.7		7138.7	0.00035464					0.0	0.0	0.00023745		632.6	0.0016848
	Kashagan	Kazakhsta	5.0862	132.2	14699.6	111.8	12840.6	0.00035464		0.0		0.0	0.0	0.0	0.00023745	20.5	316.0	0.0016848
	Tengiz	Kazakhsta	3.3579	308.4	10101.0	237.7	7013.1	0.00035464		0.2	14.8	276.5	14.8	276.7	0.00023745	55.8	477.8	0.0016848
*	Carboniferous Shale	Kazakhsta	1.2872	0.0	3770.8		3182.5	0.00035464		202.1			0.0	202.1	0.00023745		65.6	0.0016848
	Karachaganak	Kazakhsta	1.2077	133.4	4532.6		0.1	0.00035464	79.8	1845.2		0.0	79.8	1845.2	0.00023745	53.6	456.8	0.0016848
*	Sirte Shale	Libya	1.7033	0.0	5363.9		3218.3	0.00035464				1072.8	0.0	1072.8	0.00023745		182.3	0.0016848
	El Sharara	Libya	1.0078	75.5	2844.2	75.5	2832.4	0.00035464					0.0	0.0	0.00023745		2.0	0.0016848
*	Eagle Ford Shale	Mexico	5.0680	0.0	17850.0			0.00035464				892.5	0.0	892.5	0.00023745		2882.3	0.0016848
*	Gulf Deepwater Offshore	Mexico	2.2048	0.0	6623.8		4511.4	0.00035464					0.0	0.0	0.00023745		359.0	0.0016848
	Ku-Maloob-Zaap Project	Mexico	1.9602	329.0	5614.3	307.1	5258.7	0.00035464	1.9	28.4	5.5	105.7	7.4	134.0	0.00023745	14.5	37.7	0.0016848
*	Yucatan Platform Offshore	Mexico	1.0258	0.0	3084.3		2087.9	0.00035464					0.0	0.0	0.00023745		169.4	0.0016848
*	MZLNG Joint Development (	Mozambi	1.3102	0.0	4626.0			0.00035464		82.3		215.4	0.0	297.8	0.00023745		735.7	0.0016848
*	Area-1 Future Phases	Mozambi	1.0227	0.0	3610.1		48.2	0.00035464		48.8		245.1	0.0	294.0	0.00023745		555.4	0.0016848
*	Area 1 LNG (T1&T2)	Mozambi	1.0067	0.0	3590.5			0.00035464		86.9		353.6	0.0	440.4	0.00023745		535.4	0.0016848
	NLNG Base Project	Nigeria	1.0334	191.2	3207.3	140.3	1727.1	0.00035464	1.4	9.0	0.3	51.8	1.7	60.8	0.00023745	49.2	241.3	0.0016848
	Troll	Norway	1.7721	245.3	6135.7	39.4	350.4	0.00035464			7.5	181.8	7.5	181.8	0.00023745	198.4	952.4	0.0016848
	Johan Sverdrup	Norway	1.0739	25.1	3066.0	23.4	2917.2	0.00035464			0.9	67.1	0.9	67.1	0.00023745	0.8	13.9	0.0016848
*	Khafji	Kuwait-Sa	1.4399	0.0	4166.3	0.0	3615.0	0.00035464					0.0	0.0	0.00023745		93.7	0.0016848
*	Sembar Shale	Pakistan	2.8402	0.0	8944.3		5366.6	0.00035464		1788.9			0.0	1788.9	0.00023745		304.1	0.0016848
*	Lublin Basin Silurian Shale	Poland	5.6471	0.0	17783.5		10670.1	0.00035464		44.5		3512.2	0.0	3556.7	0.00023745		604.5	0.0016848
*	North Field	Qatar	11.6128	0.0	42432.4			0.00035464		7504.6		3504.0	0.0	11008.5	0.00023745		5341.2	0.0016848
*	North Field C LNG	Qatar	7.7681	0.0	28381.0			0.00035464		5006.4		2338.5	0.0	7344.8	0.00023745		3575.6	0.0016848
*	North Field E	Qatar	4.5945	0.0	16875.5			0.00035464		3001.3		1866.7	0.0	4867.9	0.00023745		2041.0	0.0016848
*	QatarGas LNG T8-T11 (NFE-E	Qatar	3.3950	0.0	12523.6			0.00035464		2693.3		1218.8	0.0	3912.1	0.00023745		1463.7	0.0016848
*	Barzan	Qatar	3.0941	0.0	11247.5			0.00035464		971.2	0.0	1621.4	0.0	2592.6	0.00023745	0.0	1471.1	0.0016848
*	Central Arabian Onshore	Qatar	2.2172	0.0	6700.1		4372.8	0.00035464					0.0	0.0	0.00023745		395.6	0.0016848
	Qatargas 2 LNG T4-T5	Qatar	1.8280	190.2	6745.7			0.00035464	43.4	1329.2	18.0	790.7	61.4	2119.9	0.00023745	128.8	786.2	0.0016848
*	QatarGas LNG T12-T13 (NFE-	Qatar	1.7852	0.0	6567.2			0.00035464		1231.7		718.9	0.0	1950.6	0.00023745		784.7	0.0016848
	Dolphin	Qatar	1.5502	177.9	5710.9			0.00035464	31.0	1090.1	22.2	651.1	53.2	1741.3	0.00023745	124.6	674.7	0.0016848
	Rasgas 2 LNG T3-T5	Qatar	1.5098	147.5	5601.1			0.00035464	34.0	1133.3	5.7	792.0	39.7	1925.2	0.00023745	107.8	624.8	0.0016848
	Rasgas 3 LNG T6-T7	Qatar	1.4907	190.1	5527.4			0.00035464	39.8	1239.5	19.2	644.9	58.9	1884.3	0.00023745	131.2	619.2	0.0016848
	QatarGas 1 LNG T1-T3	Qatar	1.2833	116.7	4647.5			0.00035464	23.0	597.2	18.6	376.1	41.6	973.4	0.00023745	75.1	624.5	0.0016848
	Al Khaleej Gas project	Qatar	1.1353	137.8	4081.3			0.00035464	21.1	499.7	17.6	184.0	38.6	683.8	0.00023745	99.2	577.5	0.0016848
	Bovanenkovo Zone (Yamal M	Russian F	11.1586	690.0	39645.9	2.6	28.4	0.00035464	0.7	700.9	6.6	3318.8	7.4	4019.7	0.00023745	680.0	6050.6	0.0016848
	Gazprom dobycha Yamburg	Russian F	8.8638	1075.4	31584.7	0.1	3.4	0.00035464	31.4	1524.9	33.9	2181.3	65.3	3706.2	0.00023745	1010.0	4738.0	0.0016848

			Potentia	Total (mboe)		Oil (mbbl)			NGLs (mbbl)							Gas		
Ne	Project	Country	Gt CO2	Productior	Resources	Production	Resources	Emissions factor	Condensate Production	Condensate Resources	NGL Production	NGL Resources	Sum Production	Sum Resources	Emissions factor	Production (mboe)	Resources (bcm)	Emissions factor
*	Tunguska Basin CBM	Russian F	8.8438	0.0	30882.6			0.00035464					0.0	0.0	0.00023745		5249.2	0.0016848
*	Shtokman	Russian F	6.1359	0.0	21790.2		2.0	0.00035464		151.5		1980.3	0.0	2131.8	0.00023745		3341.0	0.0016848
	Urengoyskoye	Russian F	5.1993	289.4	18625.9	0.4	13.7	0.00035464	32.2	1602.6	16.9	1167.2	49.0	2769.7	0.00023745	240.0	2692.8	0.0016848
*	Kuznetsk Depression (Kuzba:	Russian F	4.9061	0.0	17132.1			0.00035464					0.0	0.0	0.00023745		2912.0	0.0016848
	Yuganskneftegaz	Russian F	4.3452	511.1	12297.7	507.9	12080.2	0.00035464	0.0	17.7		7.4	0.0	25.1	0.00023745	3.2	32.7	0.0016848
	Eastern Gas Program	Russian F	4.2741	0.6	15145.0		110.2	0.00035464	0.0	650.6	0.0	791.0	0.1	1441.6	0.00023745	0.5	2310.5	0.0016848
*	West Siberia Offshore	Russian F	2.8564	0.0	9370.3		2534.5	0.00035464					0.0	0.0	0.00023745		1161.9	0.0016848
*	Lensky Basin CBM	Russian F	2.7377	0.0	9560.1			0.00035464					0.0	0.0	0.00023745		1625.0	0.0016848
*	Timan - Pechora Basin Offsh	Russian F	2.4814	0.0	7745.4		3858.0	0.00035464					0.0	0.0	0.00023745		660.7	0.0016848
*	Tambey Zone (Yamal Megap	Russian F	2.4749	0.0	8847.9		25.7	0.00035464		468.6		770.5	0.0	1239.1	0.00023745		1288.9	0.0016848
*	Timan - Pechora Basin Onsh	Russian F	2.3516	0.0	7357.7		3583.1	0.00035464					0.0	0.0	0.00023745		641.6	0.0016848
	Samotlorneftegaz (TNK-BP)	Russian F	1.8678	179.0	5544.1	135.6	4257.7	0.00035464	0.0	118.4	8.0	96.8	8.0	215.2	0.00023745	35.3	182.1	0.0016848
*	Leningradskoye (Kara Sea)	Russian F	1.8006	0.0	6397.3		1.0	0.00035464		2.5		640.2	0.0	642.7	0.00023745		977.9	0.0016848
	Gazprom dobycha Orenburg	Russian F	1.5933	119.4	5618.6	0.0	2.5	0.00035464	0.3	180.8	0.8	143.4	1.2	324.2	0.00023745	118.3	899.5	0.0016848
*	Arctic LNG 2 T1-3	Russian F	1.4756	0.0	5285.2		0.8	0.00035464		225.6		550.8	0.0	776.4	0.00023745		766.2	0.0016848
*	Volga - Urals Onshore	Russian F	1.3676	0.0	4277.8		2089.0	0.00035464					0.0	0.0	0.00023745		372.0	0.0016848
	Romashkino	Russian F	1.3386	107.9	3790.1	105.3	3709.3	0.00035464					0.0	0.0	0.00023745	2.6	13.7	0.0016848
*	Rusanovskoye (Kara Sea)	Russian F	1.3161	0.0	4686.3		3.9	0.00035464		93.6		440.7	0.0	534.3	0.00023745		705.1	0.0016848
	Gazprom dobycha Nadym	Russian F	1.2866	257.8	4522.4		1.2	0.00035464	0.2	65.6	2.3	109.7	2.6	175.3	0.00023745	255.3	738.7	0.0016848
*	Taymyr Basin CBM	Russian F	1.2333	0.0	4306.8			0.00035464					0.0	0.0	0.00023745		732.0	0.0016848
*	North Kara Sea Offshore	Russian F	1.1770	0.0	3811.8		1250.4	0.00035464					0.0	0.0	0.00023745		435.4	0.0016848
*	West Siberia Onshore	Russian F	1.1645	0.0	3824.3		1015.7	0.00035464					0.0	0.0	0.00023745		477.4	0.0016848
	SeverEnergia Project	Russian F	1.0995	251.4	3976.8	5.7	79.3	0.00035464	63.9	890.4	1.3	23.6	65.1	914.0	0.00023745	180.5	507.1	0.0016848
	Ghawar Uthmaniyah	Saudi-Ara	19.2219	804.2	57903.7	590.0	44452.6	0.00035464	0.0	8.2	173.4	8060.7	173.4	8068.8	0.00023745	40.8	914.8	0.0016848
	Safaniya	Saudi-Ara	11.9261	414.8	33706.0	385.5	33305.4	0.00035464					0.0	0.0	0.00023745	29.2	68.1	0.0016848
	Khurais project	Saudi-Ara	7.6349	413.1	21926.5	388.4	20333.9	0.00035464	0.6	16.9	19.1	644.0	19.8	660.9	0.00023745	4.9	158.4	0.0016848
	Ghawar Haradh	Saudi-Ara	6.9668	264.8	21437.5	196.2	14419.2	0.00035464	21.0	3201.7			21.0	3201.7	0.00023745	47.5	648.7	0.0016848
*	Central Arabian Offshore	Saudi-Ara	6.8601	0.0	20673.2		13767.1	0.00035464					0.0	0.0	0.00023745		1173.8	0.0016848
	Ghawar Shedgum	Saudi-Ara	5.6950	354.9	17475.3	225.0	12360.4	0.00035464			111.5	3132.0	111.5	3132.0	0.00023745	18.4	337.0	0.0016848
	Qatif project	Saudi-Ara	5.0668	327.7	14493.0	305.0	13589.1	0.00035464	1.5	185.8	2.7	44.5	4.2	230.3	0.00023745	18.5	114.5	0.0016848
	Manifa (redevelop)	Saudi-Ara	5.0003	323.4	14289.7	310.5	13537.0	0.00035464	10.6	279.3	0.4	48.2	11.0	327.5	0.00023745	1.9	72.3	0.0016848
	Ghawar Hawiyah	Saudi-Ara	4.6497	109.2	14978.9	34.7	6908.7	0.00035464	14.8	2277.7			14.8	2277.7	0.00023745	59.7	984.6	0.0016848
*	Central Arabian Onshore	Saudi-Ara	4.3600	0.0	13201.4		8488.5	0.00035464					0.0	0.0	0.00023745		801.1	0.0016848
	Shaybah	Saudi-Ara	4.2686	325.5	12433.7	319.4	10627.8	0.00035464	6.2	360.0			6.2	360.0	0.00023745		245.8	0.0016848
	Berri	Saudi-Ara	3.5571	208.0	10693.6	154.5	7746.2	0.00035464	15.6	580.8	29.4	115.2	45.0	695.9	0.00023745	8.5	382.7	0.0016848
*	Zuluf (CR in field)	Saudi-Ara	3.5351	0.0	9968.0		9968.0	0.00035464					0.0	0.0	0.00023745			0.0016848
	Zuluf	Saudi-Ara	2.4500	201.1	7094.5	169.2	6134.1	0.00035464	0.1	9.3			0.1	9.3	0.00023745	31.8	161.7	0.0016848
	Khursaniyah	Saudi-Ara	2.4133	148.6	7049.9	130.0	5947.7	0.00035464	7.3	165.9	1.0	72.9	8.3	238.8	0.00023745	10.3	146.8	0.0016848
	Ghawar Ain Dar N	Saudi-Ara	2.0886	125.6	6094.7	116.8	5050.5	0.00035464	0.2	31.8			0.2	31.8	0.00023745	8.6	172.1	0.0016848
	Marjan	Saudi-Ara	1.8899	97.9	5824.1	73.5	3562.6	0.00035464			10.9	432.2	10.9	432.2	0.00023745	13.5	310.9	0.0016848
*	Safaniya YTF Concession	Saudi-Ara	1.8429	0.0	5379.2		4511.4	0.00035464		64.2		49.4	0.0	113.6	0.00023745		128.2	0.0016848
*	Zuluf (expansion)	Saudi-Ara	1.8332	0.0	5430.2		4160.6	0.00035464		120.0			0.0	120.0	0.00023745		195.4	0.0016848
	Abqaiq	Saudi-Ara	1.5928	98.6	5030.6	31.6	3034.4	0.00035464			67.0	1123.0	67.0	1123.0	0.00023745		148.4	0.0016848
	Ghawar Ain Dar S	Saudi-Ara	1.4346	89.9	4227.6	84.3	3301.3	0.00035464	0.9	28.6			0.9	28.6	0.00023745	4.7	152.6	0.0016848
*	Sudair Shale	Saudi-Ara	1.0329	0.0	3637.9			0.00035464				181.9	0.0	181.9	0.00023745		587.4	0.0016848
	Harmaliyah	Saudi-Ara	1.0281	49.4	3045.4	49.0	2560.7	0.00035464	0.4	69.3	0.0	315.9	0.4	385.2	0.00023745	0.0	16.9	0.0016848
*	Tanf Shale	Syria	1.3637	0.0	4802.9			0.00035464				240.1	0.0	240.1	0.00023745		775.5	0.0016848
	Yolotan (Iolotan) South	Turkmeni	9.5482	159.0	33684.6			0.00035464				2003.1	0.0	2003.1	0.00023745	159.0	5385.0	0.0016848
*	Yashlar Vostochnyy (East)	Turkmeni	2.1291	0.0	7450.1			0.00035464				88.6	0.0	88.6	0.00023745		1251.3	0.0016848
	Dovletabad-Donmez	Turkmeni	1.5781	182.6	5516.6			0.00035464	0.0	8.4	0.6	26.1	0.6	34.5	0.00023745	182.0	931.8	0.0016848
*	Tanzanian Coastal Offshore	Tanzania	1.0312	0.0	3263.4		1416.0	0.00035464					0.0	0.0	0.00023745		314.0	0.0016848
*	Menilite Shale	Ukraine	1.6667	0.0	5248.6		3149.2	0.00035464				1049.7	0.0	1049.7	0.00023745		178.4	0.0016848
	Permian Delaware Tight	United St	27.8044	1399.6	89568.2	746.9	45619.0	0.00035464	2.8	63.2	282.1	19551.5	285.0	19614.7	0.00023745	367.8	4136.2	0.0016848
	Marcellus Shale	United St	26.7144	1557.7	96186.2			0.00035464	21.7	1836.6	183.0	15136.1	204.8	16972.7	0.00023745	1352.9	13464.1	0.0016848
	Permian Midland Tight	United St	16.6288	1065.8	52167.6	649.2	32369.6	0.00035464			217.9	10634.7	217.9	10634.7	0.00023745	198.7	1557.5	0.0016848
	Haynesville/Bossier Shale	United St	13.2041	572.3	46296.7	0.2	0.2	0.00035464			6.6	1099.8	6.6	1099.8	0.00023745	565.5	7682.2	0.0016848
	Utica Shale	United St	7.7132	522.4	27383.9	0.4	265.5	0.00035464	23.9	710.4	39.4	2290.9	63.3	3001.3	0.00023745	458.8	4099.2	0.0016848
	Bakken Shale	United St	5.9486	736.9	18262.5	514.6	12613.1	0.00035464			114.9	2909.6	114.9	2909.6	0.00023745	107.4	465.7	0.0016848
	Eagle Ford Shale	United St	5.9242	872.6	20105.1	313.3	6506.4	0.00035464	133.4	1941.1	185.7	3729.9	319.1	5671.0	0.00023745	240.2	1347.5	0.0016848

			Potentia	Total (mboe)		Oil (mbbl)			NGLs (mbbl)							Gas		
Ne	Project	Country	Gt CO2	Productior	Resources	Production	Resources	Emissions factor	Condensate Production	Condensate Resources	NGL Production	NGL Resources	Sum Production	Sum Resources	Emissions factor	Production (mboe)	Resources (bcm)	Emissions factor
	DJ Basin Tight Oil	United St	5.8521	413.9	19603.2	174.3	7323.4	0.00035464	18.0	1047.4	82.5	4299.8	100.6	5347.3	0.00023745	139.0	1178.3	0.0016848
	Western Gulf Province_Texa	United St	5.0617	286.8	17404.5	47.5	4457.8	0.00035464	4.5	183.6	91.7	4451.9	96.2	4635.5	0.00023745	143.1	1412.7	0.0016848
	Woodford Shale	United St	3.3771	321.4	12147.8	32.1	1556.8	0.00035464	19.8	806.0	78.8	3443.7	98.5	4249.7	0.00023745	190.8	1077.8	0.0016848
	PRB Tight Oil	United St	2.7709	85.2	8572.8	50.5	5313.8	0.00035464	0.0	0.8	8.9	956.2	9.0	957.0	0.00023745	25.8	391.3	0.0016848
*	Chukchi Sea Offshore	United St	2.5393	0.0	7649.5		5107.7	0.00035464					0.0	0.0	0.00023745		432.0	0.0016848
	Meramec Shale	United St	2.4396	227.5	8758.5	45.3	1565.8	0.00035464	16.7	867.3	71.3	2719.6	88.0	3586.8	0.00023745	94.2	612.9	0.0016848
	Permian Conventional_Texas	United St	2.0618	261.4	6533.1	170.6	3220.7	0.00035464	0.7	35.7	30.1	555.5	30.8	591.1	0.00023745	60.0	462.5	0.0016848
*	North Slope Onshore	United St	2.0360	0.0	6149.6		4026.5	0.00035464					0.0	0.0	0.00023745		360.9	0.0016848
	Anadarko Shelf_Oklahoma	United St	1.8178	83.3	6330.6	11.3	482.8	0.00035464	3.3	68.3	10.4	504.3	13.7	572.6	0.00023745	58.3	896.6	0.0016848
*	Baltimore Canyon Offshore	United St	1.6485	0.0	4957.3		3352.9	0.00035464					0.0	0.0	0.00023745		272.7	0.0016848
	Austin Chalk Tight	United St	1.3928	60.3	4664.8	23.0	1917.2	0.00035464	4.2	485.1	14.1	1025.6	18.3	1510.7	0.00023745	19.0	210.2	0.0016848
	Barnett Shale	United St	1.3609	198.3	4885.6	1.7	199.8	0.00035464	0.2	10.9	38.7	1048.6	38.9	1059.5	0.00023745	157.7	616.4	0.0016848
*	Beaufort Sea Offshore	United St	1.2548	0.0	3778.8		2529.2	0.00035464					0.0	0.0	0.00023745		212.4	0.0016848
*	Gulf Coast Centre Offshore	United St	1.1062	0.0	3347.2		2163.0	0.00035464					0.0	0.0	0.00023745		201.3	0.0016848
*	West Florida Offshore	United St	1.0693	0.0	3227.6		2123.6	0.00035464					0.0	0.0	0.00023745		187.6	0.0016848
	Orinoco Joint Ventures	Venezuel	6.7034	142.0	19024.8	133.7	18469.1	0.00035464	2.5	16.7	0.0	98.3	2.5	115.1	0.00023745	5.8	74.9	0.0016848
*	La Luna Shale	Venezuel	1.0905	0.0	3434.2		2060.5	0.00035464				686.8	0.0	686.8	0.00023745		116.7	0.0016848
*	Collingham Shale	South Afr	1.8499	0.0	5448.7		4631.4	0.00035464				544.9	0.0	544.9	0.00023745		46.3	0.0016848
	Total		**646.027**	**27,324.0**	**2,084,511.8**	**13,462.2**	**875,490.6**		**916.4**	**66,691.2**	**2,349.2**	**151,676.4**	**3,265.6**	**218,367.5**		**10,596.2**	**168,383.4**	
	Total Producing Carbon Bombs		**452.212**	**27324.0**	**119**													
	Total New Carbon Bombs		**193.814**	**0.0**	**76**													
	Data source: Rystad, 2020, Production figures for 2019																	

New	Project Name	Country	Potential emissions (GtCO2)	Fuel	Status	Reserves (Million tons)	Reserve catego	Year	Emissions f	Coal type	Source	Page Number	Region/State/Pr	Coal Basin	Production	Year	Source	Comments
	Ensham Coal Mine	Australia	1.3	Coal	Operating	724	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5.3			
	Hunter Valley North C	Australia	1.7	Coal	Operating	650	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8.4			
	Byerwen Coal Mine	Australia	1.8	Coal	Operating	690	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Mount Pleasant Coal	Australia	1.1	Coal	Operating	459	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10.5			
	Hunter Valley South C	Australia	1.2	Coal	Operating	440	Resource	2013	0.00266772	Bituminous (Met	https://datag	n/a (dataset)	New South Wales		10.8			
	Peak Downs Coal Mir	Australia	2.3	Coal	Operating	869	Recoverable		0.00266772	Bituminous (Met	https://datag	n/a (dataset)	Queensland		11.8			
	Blackwater Coal Mine	Australia	1.0	Coal	Operating	375	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				14			
	Goonyella-Riverside (	Australia	2.2	Coal	Operating	818	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				17.1			
	Loy Yang Coal Mine	Australia	3.1	Coal	Operating	1680	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				28			
	Yallourn	Australia	1.1	Coal	Operating	463	Recoverable	2013	0.00244068	bituminous	Global Energy Monitor. (2021)		Victoria		n/d			
*	Red Hill Coal Project	Australia	4.6	Coal	Proposed	1711	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Wards Well Coal Mine	Australia	2.7	Coal	Proposed	1000	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Alpha North Coal Min	Australia	2.5	Coal	Proposed	1400	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Carmichael Coal Proj	Australia	2.1	Coal	Proposed	1160	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Valeria Coal Mine	Australia	2.0	Coal	Proposed	762	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Wilton and Fairhill Co	Australia	1.9	Coal	Proposed	700	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Galilee Coal Mine	Australia	1.8	Coal	Proposed	1000	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Hutton Coal Mine	Australia	1.7	Coal	Proposed	632	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Olive Downs Coal Mir	Australia	1.4	Coal	Proposed	514	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Saraji East Coal Mine	Australia	1.3	Coal	Proposed	502	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Phulbari Coal Mine	Bangladesh	1.4	Coal	Proposed	572	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Project Motheo	Botswana	2.2	Coal	Proposed	1200	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Maritsa Coal Mines	Bulgaria	2.5	Coal	Operating	2096	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				28			
	Fording River	Canada	1.0	Coal	Operating	388	Reserves		0.00266772	coking coal	http://cmscor	6	British Columbia		8.15	2019		Total resource ca
*	Murray River Coal Mir	Canada	8.5	Coal	Proposed	3180	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Gething Coal Mine	Canada	2.1	Coal	Proposed	780	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Qingshuiying Coal Mi	China	1.8	Coal	Operating	749	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
	Sijiazhuang Coal Min	China	1.6	Coal	Operating	594	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
	Shangyuquan Coal M	China	1.4	Coal	Operating	585	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
	Shaqu No.1 Coal Min	China	1.4	Coal	Operating	568	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
	Shahaiji No.1 Coal Mi	China	1.2	Coal	Operating	490	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
	Gaojiabao Coal Mine	China	1.1	Coal	Operating	470	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
	Shajihai No.2 Coal Mi	China	1.1	Coal	Operating	470	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
	Yangjiacun Coal Mine	China	1.1	Coal	Operating	442	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
	Kouzi East Coal Mine	China	1.0	Coal	Operating	382	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
	Wangjialing Coal Min	China	2.7	Coal	Operating	1021	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Yili No.4 Coal Mine	China	2.6	Coal	Operating	968	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Hongqingliang Coal M	China	2.0	Coal	Operating	810	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Weijiamao Open Pit M	China	1.7	Coal	Operating	691	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Dingji Coal Mine	China	1.7	Coal	Operating	625	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Wudong Coal Mine	China	1.6	Coal	Operating	661	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Lijiahao Coal Mine	China	1.5	Coal	Operating	606	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Shicaocun Coal Mine	China	1.5	Coal	Operating	597	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Qingchunta Coal Min	China	1.4	Coal	Operating	583	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Xiaozhuang Coal Min	China	1.4	Coal	Operating	578	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Talahao Coal Mine	China	1.3	Coal	Operating	532	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Baishihu Surface Min	China	1.3	Coal	Operating	530	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Fengjiata Coal Mine	China	1.2	Coal	Operating	486	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Wucaiwan No.1 Surfa	China	1.4	Coal	Operating	765	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7			
	Gaojialiang No.1 Coal	China	2.0	Coal	Operating	825	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7.5			
	Gaohe Coal Mine	China	1.5	Coal	Operating	575	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7.5			
	Hongshaquan No.1 C	China	9.0	Coal	Operating	3676	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			
	Ningxia Hongliu Coal	China	2.9	Coal	Operating	1188	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			
	Guojiawan Coal Mine	China	1.9	Coal	Operating	769	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			
	Gaotouyao Coal Mine	China	1.9	Coal	Operating	766	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			
	Shanxi Lu'an Guchen	China	1.8	Coal	Operating	742	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			
	Hanglaiwan Coal Min	China	1.8	Coal	Operating	730	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			

New	Project Name	Country	Potential emissions (GtCO2)	Fuel	Status	Reserves (Million tons)	Reserve catego	Year	Emissions f	Coal type	Source	Page Number	Region/State/Pr	Coal Basin	Production	Year	Source	Comments
	Xiaojiawa Coal Mine	China	1.8	Coal	Operating	725	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			
	Wangjiata Coal Mine	China	1.6	Coal	Operating	661	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			
	Huangling No.2 Coal I	China	1.4	Coal	Operating	558	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			
	Dafosi Coal Mine	China	1.4	Coal	Operating	557	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			
	Zaoquan Coal Mine	China	1.1	Coal	Operating	434	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			
	Yangquan No.1 Coal I	China	1.2	Coal	Operating	461	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8.5			
	Sandaogou Coal Mine	China	2.3	Coal	Operating	927	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				9			
	Guqiao Coal Mine	China	2.0	Coal	Operating	831	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				9			
	Sihe Coal Mine	China	1.0	Coal	Operating	383	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				9			
	Dananhu No.1 Coal M	China	7.2	Coal	Operating	2936	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Xiaojihan Coal Mine	China	4.6	Coal	Operating	1894	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Shengli East No.2 Co	China	4.6	Coal	Operating	3822	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Chahasu Coal Mine	China	4.2	Coal	Operating	1724	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Majialiang Coal Mine	China	3.2	Coal	Operating	1299	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Yushuwan Coal Mine	China	2.8	Coal	Operating	1158	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Huangyuchuan Coal M	China	2.3	Coal	Operating	926	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Dongzhouyao Coal M	China	2.2	Coal	Operating	882	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Longwanggou Coal M	China	1.9	Coal	Operating	788	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Tongxin Coal Mine	China	1.6	Coal	Operating	588	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Xiwan Surface Coal M	China	1.5	Coal	Operating	627	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Zhangjiamao Coal Mi	China	1.3	Coal	Operating	543	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Liuzhuang Coal Mine	China	1.5	Coal	Operating	623	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				11.4			
	Menkeqing Coal Mine	China	3.7	Coal	Operating	1510	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				12			
	Meihuajing Coal Mine	China	3.5	Coal	Operating	1433	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				12			
	Shigetai Coal Mine	China	1.2	Coal	Operating	657	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				12			
	Yangchangwan No.1 \	China	1.1	Coal	Operating	440	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				12			
	Zhangji Coal Mine	China	2.2	Coal	Operating	822	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				12.3			
	Hulusu Coal Mine	China	4.0	Coal	Operating	1624	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				13			
	Baode Coal Mine	China	1.7	Coal	Operating	680	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				14			
	Tashan Coal Mine	China	9.0	Coal	Operating	3375	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15			
	Hongqinghe Coal Min	China	5.7	Coal	Operating	2338	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15			
	Xiaobaodang No.1 Cc	China	3.8	Coal	Operating	1550	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15			
	Hongliulin Coal Mine	China	3.1	Coal	Operating	1266	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15			
	Buliangou Coal Mine	China	1.8	Coal	Operating	746	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15			
	Huojitu Well Of Daliut	China	1.1	Coal	Operating	624	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15			
	Shangwan Coal Mine	China	1.8	Coal	Operating	732	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				16			
	Halagou Coal Mine	China	1.3	Coal	Operating	516	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				16			
	Ningtiaota Coal Mine	China	4.0	Coal	Operating	1645	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18			
	Jinjie Coal Mine	China	3.9	Coal	Operating	1578	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18			
	Suancigou Coal Mine	China	2.1	Coal	Operating	851	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18			
	Daliuta Coal Mine	China	1.2	Coal	Operating	495	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18			
	Buertai Coal Mine	China	4.5	Coal	Operating	1850	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				20			
	Pingshuo East Coal M	China	2.6	Coal	Operating	1459	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				20			
	Baiyinhua No.3 Surfa	China	1.6	Coal	Operating	1314	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				20			
	Yimin Surface Coal M	China	2.0	Coal	Operating	1692	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				22			
	Antaibao Surface Min	China	1.2	Coal	Operating	491	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				22			
	Shenhua Bulianta Co	China	2.2	Coal	Operating	1224	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				28			
	Anjialing Open-Pit Mir	China	1.0	Coal	Operating	428	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				30			
	Shenhua Heidaigou S	China	2.7	Coal	Operating	1498	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				34			
	Haerwusu Surface Mi	China	2.1	Coal	Operating	1731	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				35			
	Shenhua Baorixile Su	China	1.6	Coal	Operating	1303	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				35			
*	Dahaize Coal Mine	China	8.0	Coal	Proposed	3275	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Jiangjun Gebi No.2 C	China	7.8	Coal	Proposed	3212	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Balasu Coal Mine	China	6.4	Coal	Proposed	2623	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Baijia Haizi Coal Mine	China	5.0	Coal	Proposed	2033	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Xinwen Ili No.1 Coal M	China	4.5	Coal	Proposed	1839	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Shilawusu Coal Mine	China	3.9	Coal	Proposed	1591	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		

New	Project Name	Country	Potential emissions (GtCO2)	Fuel	Status	Reserves (Million tons)	Reserve catego	Year	Emissions f	Coal type	Source	Page Number	Region/State/Pr	Coal Basin	Production	Year	Source	Comments
*	Yingpanhao Coal Min	China	3.8	Coal	Proposed	1541	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Dananhu No. 7 Coal M	China	3.6	Coal	Proposed	1488	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Zhundong Surface Mi	China	3.5	Coal	Proposed	1447	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Qinghua No.7 Coal M	China	3.4	Coal	Proposed	1383	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Shaanxi Caojiatan Co	China	3.3	Coal	Proposed	1367	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Wucaiwan No.1 Coal	China	3.3	Coal	Proposed	1367	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Hetaoyu Coal Mine	China	3.0	Coal	Proposed	1230	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Taran Gaole Coal Min	China	2.9	Coal	Proposed	1200	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Dalaihushuo Coal Mir	China	2.9	Coal	Proposed	1178	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Dananhu West No.2 (	China	2.7	Coal	Proposed	1513	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Shitoumei No.1 Coal I	China	2.4	Coal	Proposed	990	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Xinzhuang Coal Mine	China	2.3	Coal	Proposed	942	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Inner Mongolia Erlintu	China	2.2	Coal	Proposed	913	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Jinjitan Coal Mine	China	2.2	Coal	Proposed	898	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Pangpangta Coal Min	China	2.2	Coal	Proposed	894	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Guojiatan Coal Mine	China	2.2	Coal	Proposed	1190	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Boli Coal Mine	China	2.0	Coal	Proposed	770	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Xiaobaodang No.2 Co	China	1.9	Coal	Proposed	792	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Zhaoshipan Coal Min	China	1.9	Coal	Proposed	792	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Madaotou Coal Mine	China	1.8	Coal	Proposed	1527	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Chagannur No.1 Coal	China	1.7	Coal	Proposed	1445	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Muduchaideng Coal M	China	1.7	Coal	Proposed	705	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Qiyuan Coal Mine	China	1.7	Coal	Proposed	653	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Nalin River No.2 Coal	China	1.7	Coal	Proposed	686	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Shengli No.1 Open-Pi	China	1.6	Coal	Proposed	1342	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				0	2019		
*	Yadian Coal Mine	China	1.5	Coal	Proposed	611	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Taohe Coal Mine	China	1.4	Coal	Proposed	579	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Sanjiao No.1 Coal Mir	China	1.4	Coal	Proposed	567	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Zhong Yu Coal Mine	China	1.4	Coal	Proposed	514	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Mengcun Coal Mine	China	1.4	Coal	Proposed	558	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Wenjiazhuang Coal M	China	1.3	Coal	Proposed	514	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Yuwang No.1 Coal Mi	China	1.3	Coal	Proposed	477	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Baiyanghe Coal Mine	China	1.2	Coal	Proposed	508	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Xinjiang Hongshan Co	China	1.2	Coal	Proposed	494	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Talike District No. 2 C	China	1.1	Coal	Proposed	465	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Changcheng No.3 Co	China	1.1	Coal	Proposed	421	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Wangwa Coal Mine	China	1.1	Coal	Proposed	439	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Ba Leng Coal Mine	China	1.1	Coal	Proposed	439	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Longwan Coal Mine	China	1.0	Coal	Proposed	395	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Shanxi Dongda Coal I	China	1.0	Coal	Proposed	422	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Hongshuliang Coal M	China	1.0	Coal	Proposed	415	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	West Well of Faer Se	China	1.0	Coal	Proposed	377	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Pribbenow Coal Mine	Colombia	1.4	Coal	Operating	561	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	El Descanso Coal Mir	Colombia	4.1	Coal	Operating	1700	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				22.5			
	Cerrejón Coal Mine	Colombia	2.4	Coal	Operating	987	Marketable Rese	2020	0.00244068	Bituminous	https://www.b	300			27.7	2019	https://ww	BP owns 33% of
*	San Juan Coal Mine	Colombia	1.6	Coal	Proposed	672	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Garzweiler Coal Mine	Germany	1.3	Coal	Operating	1100	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				35			
	Hambach Coal Mine	Germany	1.7	Coal	Operating	1419	Recoverable	2019	0.0012019	Lignite	https://www.e	14	North-Rhine We:	Rhineland Coalfi	40			
	West Macedonia Lign	Greece	2.2	Coal	Operating	1800	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				27.2			
	Kaniha Coal Mine	India	1.2	Coal	Operating	659	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7.5			
	Rajmahal Coal Mine	India	5.8	Coal	Operating	3211	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				17.4			
	Talaipalli Coal Mine	India	1.5	Coal	Operating	844	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18.7			
	Moher Amlohri Coal M	India	1.0	Coal	Operating	575	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18.7			
	Lakhanpur Coal Mine	India	1.5	Coal	Operating	1263	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				21			
	Dipka Coal Mine	India	1.2	Coal	Operating	975	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				25.2			
	Gevra Coal Mine	India	2.4	Coal	Operating	1338	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				41			
	Kusmunda Coal Mine	India	1.2	Coal	Operating	957	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				42.3			

New	Project Name	Country	Potential emissions (GtCO2)	Fuel	Status	Reserves (Million tons)	Reserve catego	Year	Emissions f	Coal type	Source	Page Number	Region/State/Pr	Coal Basin	Production	Year	Source	Comments
*	Siarmal Coal Mine	India	1.9	Coal	Proposed	1548	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Kerandari BC	India	1.8	Coal	Proposed	917	Geological Rese	2019	0.002	n/d	http://www.co	9.7	Jharkhand		0	2019		
*	Integrated Belpahar, L	India	1.5	Coal	Proposed	1262	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Balaram Coal Mine	India	1.4	Coal	Proposed	756	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Gare Pelma Sector II	India	1.3	Coal	Proposed	655	Extractable Rese	2019	0.002	n/d	http://www.co	9.8	Chhattisgarh		0	2019		
*	Banhardih	India	1.1	Coal	Proposed	553	Extractable Rese	2019	0.002	n/d	http://www.co	9.8	Jharkhand		0	2019		
*	Bankui	India	1.6	Coal	Proposed	800	Geological Rese	2017	0.002	n/d	http://www.co	9.7	Orissa					
*	Mandakini B	India	1.3	Coal	Proposed	657	Extractable Reserves		0.002	n/d	http://environmentclearance.nic.in/writereaddata/Online/TOR/22_Feb_2019_1900473301BRPYEH7Pre-feasibil							
*	Saharpur Jamarpani	India	1.0	Coal	Proposed	524	Extractable Rese	2019	0.002	n/d	http://www.co	9.8	Jharkhand					
	MHU Coal Mine	Indonesia	1.1	Coal	Operating	592	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				9.1			
	Indexim Coalindo Coa	Indonesia	1.1	Coal	Operating	613	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				9.2			
	PTBA Coal Mines	Indonesia	8.9	Coal	Operating	3334	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				27.3			
	BIB Coal Mine	Indonesia	1.1	Coal	Operating	591	Marketable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				28			
	Pasir Coal Mine	Indonesia	1.0	Coal	Operating	537	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				34.6			
	Tutupan Coal Mine	Indonesia	1.1	Coal	Operating	602	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				35.6			
	KPC Operation Coal M	Indonesia	3.1	Coal	Operating	1160	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				60.9			
*	GAM Coal Mine	Indonesia	1.3	Coal	Proposed	539	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Pakar North Coal Min	Indonesia	1.1	Coal	Proposed	911	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Borly Coal Mines	Kazakhstan	1.0	Coal	Operating	419	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7.3			
	Shubarkol Coal Mine	Kazakhstan	1.0	Coal	Operating	406	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				11.3			
	Bogatyr Coal Mine	Kazakhstan	7.3	Coal	Operating	3000	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				32			
*	Tavan Tolgoi Coal Min	Mongolia	16.0	Coal	Proposed	6009	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Zambezi Coal Mine	Mozambique	4.1	Coal	Proposed	1700	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Chirodzi Coal Mine	Mozambique	2.9	Coal	Proposed	1200	Resource		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Revuboe Coal Mine	Mozambique	1.4	Coal	Proposed	519	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Saebyol Coal Mining (	North Korea	3.2	Coal	Operating	1230	Resource		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Thar Coal Mine	Pakistan	1.9	Coal	Operating	1570	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				3.8			
	Erkovetskiy Coal Mine	Russian Federat	1.0	Coal	Operating	572	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				2.5			
	Stepnoy Coal Mine	Russian Federat	3.6	Coal	Operating	1458	Resource		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
	Listvianskaya Coal Mi	Russian Federat	2.4	Coal	Operating	895	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
	Raspadskaya Coal Mi	Russian Federat	2.4	Coal	Operating	906	Proved and Prob	2020	0.00266772	Bituminous (Met	https://ar2020.evraz.com/en/additional-information/data-on-mine				5.5			
	Pereyaslovskiy Coal M	Russian Federat	1.6	Coal	Operating	900	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6			
	Elegest Coal Mine	Russian Federat	2.3	Coal	Operating	855	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7			
	Arshanovsky Coal Mir	Russian Federat	1.7	Coal	Operating	700	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
	Taldinsky Coal Mine	Russian Federat	2.2	Coal	Operating	900	Resource	2014	0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				13.1			
*	Elga Coal Mine	Russian Federat	4.5	Coal	Proposed	1698	Resource	2012	0.00266772	Bituminous (Met	https://www.s	98	Sakha Republic	Elginskoye coal	0	2019		
*	Beisky-Zapadniy Coal	Russian Federat	2.4	Coal	Proposed	1340	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Ulug-Khem Project	Russian Federat	2.2	Coal	Proposed	807	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Sugodinsk-Ogodzhins	Russian Federat	1.8	Coal	Proposed	744	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Usinsk-1 Coal Mine	Russian Federat	1.7	Coal	Proposed	621	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Pervomaisky Coal Mir	Russian Federat	1.5	Coal	Proposed	629	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Shurapskaya Coal Mi	Russian Federat	1.0	Coal	Proposed	423	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Inaglinskaya-2 Mine	Russian Federat	1.3	Coal	Proposed	648	Recoverable	2020	0.002	Bituminous (Met	http://www.kolmar.ru/en/activit		South Yakutia					
	Kolubara Mine Compl	Serbia	2.5	Coal	Operating	2100	Recoverable	2000	0.0012019	Lignite	https://www.s	122			22.683	1999		
	Grootegeluk Coal Min	South Africa	6.9	Coal	Operating	2576	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				29.7			
*	Greater Soutpansberg	South Africa	2.8	Coal	Proposed	1051	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Boikarabelo Coal Min	South Africa	2.4	Coal	Proposed	995	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Paardekop Coal Mine	South Africa	1.7	Coal	Proposed	695	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	New Largo Coal Mine	South Africa	1.4	Coal	Proposed	585	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Bernice-Cygnus Coal	South Africa	1.1	Coal	Proposed	402	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Afşin-Elbistan Coal M	Turkey	4.1	Coal	Operating	3400	Resource		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				14			
	Cumberland Coal Min	United States	1.9	Coal	Operating	776	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5.9			
	Hamilton County Mine	United States	1.2	Coal	Operating	485	Proven and Prob	2019	0.00244068	Bituminous	https://www.arlp.com/mines-facilities/illinois-basin/default.aspx#h				5.9	2019	https://ww	535.1 short tons
	MC #1 Coal Mine	United States	2.9	Coal	Operating	1179	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				11.5			
	Black Thunder Coal M	United States	1.4	Coal	Operating	748	Recoverable		0.00181629	Subbituminous	https://investor.archrsc.com/static-files/089edfb1-21ad-4445-881				65.2			
	North Antelope Roche	United States	2.9	Coal	Operating	1610	Proven and Prob	2019	0.00181629	Subbituminous	https://www.p	48	Wyoming		77.4			
*	Youngs Creek Coal M	United States	1.1	Coal	Proposed	408	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		

New	Project Name	Country	Potential emissions (GtCO2)	Fuel	Status	Reserves (Million tons)	Reserve catego	Year	Emissions f	Coal type	Source	Page Number	Region/State/Pr	Coal Basin	Production	Year	Source	Comments
*	Angren Coal Mine	Uzbekistan	2.4	Coal	Proposed	2000	Resource		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Sengwe Colliery	Zimbabwe	1.0	Coal	Operating	500	Recoverable	2013	0.002	Coal	https://usea.c	60			0.3	2013		
	Total		**536.2**		230	**242752**									**2005**			
	Total Operating		**311.0**		137													
	Total Proposed		**225.2**		93													

			Potentia	Total (mboe)																																				
Ne	Project	Country	Gt CO2	Production	Resources	Production 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	Total 2019-2050	Resources 2019	Remaining resources in 20
	Marcellus Shale	United St	26.7	1557.7	96186.2	1557.7	1433.	1318.	1212.	1115.	1026.	944.5	868.9	799.4	735.4	676.6	622.5	572.7	526.8	484.7	445.9	410.2	377.4	347.2	319.4	293.9	270.4	248.7	228.8	210.5	193.7	178.2	163.9	150.8	138.7	127.6	117.4	18120.3	96186.2	78066.0
	Permian Delaware Tight	United St	27.8	1399.6	89568.2	1399.6	1287.	1184.	1089.	1002.	922.4	848.6	780.7	718.3	660.8	607.9	559.3	514.5	473.4	435.5	400.7	368.6	339.1	312.0	287.0	264.0	242.9	223.5	205.6	189.1	174.0	160.1	147.3	135.5	124.6	114.7	105.5	16281.3	89568.2	73286.9
*	North Field	Qatar	11.6	0.0	42432.4	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	42432.4	42432.4
	Ghawar Uthmaniyah	Saudi-Ara	19.2	804.2	57903.7	804.2	739.8	680.6	626.2	576.1	530.0	487.6	448.6	412.7	379.7	349.3	321.3	295.6	272.0	250.2	230.2	211.8	194.8	179.2	164.9	151.7	139.6	128.4	118.1	108.7	100.0	92.01	84.65	77.88	71.65	65.91	60.64	9355.3	57903.7	48548.4
	Montney Play	Canada	13.7	616.9	48822.0	616.9	567.5	522.1	480.4	441.9	406.6	374.0	344.1	316.6	291.2	267.9	246.5	226.8	208.6	191.9	176.6	162.4	149.4	137.5	126.5	116.4	107.1	98.53	90.64	83.39	76.72	70.58	64.94	59.74	54.96	50.56	46.52	7176.8	48822.0	41645.2
	Haynesville/Bossier Shale	United St	13.2	572.3	46296.7	572.3	526.5	484.4	445.6	409.9	377.1	347.0	319.2	293.7	270.2	248.6	228.7	210.4	193.5	178.0	163.8	150.7	138.6	127.5	117.3	107.9	99.35	91.40	84.09	77.36	71.17	65.48	60.24	55.42	50.98	46.91	43.15	6657.6	46296.7	39639.1
*	Tunguska Basin CBM	Russian F	8.8	0.0	30882.6	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	30882.6	30882.6
	Yolotan (Iolotan) South	Turkmeni	9.5	159.0	33684.6	159.0	146.2	134.5	123.8	113.9	104.7	96.41	88.69	81.60	75.07	69.06	63.54	58.45	53.78	49.47	45.52	41.87	38.52	35.44	32.61	30.00	27.60	25.39	23.36	21.49	19.77	18.19	16.73	15.39	14.16	13.03	11.99	1849.6	33684.6	31835.0
	Permian Midland Tight	United St	16.6	1065.8	52167.6	1065.8	980.5	902.1	829.9	763.5	702.4	646.2	594.5	547.0	503.2	462.9	425.9	391.8	360.5	331.6	305.1	280.7	258.2	237.6	218.6	201.1	185.0	170.2	156.6	144.0	132.5	121.9	112.1	103.2	94.95	87.36	80.37	12398.6	52167.6	39769.0
*	North Field C LNG	Qatar	7.8	0.0	28381.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	28381.0	28381.0
	Bovanenkovo Zone (Yamal M	Russian F	11.2	690.0	39645.9	690.0	634.7	583.9	537.2	494.2	454.7	418.3	384.8	354.0	325.7	299.7	275.7	253.6	233.3	214.7	197.5	181.7	167.1	153.8	141.5	130.1	119.7	110.1	101.3	93.26	85.80	78.94	72.62	66.81	61.47	56.55	52.02	8026.1	39645.9	31619.8
	Safaniya	Saudi-Ara	11.9	414.8	33706.0	414.8	381.5	351.0	322.9	297.1	273.3	251.4	231.3	212.8	195.8	180.1	165.7	152.4	140.2	129.0	118.7	109.2	100.5	92.46	85.07	78.26	72.00	66.24	60.94	56.06	51.58	47.45	43.65	40.16	36.95	33.99	31.27	4825.0	33706.0	28881.0
*	Shtokman	Russian F	6.1	0.0	21790.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	21790.2	21790.2
*	Central Arabian Offshore	Saudi-Ara	6.9	0.0	20673.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	20673.2	20673.2
*	Eagle Ford Shale	Mexico	5.1	0.0	17850.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	17850.0	17850.0
*	Lublin Basin Silurian Shale	Poland	5.6	0.0	17783.5	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	17783.5	17783.5
	Longmaxi Shale	China	5.7	59.8	18742.7	59.8	55.02	50.61	46.56	42.84	39.41	36.26	33.36	30.69	28.23	25.97	23.90	21.98	20.22	18.61	17.12	15.75	14.49	13.33	12.26	11.28	10.38	9.551	8.787	8.084	7.437	6.842	6.295	5.791	5.328	4.902	4.509	695.7	18742.7	18046.9
*	Kuznetsk Depression (Kuzba	Russian F	4.9	0.0	17132.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	17132.1	17132.1
*	North Field E	Qatar	4.6	0.0	16875.5	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	16875.5	16875.5
	Utica Shale	United St	7.7	522.4	27383.9	522.4	480.6	442.1	406.7	374.2	344.3	316.7	291.4	268.1	246.6	226.9	208.7	192.0	176.7	162.5	149.5	137.5	126.5	116.4	107.1	98.57	90.68	83.43	76.75	70.61	64.96	59.77	54.98	50.58	46.54	42.81	39.39	6076.9	27383.9	21307.0
	Orinoco Joint Ventures	Venezuel	6.7	142.0	19024.8	142.0	130.6	120.1	110.5	101.7	93.58	86.09	79.20	72.87	67.04	61.67	56.74	52.20	48.02	44.18	40.65	37.39	34.40	31.65	29.12	26.79	24.64	22.67	20.86	19.19	17.65	16.24	14.94	13.75	12.65	11.63	10.70	1651.7	19024.8	17373.1
	Ghawar Haradh	Saudi-Ara	7.0	264.8	21437.5	264.8	243.5	224.0	206.1	189.6	174.4	160.5	147.6	135.8	125.0	115.0	105.8	97.34	89.55	82.39	75.79	69.73	64.15	59.02	54.30	49.95	45.96	42.28	38.90	35.78	32.92	30.29	27.86	25.63	23.58	21.70	19.96	3079.9	21437.5	18357.7
	Eastern Gas Program	Russian F	4.3	0.6	15145.0	0.6	0.553	0.509	0.468	0.431	0.396	0.365	0.335	0.309	0.284	0.261	0.240	0.221	0.203	0.187	0.172	0.158	0.145	0.134	0.123	0.113	0.104	0.096	0.088	0.081	0.074	0.068	0.063	0.058	0.053	0.049	0.045	7.0	15145.0	15138.0
*	Llandovery Shale	Brazil	4.3	0.0	15051.5	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	15051.5	15051.5
	Vaca Muerta Shale	Argentina	5.2	102.6	16380.7	102.6	94.43	86.87	79.92	73.53	67.65	62.23	57.26	52.67	48.46	44.58	41.02	37.73	34.72	31.94	29.38	27.03	24.87	22.88	21.05	19.36	17.81	16.39	15.08	13.87	12.76	11.74	10.80	9.940	9.145	8.413	7.740	1194.1	16380.7	15186.6
*	Goldwyer Shale	Australia	4.5	0.0	14073.6	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	14073.6	14073.6
	Greater Burgan	Kuwait	8.3	483.0	23537.0	483.0	444.3	408.8	376.1	346.0	318.3	292.8	269.4	247.8	228.0	209.8	193.0	177.5	163.3	150.3	138.2	127.2	117.0	107.6	99.06	91.13	83.84	77.13	70.96	65.29	60.06	55.26	50.84	46.77	43.03	39.58	36.42	5618.6	23537.0	17918.3
	Khurais project	Saudi-Ara	7.6	413.1	21926.5	413.1	380.0	349.6	321.6	295.9	272.2	250.4	230.4	212.0	195.0	179.4	165.0	151.8	139.7	128.5	118.2	108.8	100.0	92.09	84.72	77.94	71.71	65.97	60.69	55.84	51.37	47.26	43.48	40.00	36.80	33.85	31.15	4805.4	21926.5	17121.1
*	Central Arabian Onshore	Saudi-Ara	4.4	0.0	13201.4	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	13201.4	13201.4
*	Santos Offshore	Brazil	4.3	0.0	13049.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	13049.2	13049.2
	Ghawar Hawiyah	Saudi-Ara	4.6	109.2	14978.9	109.2	100.4	92.42	85.03	78.23	71.97	66.21	60.91	56.04	51.56	47.43	43.64	40.14	36.93	33.98	31.26	28.76	26.46	24.34	22.39	20.60	18.95	17.44	16.04	14.76	13.58	12.49	11.49	10.57	9.729	8.950	8.234	1270.3	14978.9	13708.6
	Urengoyskoye	Russian F	5.2	289.4	18625.9	289.4	266.2	244.9	225.3	207.3	190.7	175.5	161.4	148.5	136.6	125.7	115.6	106.4	97.90	90.06	82.86	76.23	70.13	64.52	59.36	54.61	50.24	46.22	42.52	39.12	35.99	33.11	30.46	28.02	25.78	23.72	21.82	3366.9	18625.9	15259.0
	Upper Zakum	United Ar	6.4	272.3	18255.9	272.3	250.5	230.4	212.0	195.0	179.4	165.1	151.8	139.7	128.5	118.2	108.8	100.1	92.10	84.73	77.95	71.71	65.98	60.70	55.84	51.37	47.26	43.48	40.00	36.80	33.86	31.15	28.66	26.36	24.25	22.31	20.53	3167.4	18255.9	15088.4
*	QatarGas LNG T8-T11 (NFE-E	Qatar	3.4	0.0	12523.6	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	12523.6	12523.6
	Kashagan	Kazakhsta	5.1	132.2	14699.6	132.2	121.6	111.9	102.9	94.74	87.16	80.18	73.77	67.87	62.44	57.44	52.85	48.62	44.73	41.15	37.86	34.83	32.04	29.48	27.12	24.95	22.95	21.12	19.43	17.87	16.44	15.13	13.92	12.80	11.78	10.83	9.972	1538.4	14699.6	13161.2
	Western Gulf Province_Texa	United St	5.1	286.8	17404.5	286.8	263.8	242.7	223.2	205.4	188.9	173.8	159.9	147.1	135.3	124.5	114.5	105.4	96.99	89.23	82.09	75.52	69.48	63.92	58.81	54.10	49.77	45.79	42.13	38.76	35.66	32.80	30.18	27.76	25.54	23.50	21.62	3335.8	17404.5	14068.7
*	Barzan	Qatar	3.1	0.0	11247.5	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	11247.5	11247.5
	Rumaila North & South	Iraq	7.8	530.7	22061.6	530.7	488.2	449.1	413.2	380.1	349.7	321.7	296.0	272.3	250.5	230.5	212.0	195.1	179.5	165.1	151.9	139.7	128.6	118.3	108.8	100.1	92.12	84.75	77.97	71.74	66.00	60.72	55.86	51.39	47.28	43.50	40.02	6173.6	22061.6	15888.0
	DJ Basin Tight Oil	United St	5.9	413.9	19603.2	413.9	380.7	350.3	322.2	296.5	272.7	250.9	230.8	212.4	195.4	179.7	165.4	152.1	139.9	128.7	118.4	109.0	100.2	92.27	84.88	78.09	71.84	66.10	60.81	55.94	51.47	47.35	43.56	40.08	36.87	33.92	31.21	4814.7	19603.2	14788.5
*	Central Arabian Onshore	Kuwait	3.6	0.0	10860.7	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	10860.7	10860.7
	Ghawar Shedgum	Saudi-Ara	5.7	354.9	17475.3	354.9	326.4	300.3	276.3	254.2	233.8	215.1	197.9	182.1	167.5	154.1	141.8	130.4	120.0	110.4	101.6	93.47	85.99	79.11	72.78	66.96	61.60	56.67	52.14	47.97	44.13	40.60	37.35	34.36	31.61	29.08	26.76	4128.3	17475.3	13346.9
	Bu Hasa	United Ar	4.9	186.4	13861.3	186.4	171.4	157.7	145.1	133.5	122.8	113.0	103.9	95.66	88.01	80.97	74.49	68.53	63.05	58.00	53.36	49.09	45.16	41.55	38.23	35.17	32.35	29.77	27.38	25.19	23.18	21.32	19.62	18.05	16.60	15.27	14.05	2168.4	13861.3	11692.9
*	Zuluf (CR in field)	Saudi-Ara	3.5	0.0	9968.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	9968.0	9968.0
	Bab	United Ar	4.2	149.7	12879.9	149.7	137.7	126.7	116.5	107.2	98.66	90.77	83.51	76.83	70.68	65.02	59.82	55.04	50.63	46.58	42.85	39.43	36.27	33.37	30.70	28.24	25.98	23.90	21.99	20.23	18.61	17.12	15.75	14.49	13.33	12.27	11.28	1741.5	12879.9	11138.4
*	Lensky Basin CBM	Russian F	2.7	0.0	9560.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	9560.1	9560.1
*	Irati Shale	Brazil	2.7	0.0	9493.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	9493.0	9493.0
*	West Siberia Offshore	Russian F	2.9	0.0	9370.3	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	9370.3	9370.3
	Gazprom dobycha Yamburg	Russian F	8.9	1075.4	31584.7	1075.4	989.3	910.2	837.3	770.4	708.7	652.0	599.9	551.9	507.7	467.1	429.7	395.3	363.7	334.6	307.8	283.2	260.5	239.7	220.5	202.9	186.6	171.7	158.0	145.3	133.7	123.0	113.1	104.1	95.81	88.14	81.09	12509.8	31584.7	19074.9
*	Sembar Shale	Pakistan	2.8	0.0	8944.3	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	8944.3	8944.3
*	Tambey Zone (Yamal Megap	Russian F	2.5	0.0	8847.9	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	8847.9	8847.9
	Buzios (x-Franco)	Brazil	3.6	92.2	10568.9	92.2	84.82	78.04	71.79	66.05	60.77	55.90	51.43	47.32	43.53	40.05	36.84	33.90	31.18	28.69	26.39	24.28	22.34	20.55	18.91	17.39	16.00	14.72	13.54	12.46	11.46	10.54	9.705	8.929	8.214	7.557	6.953	1072.6	10568.9	9496.3
*	Central Arabian Onshore	Iraq	2.6	0.0	7879.6	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	7879.6	7879.6
	Qurna West	Iraq	4.0	164.2	11230.9	164.2	151.0	138.9	127.8	117.6	108.2	99.56	91.59	84.27	77.52	71.32	65.62	60.37	55.54	51.09	47.01	43.24	39.78	36.60	33.67	30.98	28.50	26.22	24.12	22.19	20.42	18.78	17.28	15.90	14.62	13.45	12.38	1910.1	11230.9	9320.8
*	Timan - Pechora Basin Offsh	Russian F	2.5	0.0	7745.4	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	7745.4	7745.4
	Baghdad East	Iraq	2.7	2.6	7771.6	2.6	2.355	2.166	1.993	1.833	1.687	1.552	1.428	1.313	1.208	1.112	1.023	0.941	0.865	0.796	0.732	0.674	0.620	0.570	0.525	0.483	0.444	0.408	0.376	0.346	0.318	0.292	0.269	0.247	0.228	0.209	0.193	29.8	7771.6	7741.8
	Qatif project	Saudi-Ara	5.1	327.7	14493.0	327.7	301.4	277.3	255.1	234.7	215.9	198.6	182.7	168.1	154.7	142.3	130.9	120.4	110.8	101.9	93.80	86.30	79.39	73.04	67.20	61.82	56.88	52.32	48.14	44.29	40.74	37.48	34.48	31.73	29.19	26.85	24.70	3811.5	14493.0	10681.4
*	East Natuna (x-Natuna D-Alp	Indonesia	2.2	0.0	7668.5	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	7668.5	7668.5
*	Chukchi Sea Offshore	United St	2.5	0.0	7649.5	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	7649.5	7649.5
*	Cambrian/Silurian Marine Sh	China	2.4	0.0	7640.5	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	7640.5	7640.5
	Manifa (redevelop)	Saudi-Ara	5.0	323.4	14289.7	323.4	297.5	273.7	251.8	231.6	213.1	196.0	180.4	165.9	152.6	140.4	129.2	118.9	109.3	100.6	92.58	85.17	78.36	72.09	66.32	61.02	56.14	51.64	47.51	43.71	40.21	37.00	34.04	31.31	28.81	26.50	24.38	3762.0	14289.7	10527.7
*	Barail Shale	India	2.1	0.0	7542.8	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	7542.8	7542.8
*	Tannezuft Shale	Algeria	2.3	0.0	7536.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	7536.0	7536.0
*	Yashlar Vostochnyy (East)	Turkmeni	2.1	0.0	7450.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	7450.1	7450.1
	Longmaxi Shale (Sichuan/Ch	China	2.2	19.4	7851.1	19.4	17.86	16.43	15.12	13.91	12.79	11.77	10.83	9.966	9.169	8.435	7.760	7.139	6.568	6.043	5.559	5.114	4.705	4.329	3.982	3.664	3.371	3.101	2.853	2.625	2.415	2.221	2.044	1.880	1.730	1.591	1.464	225.9	7851.1	7625.2
*	Timan - Pechora Basin Onsh	Russian F	2.4	0.0	7357.7	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	7357.7	7357.7

			Potentia	Total (mboe)																																				
Ne	Project	Country	Gt CO2	Production	Resources	Production 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	Total 2019-2050	Resources 2019	Remaining resources in 20
	Spirit River (Notikewin, Falhe	Canada	3.0	160.3	10651.5	160.3	147.4	135.6	124.7	114.8	105.6	97.17	89.39	82.24	75.66	69.61	64.04	58.92	54.20	49.87	45.88	42.21	38.83	35.72	32.86	30.23	27.81	25.59	23.54	21.66	19.93	18.33	16.86	15.51	14.27	13.13	12.08	1864.2	10651.5	8787.3
	Changqing	China	4.9	411.6	15751.4	411.6	378.6	348.3	320.4	294.8	271.2	249.5	229.5	211.2	194.3	178.7	164.4	151.3	139.2	128.0	117.8	108.4	99.72	91.75	84.41	77.65	71.44	65.72	60.47	55.63	51.18	47.08	43.32	39.85	36.66	33.73	31.03	4787.6	15751.4	10963.8
	PRB Tight Oil	United St	2.8	85.2	8572.8	85.2	78.39	72.12	66.35	61.04	56.16	51.67	47.53	43.73	40.23	37.01	34.05	31.33	28.82	26.51	24.39	22.44	20.65	18.99	17.47	16.07	14.79	13.61	12.52	11.51	10.59	9.750	8.970	8.252	7.592	6.984	6.426	991.3	8572.8	7581.5
*	Kronprins Christian Offshore	Denmark	2.2	0.0	6722.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	6722.1	6722.1
*	Central Arabian Onshore	Qatar	2.2	0.0	6700.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	6700.1	6700.1
*	Gulf Deepwater Offshore	Mexico	2.2	0.0	6623.8	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	6623.8	6623.8
*	Parnaiba Onshore	Brazil	2.0	0.0	6603.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	6603.0	6603.0
*	QatarGas LNG T12-T13 (NFE	Qatar	1.8	0.0	6567.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	6567.2	6567.2
*	Leningradskoye (Kara Sea)	Russian F	1.8	0.0	6397.3	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	6397.3	6397.3
*	Central Arabian Offshore	Iran	2.1	0.0	6388.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	6388.1	6388.1
	Berri	Saudi-Ara	3.6	208.0	10693.6	208.0	191.3	176.0	161.9	148.9	137.0	126.1	116.0	106.7	98.20	90.34	83.11	76.46	70.35	64.72	59.54	54.78	50.39	46.36	42.65	39.24	36.10	33.21	30.55	28.11	25.86	23.79	21.89	20.14	18.52	17.04	15.68	2419.4	10693.6	8274.2
	Majnoon	Iraq	2.5	44.6	7185.1	44.6	41.06	37.77	34.75	31.97	29.41	27.06	24.89	22.90	21.07	19.38	17.83	16.40	15.09	13.88	12.77	11.75	10.81	9.949	9.153	8.421	7.747	7.128	6.557	6.033	5.550	5.106	4.697	4.322	3.976	3.658	3.365	519.2	7185.1	6665.9
*	North Slope Onshore	United St	2.0	0.0	6149.6	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	6149.6	6149.6
	Marun	Iran	2.4	71.8	7492.7	71.8	66.05	60.76	55.90	51.43	47.32	43.53	40.05	36.84	33.90	31.18	28.69	26.39	24.28	22.34	20.55	18.91	17.39	16.00	14.72	13.54	12.46	11.46	10.54	9.705	8.929	8.214	7.557	6.952	6.396	5.884	5.414	835.2	7492.7	6657.5
	Shaybah	Saudi-Ara	4.3	325.5	12433.7	325.5	299.4	275.5	253.4	233.2	214.5	197.3	181.5	167.0	153.7	141.4	130.0	119.6	110.1	101.3	93.20	85.74	78.88	72.57	66.76	61.42	56.51	51.99	47.83	44.00	40.48	37.24	34.26	31.52	29.00	26.68	24.54	3786.9	12433.7	8646.8
*	Libra	Brazil	1.9	0.0	5556.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5556.2	5556.2
*	Southeast Uplift Onshore He	China	1.8	0.0	5512.7	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5512.7	5512.7
*	La Luna Shale	Colombia	1.6	0.0	5492.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5492.2	5492.2
	Woodford Shale	United St	3.4	321.4	12147.8	321.4	295.7	272.0	250.2	230.2	211.8	194.9	179.3	164.9	151.7	139.6	128.4	118.1	108.7	100.0	92.02	84.66	77.89	71.66	65.92	60.65	55.80	51.33	47.22	43.45	39.97	36.77	33.83	31.12	28.63	26.34	24.23	3739.2	12147.8	8408.6
	Project Kuwait	Kuwait	4.4	346.6	12644.2	346.6	318.8	293.3	269.9	248.3	228.4	210.1	193.3	177.8	163.6	150.5	138.5	127.4	117.2	107.8	99.23	91.30	83.99	77.27	71.09	65.40	60.17	55.36	50.93	46.85	43.10	39.65	36.48	33.56	30.88	28.41	26.13	4032.3	12644.2	8611.9
*	Collingham Shale	South Afr	1.8	0.0	5448.7	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5448.7	5448.7
*	Zuluf (expansion)	Saudi-Ara	1.8	0.0	5430.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5430.2	5430.2
*	Safaniya YTF Concession	Saudi-Ara	1.8	0.0	5379.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5379.2	5379.2
*	Sirte Shale	Libya	1.7	0.0	5363.9	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5363.9	5363.9
*	Arctic LNG 2 T1-3	Russian F	1.5	0.0	5285.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5285.2	5285.2
*	Menilite Shale	Ukraine	1.7	0.0	5248.6	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5248.6	5248.6
	Duvernay	Canada	1.9	63.8	6568.7	63.8	58.73	54.03	49.70	45.73	42.07	38.70	35.61	32.76	30.14	27.73	25.51	23.47	21.59	19.86	18.27	16.81	15.46	14.23	13.09	12.04	11.08	10.19	9.379	8.629	7.939	7.303	6.719	6.182	5.687	5.232	4.813	742.6	6568.7	5826.1
*	Bowland Shale	United Ki	1.5	0.0	5222.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	5222.2	5222.2
*	Baltimore Canyon Offshore	United St	1.6	0.0	4957.3	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4957.3	4957.3
	Azadegan	Iran	2.3	75.0	6480.4	75.0	69.02	63.49	58.41	53.74	49.44	45.49	41.85	38.50	35.42	32.58	29.98	27.58	25.37	23.34	21.47	19.76	18.17	16.72	15.38	14.15	13.02	11.98	11.02	10.14	9.330	8.583	7.897	7.265	6.684	6.149	5.657	872.7	6480.4	5607.7
*	Candeias Shale	Brazil	1.6	0.0	4835.8	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4835.8	4835.8
*	Tanf Shale	Syria	1.4	0.0	4802.9	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4802.9	4802.9
*	Campos Offshore	Brazil	1.6	0.0	4686.8	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4686.8	4686.8
*	Rusanovskoye (Kara Sea)	Russian F	1.3	0.0	4686.3	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4686.3	4686.3
*	MZLNG Joint Development (	Mozambi	1.3	0.0	4626.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4626.0	4626.0
	Anadarko Shelf_Oklahoma	United St	1.8	83.3	6330.6	83.3	76.64	70.51	64.87	59.68	54.91	50.51	46.47	42.75	39.33	36.19	33.29	30.63	28.18	25.92	23.85	21.94	20.18	18.57	17.08	15.72	14.46	13.30	12.24	11.26	10.36	9.532	8.769	8.068	7.422	6.829	6.282	969.2	6330.6	5361.4
	Ahwaz Asmari	Iran	2.2	114.9	6859.9	114.9	105.6	97.20	89.43	82.27	75.69	69.64	64.06	58.94	54.22	49.88	45.89	42.22	38.84	35.74	32.88	30.25	27.83	25.60	23.55	21.67	19.93	18.34	16.87	15.52	14.28	13.14	12.08	11.12	10.23	9.413	8.660	1336.0	6859.9	5523.9
	Pazanan	Iran	1.4	13.0	4721.2	13.0	11.97	11.01	10.13	9.325	8.579	7.893	7.262	6.681	6.146	5.654	5.202	4.786	4.403	4.051	3.727	3.428	3.154	2.902	2.670	2.456	2.259	2.079	1.912	1.759	1.618	1.489	1.370	1.260	1.159	1.067	0.981	151.4	4721.2	4569.7
	Hassi R'Mel (Domestic)	Algeria	2.3	177.0	8021.5	177.0	162.8	149.8	137.8	126.8	116.6	107.3	98.73	90.84	83.57	76.88	70.73	65.07	59.87	55.08	50.67	46.62	42.89	39.46	36.30	33.39	30.72	28.26	26.00	23.92	22.01	20.25	18.63	17.14	15.76	14.50	13.34	2059.0	8021.5	5962.4
*	Taymyr Basin CBM	Russian F	1.2	0.0	4306.8	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4306.8	4306.8
*	Volga - Urals Onshore	Russian F	1.4	0.0	4277.8	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4277.8	4277.8
*	Central Arabian Offshore	Bahrain	1.4	0.0	4248.5	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4248.5	4248.5
	Gachsaran	Iran	1.7	36.0	4983.2	36.0	33.15	30.50	28.06	25.81	23.75	21.85	20.10	18.49	17.01	15.65	14.40	13.25	12.19	11.21	10.31	9.492	8.732	8.034	7.391	6.800	6.256	5.755	5.295	4.871	4.481	4.123	3.793	3.489	3.210	2.953	2.717	419.2	4983.2	4564.0
*	Kish Gas Project	Iran	1.2	0.0	4215.5	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4215.5	4215.5
	Agha Jari	Iran	1.6	14.7	4504.1	14.7	13.50	12.42	11.43	10.51	9.674	8.900	8.188	7.533	6.930	6.376	5.866	5.397	4.965	4.568	4.202	3.866	3.557	3.272	3.010	2.769	2.548	2.344	2.156	1.984	1.825	1.679	1.545	1.421	1.307	1.203	1.106	170.8	4504.1	4333.4
	Liard Shale	Canada	1.2	0.3	4196.8	0.3	0.302	0.278	0.256	0.235	0.216	0.199	0.183	0.168	0.155	0.142	0.131	0.120	0.111	0.102	0.094	0.086	0.079	0.073	0.067	0.062	0.057	0.052	0.048	0.044	0.040	0.037	0.034	0.031	0.029	0.026	0.024	3.8	4196.8	4192.9
*	Khafji	Kuwait-Sa	1.4	0.0	4166.3	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4166.3	4166.3
	Horizon Oil Sands Project	Canada	2.0	72.7	5610.7	72.7	66.86	61.51	56.59	52.06	47.90	44.07	40.54	37.30	34.31	31.57	29.04	26.72	24.58	22.61	20.80	19.14	17.61	16.20	14.90	13.71	12.61	11.60	10.67	9.825	9.039	8.315	7.650	7.038	6.475	5.957	5.480	845.5	5610.7	4765.2
	Meramec Shale	United St	2.4	227.5	8758.5	227.5	209.3	192.5	177.1	162.9	149.9	137.9	126.9	116.7	107.4	98.83	90.92	83.65	76.96	70.80	65.14	59.92	55.13	50.72	46.66	42.93	39.49	36.33	33.43	30.75	28.29	26.03	23.95	22.03	20.27	18.64	17.15	2646.8	8758.5	6111.7
*	Pars Southwest	Iran	1.1	0.0	4011.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	4011.2	4011.2
	Khursaniyah	Saudi-Ara	2.4	148.6	7049.9	148.6	136.6	125.7	115.6	106.4	97.92	90.08	82.88	76.25	70.15	64.53	59.37	54.62	50.25	46.23	42.53	39.13	36.00	33.12	30.47	28.03	25.79	23.72	21.83	20.08	18.47	16.99	15.63	14.38	13.23	12.17	11.20	1728.4	7049.9	5321.6
	Gorgon LNG T1-T3	Australia	1.9	137.7	6801.8	137.7	126.6	116.5	107.2	98.65	90.75	83.49	76.81	70.67	65.01	59.81	55.03	50.62	46.57	42.85	39.42	36.27	33.36	30.69	28.24	25.98	23.90	21.99	20.23	18.61	17.12	15.75	14.49	13.33	12.26	11.28	10.38	1601.9	6801.8	5199.9
	Oil shale China	China	1.4	3.3	3906.7	3.3	3.008	2.767	2.546	2.342	2.155	1.982	1.824	1.678	1.543	1.420	1.306	1.202	1.106	1.017	0.936	0.861	0.792	0.729	0.670	0.617	0.567	0.522	0.480	0.442	0.406	0.374	0.344	0.316	0.291	0.268	0.246	38.0	3906.7	3868.6
	Lower Zakum	United Ar	2.4	146.2	6864.5	146.2	134.5	123.7	113.8	104.7	96.35	88.64	81.55	75.03	69.02	63.50	58.42	53.75	49.45	45.49	41.85	38.50	35.42	32.59	29.98	27.58	25.37	23.34	21.48	19.76	18.18	16.72	15.38	14.15	13.02	11.98	11.02	1700.7	6864.5	5163.8
*	West Siberia Onshore	Russian F	1.2	0.0	3824.3	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3824.3	3824.3
*	North Kara Sea Offshore	Russian F	1.2	0.0	3811.8	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3811.8	3811.8
	Kearl	Canada	1.9	74.8	5360.9	74.8	68.83	63.33	58.26	53.60	49.31	45.37	41.74	38.40	35.32	32.50	29.90	27.51	25.30	23.28	21.42	19.70	18.13	16.68	15.34	14.11	12.98	11.95	10.99	10.11	9.305	8.561	7.876	7.246	6.666	6.133	5.642	870.4	5360.9	4490.5
	Marjan	Saudi-Ara	1.9	97.9	5824.1	97.9	90.07	82.87	76.24	70.14	64.53	59.36	54.61	50.24	46.22	42.53	39.12	35.99	33.11	30.46	28.03	25.78	23.72	21.82	20.08	18.47	16.99	15.63	14.38	13.23	12.17	11.20	10.30	9.481	8.723	8.025	7.383	1139.0	5824.1	4685.2
*	Beaufort Sea Offshore	United St	1.3	0.0	3778.8	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3778.8	3778.8
*	Carboniferous Shale	Kazakhsta	1.3	0.0	3770.8	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3770.8	3770.8
	Leviathan	Israel	1.1	0.1	3711.9	0.1	0.056	0.052	0.047	0.044	0.040	0.037	0.034	0.031	0.029	0.026	0.024	0.022	0.020	0.019	0.017	0.016	0.014	0.013	0.012	0.011	0.010	0.009	0.009	0.008	0.007	0.007	0.006	0.005	0.005	0.005	0.004	0.7	3711.9	3711.1
	Tengiz	Kazakhsta	3.4	308.4	10101.0	308.4	283.6	260.9	240.1	220.9	203.2	186.9	172.0	158.2	145.5	133.9	123.2	113.3	104.3	95.95	88.28	81.21	74.72	68.74	63.24	58.18	53.52	49.24	45.30	41.68	38.34	35.28	32.45	29.86	27.47	25.27	23.25	3587.0	10101.0	6514.0
*	Velkerri Shale	Australia	1.1	0.0	3688.5	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3688.5	3688.5
*	Sudair Shale	Saudi-Ara	1.0	0.0	3637.9	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3637.9	3637.9
*	Area-1 Future Phases	Mozambi	1.0	0.0	3610.1	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3610.1	3610.1

Ne	Project	Country	Potentia Gt CO2	Total (mboe) Production	Resources	Production 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	Total 2019-2050	Resources 2019	Remaining resources in 20
	Ahwaz Bangestan	Iran	1.4	27.0	4159.2	27.0	24.83	22.84	21.01	19.33	17.78	16.36	15.05	13.85	12.74	11.72	10.78	9.923	9.129	8.398	7.727	7.108	6.540	6.016	5.535	5.092	4.685	4.310	3.965	3.648	3.356	3.088	2.840	2.613	2.404	2.212	2.035	314.0	4159.2	3845.2
*	Area 1 LNG (T1&T2)	Mozambi	1.0	0.0	3590.5	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3590.5	3590.5
	Ghawar Ain Dar N	Saudi-Ara	2.1	125.6	6094.7	125.6	115.5	106.3	97.81	89.98	82.78	76.16	70.07	64.46	59.30	54.56	50.19	46.18	42.48	39.08	35.96	33.08	30.43	28.00	25.76	23.70	21.80	20.06	18.45	16.97	15.62	14.37	13.22	12.16	11.19	10.29	9.472	1461.2	6094.7	4633.5
	Mero (Libra NW)	Brazil	1.3	13.1	3757.7	13.1	12.06	11.10	10.21	9.395	8.643	7.952	7.316	6.730	6.192	5.697	5.241	4.822	4.436	4.081	3.754	3.454	3.178	2.923	2.689	2.474	2.276	2.094	1.927	1.772	1.631	1.500	1.380	1.270	1.168	1.075	0.989	152.6	3757.7	3605.1
	Umm Shaif/Nasr	United Ar	1.9	96.2	5468.2	96.2	88.50	81.42	74.91	68.91	63.40	58.33	53.66	49.37	45.42	41.78	38.44	35.37	32.54	29.93	27.54	25.33	23.31	21.44	19.73	18.15	16.70	15.36	14.13	13.00	11.96	11.00	10.12	9.316	8.571	7.885	7.254	1119.1	5468.2	4349.1
*	La Luna Shale	Venezuel	1.1	0.0	3434.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3434.2	3434.2
	Nahr bin Umar	Iraq	1.3	9.2	3610.9	9.2	8.418	7.744	7.124	6.554	6.030	5.548	5.104	4.695	4.320	3.974	3.656	3.364	3.095	2.847	2.619	2.410	2.217	2.039	1.876	1.726	1.588	1.461	1.344	1.236	1.137	1.046	0.963	0.886	0.815	0.749	0.689	106.4	3610.9	3504.4
	Austin Chalk Tight	United St	1.4	60.3	4664.8	60.3	55.46	51.02	46.94	43.18	39.73	36.55	33.62	30.93	28.46	26.18	24.09	22.16	20.39	18.76	17.25	15.87	14.60	13.43	12.36	11.37	10.46	9.628	8.857	8.149	7.497	6.897	6.345	5.838	5.370	4.941	4.545	701.3	4664.8	3963.5
*	Gulf Coast Centre Offshore	United St	1.1	0.0	3347.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3347.2	3347.2
*	Tanzanian Coastal Offshore	Tanzania	1.0	0.0	3263.4	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3263.4	3263.4
*	Greater Turbot (Stabroek)	Guyana	1.1	0.0	3230.2	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3230.2	3230.2
*	West Florida Offshore	United St	1.1	0.0	3227.6	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3227.6	3227.6
	Gazprom dobycha Orenburg	Russian F	1.6	119.4	5618.6	119.4	109.8	101.0	93.00	85.56	78.72	72.42	66.63	61.29	56.39	51.88	47.73	43.91	40.40	37.16	34.19	31.46	28.94	26.62	24.49	22.53	20.73	19.07	17.54	16.14	14.85	13.66	12.57	11.56	10.64	9.790	9.006	1389.4	5618.6	4229.2
	South Pars (Phases 22-24)	Iran	1.0	34.7	3812.0	34.7	31.89	29.34	26.99	24.83	22.85	21.02	19.34	17.79	16.36	15.06	13.85	12.74	11.72	10.78	9.925	9.131	8.401	7.729	7.110	6.541	6.018	5.537	5.094	4.686	4.311	3.966	3.649	3.357	3.088	2.841	2.614	403.3	3812.0	3408.7
*	Yucatan Platform Offshore	Mexico	1.0	0.0	3084.3	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3084.3	3084.3
*	Central Uplift Onshore Xinjia	China	1.0	0.0	3062.7	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0	3062.7	3062.7
	Abqaiq	Saudi-Ara	1.6	98.6	5030.6	98.6	90.70	83.45	76.77	70.63	64.98	59.78	55.00	50.60	46.55	42.82	39.40	36.25	33.35	30.68	28.22	25.96	23.89	21.98	20.22	18.60	17.11	15.74	14.48	13.32	12.26	11.28	10.37	9.548	8.784	8.081	7.434	1146.9	5030.6	3883.6
	Bakken Shale	United St	5.9	736.9	18262.5	736.9	677.9	623.7	573.8	527.9	485.6	446.8	411.0	378.2	347.9	320.1	294.5	270.9	249.2	229.3	210.9	194.1	178.5	164.2	151.1	139.0	127.9	117.6	108.2	99.61	91.64	84.31	77.57	71.36	65.65	60.40	55.57	8572.6	18262.5	9690.0
	Zuluf	Saudi-Ara	2.4	201.1	7094.5	201.1	184.9	170.1	156.5	144.0	132.5	121.9	112.1	103.1	94.93	87.34	80.35	73.92	68.01	62.57	57.56	52.95	48.72	44.82	41.23	37.93	34.90	32.11	29.54	27.17	25.00	23.00	21.16	19.47	17.91	16.48	15.16	2339.0	7094.5	4755.6
	Ratawi	Iraq	1.1	6.7	3044.6	6.7	6.182	5.687	5.232	4.814	4.429	4.074	3.748	3.448	3.172	2.919	2.685	2.470	2.273	2.091	1.923	1.770	1.628	1.498	1.378	1.268	1.166	1.073	0.987	0.908	0.835	0.768	0.707	0.650	0.598	0.550	0.506	78.2	3044.6	2966.5
	Greater Liza (Liza)	Guyana	1.0	0.1	2884.2	0.1	0.130	0.120	0.110	0.101	0.093	0.086	0.079	0.072	0.067	0.061	0.056	0.052	0.048	0.044	0.040	0.037	0.034	0.031	0.029	0.026	0.024	0.022	0.020	0.019	0.017	0.016	0.014	0.013	0.012	0.011	0.010	1.7	2884.2	2882.5
	Qatargas 2 LNG T4-T5	Qatar	1.8	190.2	6745.7	190.2	174.9	160.9	148.0	136.2	125.3	115.3	106.0	97.59	89.79	82.60	75.99	69.91	64.32	59.17	54.44	50.08	46.08	42.39	39.00	35.88	33.01	30.37	27.94	25.70	23.65	21.75	20.01	18.41	16.94	15.58	14.34	2212.2	6745.7	4533.5
	Daqing	China	2.6	237.3	7530.1	237.3	218.2	200.8	184.7	169.9	156.3	143.8	132.3	121.7	112.0	103.0	94.82	87.23	80.25	73.83	67.93	62.49	57.49	52.89	48.66	44.77	41.19	37.89	34.86	32.07	29.50	27.14	24.97	22.97	21.13	19.44	17.89	2760.2	7530.1	4770.0
	Johan Sverdrup	Norway	1.1	25.1	3066.0	25.1	23.11	21.26	19.56	17.99	16.55	15.23	14.01	12.89	11.86	10.91	10.04	9.236	8.497	7.818	7.192	6.617	6.087	5.600	5.152	4.740	4.361	4.012	3.691	3.396	3.124	2.874	2.644	2.432	2.238	2.059	1.894	292.3	3066.0	2773.7
	Rasgas 2 LNG T3-T5	Qatar	1.5	147.5	5601.1	147.5	135.6	124.8	114.8	105.6	97.18	89.40	82.25	75.67	69.62	64.05	58.92	54.21	49.87	45.88	42.21	38.83	35.73	32.87	30.24	27.82	25.59	23.54	21.66	19.93	18.33	16.87	15.52	14.27	13.13	12.08	11.11	1715.3	5601.1	3885.9
	Mansouri Bangestan	Iran	1.0	24.8	3006.5	24.8	22.81	20.99	19.31	17.76	16.34	15.03	13.83	12.72	11.71	10.77	9.912	9.119	8.389	7.718	7.101	6.532	6.010	5.529	5.087	4.680	4.305	3.961	3.644	3.352	3.084	2.837	2.610	2.401	2.209	2.032	1.870	288.5	3006.5	2717.9
	Asab	United Ar	1.4	72.4	3872.2	72.4	66.60	61.28	56.37	51.86	47.71	43.90	40.38	37.15	34.18	31.45	28.93	26.61	24.48	22.53	20.72	19.06	17.54	16.14	14.84	13.66	12.56	11.56	10.63	9.787	9.004	8.283	7.621	7.011	6.450	5.934	5.459	842.2	3872.2	3030.0
	Ghawar Ain Dar S	Saudi-Ara	1.4	89.9	4227.6	89.9	82.68	76.07	69.98	64.38	59.23	54.49	50.13	46.12	42.43	39.04	35.91	33.04	30.40	27.96	25.73	23.67	21.77	20.03	18.43	16.95	15.60	14.35	13.20	12.14	11.17	10.28	9.460	8.703	8.007	7.366	6.777	1045.5	4227.6	3182.1
	Tarim (CNPC)	China	2.0	214.0	6718.2	214.0	196.8	181.1	166.6	153.2	141.0	129.7	119.3	109.8	101.0	92.94	85.51	78.67	72.37	66.58	61.25	56.35	51.85	47.70	43.88	40.37	37.14	34.17	31.43	28.92	26.61	24.48	22.52	20.72	19.06	17.53	16.13	2489.1	6718.2	4229.1
	QatarGas 1 LNG T1-T3	Qatar	1.3	116.7	4647.5	116.7	107.3	98.77	90.87	83.60	76.91	70.76	65.09	59.89	55.10	50.69	46.63	42.90	39.47	36.31	33.41	30.73	28.27	26.01	23.93	22.02	20.25	18.63	17.14	15.77	14.51	13.35	12.28	11.30	10.39	9.565	8.800	1357.5	4647.5	3289.9
	Basrah Gas project	Iraq	1.0	73.1	3733.7	73.1	67.27	61.89	56.94	52.38	48.19	44.33	40.79	37.52	34.52	31.76	29.22	26.88	24.73	22.75	20.93	19.26	17.71	16.30	14.99	13.79	12.69	11.67	10.74	9.884	9.094	8.366	7.697	7.081	6.514	5.993	5.514	850.6	3733.7	2883.1
	South Pars (Phases 9-10) dry	Iran	1.3	108.9	4417.4	108.9	100.1	92.17	84.79	78.01	71.77	66.03	60.75	55.89	51.41	47.30	43.52	40.03	36.83	33.88	31.17	28.68	26.38	24.27	22.33	20.54	18.90	17.39	16.00	14.72	13.54	12.45	11.46	10.54	9.702	8.926	8.212	1266.8	4417.4	3150.6
	Harmaliyah	Saudi-Ara	1.0	49.4	3045.4	49.4	45.42	41.79	38.44	35.37	32.54	29.93	27.54	25.34	23.31	21.44	19.73	18.15	16.70	15.36	14.13	13.00	11.96	11.00	10.12	9.316	8.571	7.885	7.254	6.674	6.140	5.649	5.197	4.781	4.399	4.047	3.723	574.4	3045.4	2471.1
	Dolphin	Qatar	1.6	177.9	5710.9	177.9	163.6	150.5	138.4	127.4	117.2	107.8	99.21	91.27	83.97	77.25	71.07	65.39	60.15	55.34	50.91	46.84	43.09	39.65	36.47	33.55	30.87	28.40	26.13	24.04	22.11	20.34	18.72	17.22	15.84	14.57	13.41	2068.9	5710.9	3642.0
	Christina Lake	Canada	1.2	71.1	3474.3	71.1	65.36	60.13	55.32	50.90	46.82	43.08	39.63	36.46	33.54	30.86	28.39	26.12	24.03	22.11	20.34	18.71	17.21	15.83	14.57	13.40	12.33	11.34	10.43	9.604	8.836	8.129	7.478	6.880	6.330	5.823	5.357	826.5	3474.3	2647.8
	Eagle Ford Shale	United St	5.9	872.6	20105.1	872.6	802.8	738.5	679.4	625.1	575.1	529.1	486.7	447.8	412.0	379.0	348.7	320.8	295.1	271.5	249.8	229.8	211.4	194.5	178.9	164.6	151.4	139.3	128.2	117.9	108.5	99.83	91.85	84.50	77.74	71.52	65.80	10150.9	20105.1	9954.2
	Samotlorneftegaz (TNK-BP)	Russian F	1.9	179.0	5544.1	179.0	164.6	151.4	139.3	128.1	117.9	108.5	99.82	91.84	84.49	77.73	71.51	65.79	60.53	55.68	51.23	47.13	43.36	39.89	36.70	33.76	31.06	28.58	26.29	24.19	22.25	20.47	18.83	17.32	15.94	14.66	13.49	2081.7	5544.1	3462.4
	Xinjiang (CNPC)	China	1.4	103.8	3982.4	103.8	95.45	87.82	80.79	74.33	68.38	62.91	57.88	53.25	48.99	45.07	41.46	38.14	35.09	32.28	29.70	27.32	25.14	23.13	21.28	19.57	18.01	16.57	15.24	14.02	12.90	11.87	10.92	10.04	9.244	8.504	7.824	1207.0	3982.4	2775.4
	Karachaganak	Kazakhsta	1.2	133.4	4532.6	133.4	122.6	112.8	103.8	95.53	87.88	80.85	74.38	68.43	62.96	57.92	53.29	49.02	45.10	41.49	38.17	35.12	32.31	29.72	27.35	25.16	23.14	21.29	19.59	18.02	16.58	15.25	14.03	12.91	11.88	10.93	10.05	1551.3	4532.6	2981.4
	Dovletabad-Donmez	Turkmeni	1.6	182.6	5516.6	182.6	168.0	154.5	142.2	130.8	120.3	110.7	101.8	93.72	86.23	79.33	72.98	67.14	61.77	56.83	52.28	48.10	44.25	40.71	37.45	34.46	31.70	29.16	26.83	24.68	22.71	20.89	19.22	17.68	16.27	14.96	13.77	2124.5	5516.6	3392.1
	Athabasca Oil Sands Project	Canada	1.4	102.2	3823.2	102.2	94.02	86.50	79.58	73.21	67.35	61.97	57.01	52.45	48.25	44.39	40.84	37.57	34.57	31.80	29.26	26.91	24.76	22.78	20.96	19.28	17.74	16.32	15.01	13.81	12.71	11.69	10.75	9.897	9.105	8.377	7.706	1188.9	3823.2	2634.3
	Yuganskneftegaz	Russian F	4.3	511.1	12297.7	511.1	470.1	432.5	397.9	366.1	336.8	309.8	285.0	262.2	241.3	221.9	204.2	187.8	172.8	159.0	146.3	134.6	123.8	113.9	104.8	96.43	88.71	81.62	75.09	69.08	63.55	58.47	53.79	49.49	45.53	41.88	38.53	5945.0	12297.7	6352.7
	Rasgas 3 LNG T6-T7	Qatar	1.5	190.1	5527.4	190.1	174.9	160.9	148.0	136.2	125.3	115.2	106.0	97.58	89.78	82.59	75.99	69.91	64.31	59.17	54.43	50.08	46.07	42.39	38.99	35.87	33.00	30.36	27.93	25.70	23.64	21.75	20.01	18.41	16.94	15.58	14.33	2212.0	5527.4	3315.4
	Qurna West-2	Iraq	1.6	142.5	4525.0	142.5	131.1	120.6	110.9	102.1	93.93	86.41	79.50	73.14	67.29	61.90	56.95	52.39	48.20	44.35	40.80	37.53	34.53	31.77	29.23	26.89	24.74	22.76	20.94	19.26	17.72	16.30	15.00	13.80	12.69	11.68	10.74	1657.9	4525.0	2867.1
	Romashkino	Russian F	1.3	107.9	3790.1	107.9	99.29	91.35	84.04	77.31	71.13	65.44	60.20	55.39	50.95	46.88	43.13	39.68	36.50	33.58	30.89	28.42	26.15	24.06	22.13	20.36	18.73	17.23	15.85	14.58	13.42	12.34	11.36	10.45	9.615	8.846	8.138	1255.5	3790.1	2534.6
	South Pars (Phases 4-5) dry g	Iran	1.1	113.1	3844.6	113.1	104.0	95.74	88.08	81.03	74.55	68.58	63.10	58.05	53.40	49.13	45.20	41.58	38.26	35.20	32.38	29.79	27.41	25.21	23.20	21.34	19.63	18.06	16.62	15.29	14.06	12.94	11.90	10.95	10.07	9.271	8.529	1315.8	3844.6	2528.8
	Bab (Gasco)	United Ar	1.7	241.7	6298.4	241.7	222.3	204.5	188.2	173.1	159.3	146.5	134.8	124.0	114.1	104.9	96.59	88.86	81.75	75.21	69.19	63.66	58.56	53.88	49.57	45.60	41.95	38.60	35.51	32.67	30.05	27.65	25.44	23.40	21.53	19.81	18.22	2811.6	6298.4	3486.8
	South Pars (Phases 2-3) dry g	Iran	1.0	109.4	3548.8	109.4	100.6	92.60	85.19	78.37	72.10	66.33	61.03	56.14	51.65	47.52	43.72	40.22	37.00	34.04	31.32	28.81	26.51	24.39	22.43	20.64	18.99	17.47	16.07	14.78	13.60	12.51	11.51	10.59	9.747	8.967	8.250	1272.7	3548.8	2276.1
	El Sharara	Libya	1.0	75.5	2844.2	75.5	69.49	63.93	58.82	54.11	49.78	45.80	42.13	38.76	35.66	32.81	30.18	27.77	25.55	23.50	21.62	19.89	18.30	16.84	15.49	14.25	13.11	12.06	11.09	10.21	9.394	8.642	7.951	7.315	6.730	6.191	5.696	878.7	2844.2	1965.4
	Al Khaleej Gas project	Qatar	1.1	137.8	4081.3	137.8	126.8	116.6	107.3	98.75	90.85	83.58	76.89	70.74	65.08	59.87	55.08	50.68	46.62	42.89	39.46	36.30	33.40	30.73	28.27	26.01	23.93	22.01	20.25	18.63	17.14	15.77	14.51	13.34	12.28	11.29	10.39	1603.6	4081.3	2477.7
	Halfayah	Iraq	1.4	135.3	3994.7	135.3	124.5	114.5	105.3	96.95	89.20	82.06	75.50	69.46	63.90	58.79	54.08	49.76	45.78	42.11	38.74	35.64	32.79	30.17	27.75	25.53	23.49	21.61	19.88	18.29	16.83	15.48	14.24	13.10	12.05	11.09	10.20	1574.4	3994.7	2420.3
	Zubair	Iraq	1.7	175.9	4813.6	175.9	161.8	148.9	137.0	126.0	115.9	106.6	98.14	90.29	83.07	76.42	70.31	64.68	59.51	54.75	50.37	46.34	42.63	39.22	36.08	33.19	30.54	28.09	25.85	23.78	21.88	20.13	18.51	17.03	15.67	14.42	13.26	2046.7	4813.6	2766.9
	South Pars (Phases 20-21)	Iran	1.0	123.6	3713.3	123.6	113.7	104.6	96.23	88.53	81.45	74.93	68.94	63.42	58.35	53.68	49.39	45.43	41.80	38.45	35.38	32.55	29.94	27.55	25.34	23.32	21.45	19.73	18.15	16.70	15.36	14.14	13.00	11.96	11.01	10.12	9.319	1437.7	3713.3	2275.6
	Syncrude Mildred Lake/Auro	Canada	1.2	107.1	3338.7	107.1	98.49	90.61	83.36	76.69	70.56	64.91	59.72	54.94	50.54	46.50	42.78	39.36	36.21	33.31	30.65	28.19	25.94	23.86	21.95	20.20	18.58	17.09	15.73	14.47	13.31	12.24	11.26	10.36	9.538	8.775	8.073	1245.4	3338.7	2093.3
	Permian Conventional_Texas	United St	2.1	261.4	6533.1	261.4	240.5	221.2	203.5	187.2	172.2	158.5	145.8	134.1	123.4	113.5	104.4	96.11	88.42	81.35	74.84	68.85	63.34	58.27	53.61	49.32	45.38	41.75	38.41	35.33	32.51	29.90	27.51	25.31	23.29	21.42	19.71	3041.0	6533.1	3492.1
	Troll	Norway	1.8	245.3	6135.7	245.3	225.6	207.5	190.9	175.7	161.6	148.7	136.8	125.8	115.8	106.5	98.01	90.17	82.96	76.32	70.21	64.60	59.43	54.67	50.30	46.27	42.57	39.17	36.03	33.15	30.50	28.06	25.81	23.75	21.85	20.10	18.49	2853.1	6135.7	3282.6
	Barnett Shale	United St	1.4	198.3	4885.6	198.3	182.4	167.8	154.4	142.0	130.7	120.2	110.6	101.7	93.63	86.14	79.25	72.91	67.07	61.71	56.77	52.23	48.05	44.21	40.67	37.42	34.42	31.67	29.13	26.80	24.66	22.68	20.87	19.20	17.66	16.25	14.95	2306.9	4885.6	2578.6
	Shengli	China	1.5	170.2	4265.8	170.2	156.6	144.0	132.5	121.9	112.1	103.2	94.96	87.36	80.37	73.94	68.03	62.58	57.58	52.97	48.73	44.83	41.25	37.95	34.91	32.12	29.55	27.18	25.01	23.01	21.17	19.47	17.91	16.48	15.16	13.95	12.83	1980.3	4265.8	2285.5
	ACG (Azeri-Chirag-Guneshli D	Azerbaija	1.7	207.5	4970.5	207.5	190.8	175.6	161.5	148.6	136.7	125.7	115.7	106.4	97.95	90.12	82.91	76.27	70.17	64.56	59.39	54.64	50.27	46.25	42.55	39.14	36.01	33.13	30.48	28.04	25.80	23.73	21.83	20.09	18.48	17.00	15.64	2413.4	4970.5	2557.1
	Hassi Messaoud	Algeria	1.2	155.3	3457.0	155.3	142.8	131.4	120.9	111.2	102.3	94.15	86.62	79.69	73.31	67.45	62.05	57.09	52.52	48.32	44.45	40.90	37.62	34.61	31.84	29.30	26.95	24.80	22.81	20.99	19.31	17.76	16.34	15.03	13.83	12.72	11.70	1806.4	3457.0	1650.6
	NLNG Base Project	Nigeria	1.0	191.2	3207.3	191.2	175.9	161.8	148.9	136.9	126.0	115.9	106.6	98.13	90.28	83.06	76.41	70.30	64.68	59.50	54.74	50.36	46.33	42.63	39.22	36.08	33.19	30.54	28.09	25.84	23.78	21.87	20.12	18.51	17.03	15.67	14.41	2224.5	3207.3	982.9
	Gazprom dobycha Nadym	Russian F	1.3	257.8	4522.4	257.8	237.1	218.2	200.7	184.6	169.9	156.3	143.8	132.3	121.7	111.9	103.0	94.79	87.20	80.23	73.81	67.90	62.47	57.47	52.87	48.64	44.75	41.17	37.88	34.85	32.06	29.49	27.13	24.96	22.96	21.13	19.44	2999.1	4522.4	1523.2
	Ku-Maloob-Zaap Project	Mexico	2.0	329.0	5614.3	329.0	302.6	278.4	256.1	235.6	216.8	199.4	183.5	168.8	155.3	142.9	131.4	120.9	111.2	102.3	94.19	86.65	79.72	73.34	67.48	62.08	57.11	52.54	48.34	44.47	40.91	37.64	34.63	31.86	29.31	26.96	24.81	3827.3	5614.3	1787.0
	SeverEnergia Project	Russian F	1.1	251.4	3976.8	251.4	231.2	212.7	195.7	180.0	165.6	152.4	140.2	128.9	118.6	109.1	100.4	92.41	85.02	78.21	71.96	66.20	60.90	56.03	51.55	47.42	43.63	40.14	36.93	33.97	31.25	28.75	26.45	24.34	22.39	20.60	18.95	2923.9	3976.8	1052.9
	Lula (X-Tupi)	Brazil	2.5	415.8	7363.4	415.8	382.4	351.8	323.7	297.8	274.0	252.0	231.9	213.3	196.3	180.5	166.1	152.8	140.6	129.3	119.0	109.5	100.7	92.68	85.27	78.45	72.17	66.40	61.08	56.20	51.70	47.56	43.76	40.26	37.04	34.07	31.35	4836.4	7363.4	2527.0

Ne	Project	Country	Potentia Gt CO2	Total (mboe) Production	Resources	Production 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
	Total		**646.0**	**27,324.0**	**2,084,511.8**	27,324.0	25138	23127	21276	19574	18008	16568	15242	14023	12901	11869
	Total Producing Carbon Bombs		**452.2**	**27324.0**	**119**	27324.0	25138	23127	21276	19574	18008	16568	15242	14023	12901	11869
	Total New Carbon Bombs		**193.8**	**0.0**	**76**	0.0	0	0	0	0	0	0	0	0	0	0
	Emissions 2019-2050		**112.7**													
	Data source: Rystad, 2020, Production figures for 2019					98	90.16	82.94	76.31	70.20	64.58	59.42	54.66	50.29	46.27	42.57

Project	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Total	10919	10046	9242.	8503.	7822.	7196.	6621.	6091.	5604.	5155.	4743.
Total Producing Carbon Bombs	10919	10046	9242.	8503.	7822.	7196.	6621.	6091.	5604.	5155.	4743.
Total New Carbon Bombs	0	0	0	0	0	0	0	0	0	0	0
Emissions 2019-2050											
Data source: Rystad, 2020, Production figures for 2019	39.16	36.03	33.14	30.49	28.05	25.81	23.74	21.84	20.09	18.49	17.01

Project	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	Total 2019-2050	Resources 2019	Remaining resources in 20
Total	4363.	4014.	3693.	3398.	3126.	2876.	2646.	2434.	2239.	2060.	317,854.6	2,084,511.8	1,766,657.2
Total Producing Carbon Bombs	4363.	4014.	3693.	3398.	3126.	2876.	2646.	2434.	2239.	2060.			
Total New Carbon Bombs	0	0	0	0	0	0	0	0	0	0	0.0		0.0
Emissions 2019-2050													
Data source: Rystad, 2020, Production figures for 2019													

New	Project Name	Country	Potent	Fuel	Status	Reserves (Million tons)	Reserve catego	Year	Emissions f	Coal type	Source	Page Number	Region/State/Pr	Coal Basin	Production	Year	Source	Comments	Production 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	Combined Production (	Remaining Res
	Black Thunder Coal N	United States	1.4	Coal	Operating	748	Recoverable		0.00181629	Subbituminous	https://investor.archrsc.com/static-files/089edfb1-21ad-4445-881				65.2				65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	748	0
	North Antelope Roche	United States	2.9	Coal	Operating	1610	Proven and Prob	2019	0.00181629	Subbituminous	https://www.p	48	Wyoming		77.4				77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	1610	0
	KPC Operation Coal I	Indonesia	3.1	Coal	Operating	1160	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				60.9				60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	60.9	1160	0
	Pasir Coal Mine	Indonesia	1.0	Coal	Operating	537	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				34.6				34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	537	0
	Tutupan Coal Mine	Indonesia	1.1	Coal	Operating	602	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				35.6				35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.6	602	0
	Anjialing Open-Pit Mir	China	1.0	Coal	Operating	428	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				30				30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	428	0
	Kusmunda Coal Mine	India	1.2	Coal	Operating	957	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				42.3				42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	42.3	957	0
	BIB Coal Mine	Indonesia	1.1	Coal	Operating	591	Marketable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				28				28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	591	0
	Antaibao Surface Min	China	1.2	Coal	Operating	491	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				22				22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	491	0
	Daliuta Coal Mine	China	1.2	Coal	Operating	495	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18				18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	495	0
	Blackwater Coal Mine	Australia	1.0	Coal	Operating	375	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				14				14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	375	0
	Moher Amlohri Coal N	India	1.0	Coal	Operating	575	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18.7				18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	575	0
	Garzweiler Coal Mine	Germany	1.3	Coal	Operating	1100	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				35				35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	1100	0
	Halagou Coal Mine	China	1.3	Coal	Operating	516	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				16				16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	512	4
	Gevra Coal Mine	India	2.4	Coal	Operating	1338	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				41				41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	1312	26
	Shubarkol Coal Mine	Kazakhstan	1.0	Coal	Operating	406	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				11.3				11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	361.6	44
	Yangchangwan No.1 \	China	1.1	Coal	Operating	440	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				12				12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	384	56
	Hunter Valley South C	Australia	1.2	Coal	Operating	440	Resource	2013	0.00266772	Bituminous (Met	https://datago	n/a (dataset)	New South Wales		10.8				10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	345.6	94
	Sihe Coal Mine	China	1.0	Coal	Operating	383	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				9				9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	288	95
	Cerrejón Coal Mine	Colombia	2.4	Coal	Operating	987	Marketable Rese	2020	0.00244068	Bituminous	https://www.b	300			27.7	2019	https://w	BP owns 33% of	27.7	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	27.69	886.1	101
	Mount Pleasant Coal	Australia	1.1	Coal	Operating	459	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10.5				10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	336	123
	Fording River	Canada	1.0	Coal	Operating	388	Reserves		0.00266772	coking coal	http://cmscor	6	British Columbia		8.15	2019		Total resource ca	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	8.15	260.8	127
	Hambach Coal Mine	Germany	1.7	Coal	Operating	1419	Recoverable	2019	0.0012019	Lignite	https://www.e	14	North-Rhine We	Rhineland Coalfi	40				40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	1280	139
	Huojitu Well Of Daliut	China	1.1	Coal	Operating	624	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15				15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	480	144
	Dipka Coal Mine	India	1.2	Coal	Operating	975	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				25.2				25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	806.4	169
	Zaoquan Coal Mine	China	1.1	Coal	Operating	434	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	256	178
	Shenhua Baorixile Su	China	1.6	Coal	Operating	1303	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				35				35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	1120	183
	Borly Coal Mines	Kazakhstan	1.0	Coal	Operating	419	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7.3				7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	233.6	185
	Yangquan No.1 Coal I	China	1.2	Coal	Operating	461	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8.5				8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	272	189
	Shangwan Coal Mine	China	1.8	Coal	Operating	732	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				16				16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	512	220
	Kouzi East Coal Mine	China	1.0	Coal	Operating	382	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	160	222
	Zhangjiamao Coal Mir	China	1.3	Coal	Operating	543	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	223
	Baode Coal Mine	China	1.7	Coal	Operating	680	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				14				14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	448	232
	Pribbenow Coal Mine	Colombia	1.4	Coal	Operating	561	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	241
	Talaipalli Coal Mine	India	1.5	Coal	Operating	844	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18.7				18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	598.4	246
	Liuzhuang Coal Mine	China	1.5	Coal	Operating	623	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				11.4				11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	364.8	258
	Buliangou Coal Mine	China	1.8	Coal	Operating	746	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15				15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	480	266
	Tongxin Coal Mine	China	1.6	Coal	Operating	588	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	268
	Goonyella-Riverside (	Australia	2.2	Coal	Operating	818	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				17.1				17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	17.1	547.2	271
	Shigetai Coal Mine	China	1.2	Coal	Operating	657	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				12				12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	384	273
	Suancigou Coal Mine	China	2.1	Coal	Operating	851	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18				18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	576	275
	Yangjiacun Coal Mine	China	1.1	Coal	Operating	442	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	160	282
	Fengjiata Coal Mine	China	1.2	Coal	Operating	486	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	294
	Hamilton County Mine	United States	1.2	Coal	Operating	485	Proven and Prob	2019	0.00244068	Bituminous	https://www.arlp.com/mines-facilities/illinois-basin/default.aspx#h				5.9	2019	https://w	535.1 short tons	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	188.8	297
	MHU Coal Mine	Indonesia	1.1	Coal	Operating	592	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				9.1				9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	291.2	301
	Dafosi Coal Mine	China	1.4	Coal	Operating	557	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	256	301
	Huangling No.2 Coal I	China	1.4	Coal	Operating	558	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	256	302
	Xiwan Surface Coal N	China	1.5	Coal	Operating	627	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	307
	Gaojiabao Coal Mine	China	1.1	Coal	Operating	470	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	160	310
	Shajihai No.2 Coal Mi	China	1.1	Coal	Operating	470	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	160	310
	Indexim Coalindo Coa	Indonesia	1.1	Coal	Operating	613	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				9.2				9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	294.4	319
	Shenhua Bulianta Coa	China	2.2	Coal	Operating	1224	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				28				28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	896	328
	Shahaiji No.1 Coal Mi	China	1.2	Coal	Operating	490	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	160	330
	Gaohe Coal Mine	China	1.5	Coal	Operating	575	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7.5				7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	240	335
	Baishihu Surface Min	China	1.3	Coal	Operating	530	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	338
	Talahao Coal Mine	China	1.3	Coal	Operating	532	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	340
	Byerwen Coal Mine	Australia	1.8	Coal	Operating	690	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	370
*	West Well of Faer Sec	China	1.0	Coal	Proposed	377	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	377
	Arshanovsky Coal Mir	Russian Federat	1.7	Coal	Operating	700	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	380
	Hunter Valley North C	Australia	1.7	Coal	Operating	650	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8.4				8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	268.8	381
	Xiaozhuang Coal Min	China	1.4	Coal	Operating	578	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	386
	Qingchunta Coal Mine	China	1.4	Coal	Operating	583	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	391
*	Longwan Coal Mine	China	1.0	Coal	Proposed	395	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	395
*	Bernice-Cygnus Coal	South Africa	1.1	Coal	Proposed	402	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	402
	Shicaocun Coal Mine	China	1.5	Coal	Operating	597	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	405
	Wangjiata Coal Mine	China	1.6	Coal	Operating	661	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	256	405
	Shaqu No.1 Coal Min	China	1.4	Coal	Operating	568	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	160	408
*	Youngs Creek Coal M	United States	1.1	Coal	Proposed	408	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	408
	Shenhua Heidaigou S	China	2.7	Coal	Operating	1498	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				34				34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	1088	410
	Lijiahao Coal Mine	China	1.5	Coal	Operating	606	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	414
*	Hongshuliang Coal M	China	1.0	Coal	Proposed	415	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	415
	Kaniha Coal Mine	India	1.2	Coal	Operating	659	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7.5				7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	240	419
*	Changcheng No.3 Co	China	1.1	Coal	Proposed	421	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	421
*	Shanxi Dongda Coal I	China	1.0	Coal	Proposed	422	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	422
*	Shurapskaya Coal Mi	Russian Federat	1.0	Coal	Proposed	423	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	423
	Shangyuquan Coal M	China	1.4	Coal	Operating	585	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	160	425
	Zhangji Coal Mine	China	2.2	Coal	Operating	822	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				12.3				12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	393.6	429
	Dingji Coal Mine	China	1.7	Coal	Operating	625	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	433
	Sijiazhuang Coal Mine	China	1.6	Coal	Operating	594	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	160	434
*	Ba Leng Coal Mine	China	1.1	Coal	Proposed	439	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	439
*	Wangwa Coal Mine	China	1.1	Coal	Proposed	439	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	439
	Yallourn	Australia	1.1	Coal	Operating	463	Recoverable	2013	0.00244068	bituminous	Global Energy Monitor. (2021)		Victoria		n/d				n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	0	463
*	Talike District No. 2 C	China	1.1	Coal	Proposed	465	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	465
	Longwanggou Coal M	China	1.9	Coal	Operating	788	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	468
	Xiaojiawa Coal Mine	China	1.6	Coal	Operating	725	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	256	469
	Wudong Coal Mine	China	1.6	Coal	Operating	661	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	469
	Hanglaiwan Coal Mine	China	1.6	Coal	Operating	730	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	256	474
*	Yuwang No.1 Coal Mi	China	1.3	Coal	Proposed	477	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	477
	Taldinsky Coal Mine	Russian Federat	2.2	Coal	Operating	900	Resource	2014	0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				13.1				13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	419.2	481
	Shanxi Lu'an Guchen	China	1.6	Coal	Operating	742	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	256	486
	Sengwe Colliery	Zimbabwe	1.0	Coal	Operating	500	Recoverable	2013	0.002	Coal	https://www.z	60			0.3	2013			0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	9.6	490
	Peak Downs Coal Mir	Australia	2.3	Coal	Operating	869	Recoverable		0.00266772	Bituminous (Met	https://datago	n/a (dataset)	Queensland		11.8				11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	377.6	491
	Erkovetsky Coal Mine	Russian Federat	1.0	Coal	Operating	572	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				2.5				2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	80	492
*	Xinjiang Hongshan Co	China	1.2	Coal	Proposed	494	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	494
	Weijiamao Open Pit	China	1.7	Coal	Operating	691	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	499
*	Saraji East Coal Mine	Australia	1.3	Coal	Proposed	502	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	502
*	Baiyanghe Coal Mine	China	1.2	Coal	Proposed	508	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	508
	Gaotouyao Coal Mine	China	1.9	Coal	Operating	766	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	256	510
	Guojiawan Coal Mine	China	1.9	Coal	Operating	769	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	256	513
*	Olive Downs Coal Min	Australia	1.4	Coal	Proposed	514	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	514
*	Zhong Yu Coal Mine	China	1.4	Coal	Proposed	514	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	514
*	Wenjiazhuang Coal M	China	1.4	Coal	Proposed	514	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	514
*	Revuboe Coal Mine	Mozambique	1.4	Coal	Proposed	519	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	519
*	Saharpur Jamarpani	India	1.0	Coal	Proposed	524	Extractable Rese	2019	0.002	n/d	https://www.cc	9.6	Jharkhand																																						0	524
*	GAM Coal Mine	Indonesia	1.3	Coal	Proposed	539	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	539
	Wucaiwan No.1 Surfa	China	1.4	Coal	Operating	765	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7				7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	224	541
	Guojiao Coal Mine	China	2.0	Coal	Operating	831	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				9				9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	288	543
*	Benhardih	India	1.1	Coal	Proposed	553	Extractable Rese	2019	0.002	n/d	https://www.cc	9.8	Jharkhand		0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	553
	Ensham Coal Mine	Australia	1.9	Coal	Operating	724	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5.3				5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	169.6	554
*	Mengcun Coal Mine	China	1.4	Coal	Proposed	558	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	558
	Dongzhouyao Coal M	China	2.2	Coal	Operating	882	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	562
*	Sanjiao No.1 Coal Mi	China	1.4	Coal	Proposed	567	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	567
*	Phulbari Coal Mine	Bangladesh	1.4	Coal	Proposed	572	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	572
*	Taohe Coal Mine	China	1.4	Coal	Proposed	579	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	579
	Gaojialiang No.1 Coal	China	2.0	Coal	Operating	825	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7.5				7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	240	585
*	New Largo Coal Mine	South Africa	1.4	Coal	Proposed	585	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	585
	Cumberland Coal Min	United States	1.9	Coal	Operating	776	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5.9				5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	188.8	587
	Qingshuiying Coal Mi	China	1.9	Coal	Operating	749	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	160	589
	Lakhanpur Coal Mine	India	1.5	Coal	Operating	1263	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				21				21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	672	591
	Huangyuchuan Coal	China	2.3	Coal	Operating	926	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	606
*	Yadian Coal Mine	China	1.5	Coal	Proposed	611	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	611
	Haerwusu Surface Mi	China	2.1	Coal	Operating	1731	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				35				35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	1120	611
	Hongqinghliang Coal	China	2.0	Coal	Operating	810	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	618
*	Usinsk-1 Coal Mine	Russian Federat	1.7	Coal	Proposed	621	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	621
*	Pervomaisky Coal Mir	Russian Federat	1.5	Coal	Proposed	629	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	629
	Elegest Coal Mine	Russian Federat	2.3	Coal	Operating	855	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				7				7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	224	631
*	Hutton Coal Mine	Australia	1.7	Coal	Proposed	632	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	632
	Sandaogou Coal Mine	China	2.3	Coal	Operating	927	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				9				9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	288	639
*	Inaglinskaya-2 Mine	Russian Federat	1.3	Coal	Proposed	648	Recoverable	2020	0.002	Bituminous (Met	https://www.kolmar.ru/en/activit		South Yakutia																																						0	648
*	Qiyuan Coal Mine	China	1.7	Coal	Proposed	653	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	653
*	Gare Pelma Sector II	India	1.3	Coal	Proposed	655	Extractable Rese	2019	0.002	n/d	https://www.cc	9.8	Chhattisgarh		0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	655
*	Mandakini B	India	1.3	Coal	Proposed	657	Extractable Reserves		0.002	n/d	http://environmentclearance.nic.in/writereaddata/Online/TOR/22_Feb_2019_1900473301BRPYEHTPre-feasibil																																								0	657
*	San Juan Coal Mine	Colombia	1.6	Coal	Proposed	672	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	672
	Baiyinhua No.3 Surfa	China	1.6	Coal	Operating	1314	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				20				20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	640	674
*	Nalin River No.2 Coal	China	1.7	Coal	Proposed	686	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	686
*	Paardekop Coal Mine	South Africa	1.7	Coal	Proposed	695	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	695
*	Wilton and Fairhill Coa	Australia	1.9	Coal	Proposed	700	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	700
*	Mudtuchadeng Coal N	China	1.7	Coal	Proposed	705	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	705
	Pereyaslovskiy Coal I	Russian Federat	1.6	Coal	Operating	900	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	708
	Raspadskaya Coal M	Russian Federat	2.4	Coal	Operating	906	Proven and Prob	2020	0.00266772	Bituminous (Met	https://ar2020.evraz.com/en/additional-information/data-on-mine				5.5				5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	176	730
	Listvyanskaya Coal M	Russian Federat	2.4	Coal	Operating	895	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5				5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	160	735
*	Sugodinsk-Ogodzhins	Russian Federat	1.8	Coal	Proposed	744	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	744
*	Balaram Coal Mine	India	1.4	Coal	Proposed	756	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	756
*	Valeria Coal Mine	Australia	2.0	Coal	Proposed	762	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	762
*	Boli Coal Mine	China	2.0	Coal	Proposed	770	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	770
	Yili No.4 Coal Mine	China	2.6	Coal	Operating	968	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	776
*	Gething Coal Mine	Canada	2.1	Coal	Proposed	780	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	780
	Loy Yang Coal Mine	Australia	3.1	Coal	Operating	1680	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				28				28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	896	784
	Hongliulin Coal Mine	China	3.1	Coal	Operating	1266	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15				15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	480	786
*	Zhaoshipan Coal Mine	China	1.9	Coal	Proposed	792	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	792
*	Xiaobaodang No.2 Co	China	1.9	Coal	Proposed	792	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	792
*	Banku	India	1.6	Coal	Proposed	800	Geological Rese	2017	0.002	n/d	http://www.cc	9.7	Orissa																																						0	800
*	Ulug-Khem Project	Russian Federat	2.2	Coal	Proposed	807	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	807
	MC #1 Coal Mine	United States	2.9	Coal	Operating	1179	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				11.5				11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	368	811
	Pingshuo East Coal N	China	2.6	Coal	Operating	1459	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				20				20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	640	819
	Wangjialing Coal Mine	China	2.7	Coal	Operating	1021	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	829
	Yushuwan Coal Mine	China	2.6	Coal	Operating	1158	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	838
*	Pangpangta Coal Mine	China	2.2	Coal	Proposed	894	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	894
*	Jinjitan Coal Mine	China	2.2	Coal	Proposed	898	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	898
*	Pakar North Coal Min	Indonesia	1.1	Coal	Proposed	911	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	911
*	Inner Mongolia Erlintu	China	2.2	Coal	Proposed	913	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	913
*	Kerandari BC	India	1.8	Coal	Proposed	917	Geological Rese	2019	0.002	n/d	http://www.cc	9.7	Jharkhand		0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	917
	West Macedonia Lign	Greece	2.2	Coal	Operating	1800	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				27.2				27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	27.2	870.4	930
	Ningxia Hongliu Coal	China	2.9	Coal	Operating	1188	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8				8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	256	932
*	Xinzhuang Coal Mine	China	2.3	Coal	Proposed	942	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	942
	Majialiang Coal Mine	China	3.2	Coal	Operating	1299	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10				10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	979
	El Descanso Coal Mir	Colombia	4.1	Coal	Operating	1700	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				22.5				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	720	980
	Yimin Surface Coal M	China	2.4	Coal	Operating	1710	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				22				22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	704	988
*	Shitoumei No.1 Coal	China	2.4	Coal	Proposed	990	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	990
*	Boikarabelo Coal Min	South Africa	2.4	Coal	Proposed	995	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	995
*	Wards Well Coal Mine	Australia	2.7	Coal	Proposed	1000	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
*	Galilee Coal Mine	Australia	1.6	Coal	Proposed	1000	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
	Jinjie Coal Mine	China	3.9	Coal	Operating	1578	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18				18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	576	1002
	Saebyol Coal Mining I	North Korea	3.2	Coal	Operating	1230	Recoverable		0.00262461	Anthracite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				6				6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	192	1038

New	Project Name	Country	Potent	Fuel	Status	Reserves (Million tons)	Reserve catego	Year	Emissions f	Coal type	Source	Page Number	Region/State/Pr	Coal Basin	Production	Year	Source	Comments
	Meihuajing Coal Mine	China	3.5	Coal	Operating	1433	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				12			
*	Greater Soutpansberg	South Africa	2.8	Coal	Proposed	1051	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Ningtiaota Coal Mine	China	4.0	Coal	Operating	1645	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				18			
	Xiaobaodang No.1 Cc	China	3.8	Coal	Operating	1550	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15			
	Menkeqing Coal Mine	China	3.7	Coal	Operating	1510	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				12			
*	Carmichael Coal Proj	Australia	2.1	Coal	Proposed	1160	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Dalaihushuo Coal Min	China	2.9	Coal	Proposed	1178	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Guojiatan Coal Mine	China	2.2	Coal	Proposed	1190	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Project Motheo	Botswana	2.2	Coal	Proposed	1200	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Maritsa Coal Mines	Bulgaria	2.5	Coal	Operating	2096	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				28			
*	Taran Gaole Coal Min	China	2.9	Coal	Proposed	1200	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Chirodzi Coal Mine	Mozambique	2.9	Coal	Proposed	1200	Resource		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Hulusu Coal Mine	China	4.0	Coal	Operating	1624	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				13			
	Buertai Coal Mine	China	4.5	Coal	Operating	1850	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				20			
*	Hetaoyu Coal Mine	China	3.0	Coal	Proposed	1230	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Integrated Belpahar, L	India	1.5	Coal	Proposed	1262	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Stepnoy Coal Mine	Russian Federat	3.6	Coal	Operating	1458	Resource		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				5			
*	Beisky-Zapadniy Coal	Russian Federat	2.4	Coal	Proposed	1340	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Shengli No.1 Open-Pi	China	1.6	Coal	Proposed	1342	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker (Versic				0	2019		
*	Wucaiwan No.1 Coal	China	3.3	Coal	Proposed	1367	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Shaanxi Caojiatan Co	China	3.3	Coal	Proposed	1367	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Kolubara Mine Compl	Serbia	2.5	Coal	Operating	2100	Recoverable	2000	0.0012019	Lignite	https://www.s	122			22.683	1999		
*	Qinghua No.7 Coal M	China	3.4	Coal	Proposed	1383	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Alpha North Coal Min	Australia	2.5	Coal	Proposed	1400	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Chahasu Coal Mine	China	4.2	Coal	Operating	1724	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
*	Chagannur No.1 Coal	China	1.7	Coal	Proposed	1445	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Zhundong Surface Mi	China	3.5	Coal	Proposed	1447	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Thar Coal Mine	Pakistan	1.9	Coal	Operating	1570	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				3.8			
*	Dananhu No. 7 Coal M	China	3.6	Coal	Proposed	1488	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Dananhu West No.2 C	China	2.7	Coal	Proposed	1513	Resource		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Madaotou Coal Mine	China	1.8	Coal	Proposed	1527	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Yingpanhao Coal Min	China	3.8	Coal	Proposed	1541	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Siarmal Coal Mine	India	1.9	Coal	Proposed	1548	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Xiaojihan Coal Mine	China	4.6	Coal	Operating	1894	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
*	Shilawusu Coal Mine	China	3.9	Coal	Proposed	1591	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Grootegeluk Coal Min	South Africa	6.9	Coal	Operating	2576	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				29.7			
*	Elga Coal Mine	Russian Federat	4.5	Coal	Proposed	1698	Resource	2012	0.00266772	Bituminous (Met	https://www.s	98	Sakha Republic	Elginskoye coal f	0	2019		
*	Zambezi Coal Mine	Mozambique	4.1	Coal	Proposed	1700	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Red Hill Coal Project	Australia	4.6	Coal	Proposed	1711	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Xinwen Ili No.1 Coal M	China	4.5	Coal	Proposed	1839	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Hongqinghe Coal Min	China	5.7	Coal	Operating	2338	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15			
	Bogatyr Coal Mine	Kazakhstan	7.3	Coal	Operating	3000	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				32			
*	Angren Coal Mine	Uzbekistan	2.4	Coal	Proposed	2000	Resource		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Baijia Haizi Coal Mine	China	5.0	Coal	Proposed	2033	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	PTBA Coal Mines	Indonesia	8.9	Coal	Operating	3334	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				27.3			
	Dananhu No.1 Coal M	China	7.2	Coal	Operating	2936	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
*	Balasu Coal Mine	China	6.4	Coal	Proposed	2623	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Rajmahal Coal Mine	India	5.8	Coal	Operating	3211	Recoverable		0.00181629	Subbituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				17.4			
	Tashan Coal Mine	China	9.0	Coal	Operating	3375	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				15			
	Afşin-Elbistan Coal M	Turkey	4.1	Coal	Operating	3400	Resource		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				14			
*	Murray River Coal Mir	Canada	8.5	Coal	Proposed	3180	Recoverable		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Jiangjun Gebi No.2 C	China	7.8	Coal	Proposed	3212	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
*	Dahaize Coal Mine	China	8.0	Coal	Proposed	3275	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Hongshaquan No.1 C	China	9.0	Coal	Operating	3676	Recoverable		0.00244068	Bituminous	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				8			
	Shengli East No.2 Co	China	4.6	Coal	Operating	3822	Recoverable		0.0012019	Lignite	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				10			
*	Tavan Tolgoi Coal Min	Mongolia	16.0	Coal	Proposed	6009	Resource		0.00266772	Bituminous (Met	Global Energy Monitor. (2021). Global Coal Mine Tracker [Data s				0	2019		
	Total		**536.2**		230	**242,752**									**2005**			
	Total Operating		**311.0**		137													
	Total Proposed		**225.2**		93													

Project Name	Production 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	Combined Production (2	Remaining Res
Meihuajing Coal Mine	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	384	1049
Greater Soutpansberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1051
Ningtiaota Coal Mine	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	576	1069
Xiaobaodang No.1 Cc	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	480	1070
Menkeqing Coal Mine	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	384	1126
Carmichael Coal Proj	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1160
Dalaihushuo Coal Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1178
Guojiatan Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1190
Project Motheo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1200
Maritsa Coal Mines	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	28	896	1200
Taran Gaole Coal Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1200
Chirodzi Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1200
Hulusu Coal Mine	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	416	1208
Buertai Coal Mine	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	640	1210
Hetaoyu Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1230
Integrated Belpahar, L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1262
Stepnoy Coal Mine	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	160	1298
Beisky-Zapadniy Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1340
Shengli No.1 Open-Pi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1342
Wucaiwan No.1 Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1367
Shaanxi Caojiatan Co	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1367
Kolubara Mine Compl	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	22.683	725.856	1374
Qinghua No.7 Coal M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1383
Alpha North Coal Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1400
Chahasu Coal Mine	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	1404
Chagannur No.1 Coal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1445
Zhundong Surface Mi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1447
Thar Coal Mine	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	121.6	1448
Dananhu No. 7 Coal M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1488
Dananhu West No.2 C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1513
Madaotou Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1527
Yingpanhao Coal Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1541
Siarmal Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1548
Xiaojihan Coal Mine	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	1574
Shilawusu Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1591
Grootegeluk Coal Min	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	950.4	1626
Elga Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1698
Zambezi Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1700
Red Hill Coal Project	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1711
Xinwen Ili No.1 Coal M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1839
Hongqinghe Coal Min	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	480	1858
Bogatyr Coal Mine	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	1024	1976
Angren Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000
Baijia Haizi Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2033
PTBA Coal Mines	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	873.6	2460
Dananhu No.1 Coal M	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	2616
Balasu Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2623
Rajmahal Coal Mine	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	556.8	2654
Tashan Coal Mine	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	480	2895
Afşin-Elbistan Coal M	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	448	2952
Murray River Coal Mir	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3180
Jiangjun Gebi No.2 C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3212
Dahaize Coal Mine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3275
Hongshaquan No.1 C	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	256	3420
Shengli East No.2 Co	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	320	3502
Tavan Tolgoi Coal Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6009
Total	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	2,005	64,167	178,585

Harvest Mode Scenarios

						Production Share (%)
Carbon Bombs Scenario	**128.3**	**64,167**	**2019-**	2	covering carbon	24.7
IEA Strict Scenario	**133.6**	**66,792**	**2019-**	2	covering all glob	100
IEA Soft Scenario	**238.7**	**119,335**	**2019-**	2	covering all glob	100

IEA Harvest Mode Scenarios

World Coal Production

Year	**Mtce**	**Descri**	**Source**
2018	5566	Total	WEO 2019, Table 5.1
2040	650	Existin	WEO 2019, Table 5.13
2040	3100	Brownf	WEO 2019, Table 5.13

	Strict Scenario				**Soft Scenario**			
Year	**Output in Mtce**	**2018 C**	**Stead**	**Annual reduction (Mtce)**	**Output in Mtce**	**2018 (**	**Steady Decl**	**Annual reduction (Mtce)**
2018	5566				5566			
2019	5343	5566	0	223	5455	5566	0	111
2020	5121	5566	0	223	5343	5566	0	111
2021	4898	5566	0	223	5232	5566	0	111
2022	4675	5566	0	223	5121	5566	0	111
2023	4453	5566	0	223	5009	5566	0	111
2024	4230	5566	0	223	4898	5566	0	111
2025	4008	5566	0	223	4787	5566	0	111
2026	3785	5566	0	223	4675	5566	0	111
2027	3562	5566	0	223	4564	5566	0	111
2028	3340	5566	0	223	4453	5566	0	111
2029	3117	5566	0	223	4341	5566	0	111
2030	2894	5566	0	223	4230	5566	0	111
2031	2672	5566	0	223	4119	5566	0	111
2032	2449	5566	0	223	4008	5566	0	111
2033	2226	5566	0	223	3896	5566	0	111
2034	2004	5566	0	223	3785	5566	0	111
2035	1781	5566	0	223	3674	5566	0	111
2036	1558	5566	0	223	3562	5566	0	111
2037	1336	5566	0	223	3451	5566	0	111
2038	1113	5566	0	223	3340	5566	0	111
2039	891	5566	0	223	3228	5566	0	111
2040	668	5566	0	223	3117	5566	0	111
2041	445	5566	0	223	3006	5566	0	111
2042	223	5566	0	223	2894	5566	0	111
2043	0	5566	0	223	2783	5566	0	111
2044					2672	5566	0	111
2045					2560	5566	0	111
2046					2449	5566	0	111
2047					2338	5566	0	111
2048					2226	5566	0	111
2049					2115	5566	0	111
2050					2004	5566	0	111
Combined Productio	**66,792**				**119,335**			

Harvest Mode	Emissions 2019-2050 (Gt CO2)	
Oil&Gas	112.7	
Coal	128.3	
Total	**241.1**	

Fuel	Amount	Unit	Source
Oil & Gas			
Gas	46.8	tCO2/TJ	Production Gap Report, Table B1
	36000	TJ/bcm	https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2020-full-report.pdf
Gas emissions factor	0.0016848	GtCO2/bcm	
Oil	2.6	tCO2/t	Production Gap Report, Table B1
	0.1364	t/bbl	https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2020-full-report.pdf
Oil emissions factor	0.0003546	GtCO2/million bbl	
Natural gas liquids	44.2	TJ/kt	Production Gap Report, Table B2
	64200	kgCO2/TJ	Production Gap Report, Table B2
	2.8	tCO2/t	
	1.9	Sm3/t	https://www.norskpetroleum.no/en/calculator/about-energy-calculator/
	6.2898	bbl/m3	https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2020-full-report.pdf page 64
	0.0837	t/bbl	
Natural gas liquids emissions factor	0.0002374	GtCO2/million bbl	
Coal Emissions Factors			
Anthracite	26.7	TJ/kt	Production Gap Report, Table B2
	98.3	tCO2/TJ	Production Gap Report, Table B2
	0.00262461	GtCO2/million t	
Coking coal	28.2	TJ/kt	Production Gap Report, Table B2
	94.6	tCO2/TJ	Production Gap Report, Table B2
	0.00266772	GtCO2/million t	
Other bituminous coal	25.8	TJ/kt	Production Gap Report, Table B2
	94.6	tCO2/TJ	Production Gap Report, Table B2
	0.00244068	GtCO2/million t	
Sub-bituminous coal	18.9	TJ/kt	Production Gap Report, Table B2
	96.1	tCO2/TJ	Production Gap Report, Table B2
	0.00181629	GtCO2/million t	
Lignite	11.9	TJ/kt	Production Gap Report, Table B2
	101	tCO2/TJ	Production Gap Report, Table B2
	0.0012019	GtCO2/million t	
Coal (general)	2	tCO2/t	Production Gap Report, Table B1
	0.002	GtCO2/million t	
Limits for coal carbon bomb identification			
Reserves (million tons)		GtCO2	
385	anthracite	1.0105	
375	coking	1.0004	
410	bituminous	1.0007	
500	coal (general)	1.0000	
555	sub-bituminous	1.0080	
835	lignite	1.0036	

Fuel	Global production	Carbon bombs production	% Share
Crude Oil	28,076	13,462	47.9
Condensate	2,305	916	39.8
NGL	4,007	2,349	58.6
Refinery Gains	984	0	0.0
Other Liquids	1,091	0	0.0
Gas	24,026	10,596	44.1
Sum Oil & Gas	**60,490**	**27,324**	**45.2**
Source: Rystad, Year: 2019, Unit: mboe			
Coal	**8,135**	**2,005**	**24.7**
Source: BGR 2021, Year: 2019, Unit: mt			

Name	Country	Potential emissions (Gt CO2)	Fuel		Country	# of Carbon Bombs	Potential Emissions	Rank	Country	# of Carbon Bo	Potenti	%	Cumul	Cumulative GtCO2
Tannezuft Shale	Algeria	2.3	Oil&Gas					1	China	141	332.9	28.2	28.2	332.9
Hassi R'Mel (Domestic)	Algeria	2.3	Oil&Gas					2	United States	28	151.1	12.8	40.9	484.0
Hassi Messaoud	Algeria	1.2	Oil&Gas		Algeria	3	5.8	3	Russian Federat	41	117.0	9.9	50.8	601.0
Vaca Muerta Shale	Argentina	5.2	Oil&Gas		Argentina	1	5.2	4	Saudi-Arabia	23.5	107.1	9.1	59.9	708.1
Red Hill Coal Project	Australia	4.6	Coal					5	Australia	23	46.3	3.9	63.8	754.4
Goldwyer Shale	Australia	4.5	Oil&Gas					6	Qatar	13	43.3	3.7	67.5	797.6
Loy Yang Coal Mine	Australia	3.1	Coal					7	Canada	12	39.0	3.3	70.8	836.6
Wards Well Coal Mine	Australia	2.7	Coal					8	Iraq	11	27.6	2.3	73.1	864.3
Alpha North Coal Mine	Australia	2.5	Coal					9	India	18	27.0	2.3	75.4	891.3
Peak Downs Coal Mine	Australia	2.3	Coal					10	Brazil	10	25.9	2.2	77.6	917.2
Goonyella-Riverside Coal Mine	Australia	2.2	Coal					11	Iran	16	23.9	2.0	79.6	941.1
Carmichael Coal Project	Australia	2.1	Coal					12	United Arab Emi	7	23.0	1.9	81.5	964.1
Valeria Coal Mine	Australia	2.0	Coal					13	Indonesia	10	21.9	1.9	83.4	986.0
Gorgon LNG T1-T3	Australia	1.9	Oil&Gas					14	Kazakhstan	7	20.3	1.7	85.1	1006.2
Wilton and Fairhill Coal Projects	Australia	1.9	Coal					15	South Africa	7	18.2	1.5	86.6	1024.4
Byerwen Coal Mine	Australia	1.8	Coal					16	Kuwait	3.5	17.1	1.4	88.1	1041.5
Galilee Coal Mine	Australia	1.8	Coal					17	Mongolia	1	16.0	1.4	89.4	1057.5
Hunter Valley North Coal Mine	Australia	1.7	Coal					18	Turkmenistan	3	13.3	1.1	90.6	1070.7
Hutton Coal Mine	Australia	1.7	Coal					19	Mozambique	6	11.8	1.0	91.6	1082.5
Olive Downs Coal Mine	Australia	1.4	Coal					20	Mexico	4	10.3	0.9	92.4	1092.8
Saraji East Coal Mine	Australia	1.3	Coal					21	Colombia	5	8.8	0.7	93.2	1101.6
Ensham Coal Mine	Australia	1.3	Coal					22	Venezuela	2	7.8	0.7	93.8	1109.4
Hunter Valley South Coal Mine	Australia	1.2	Coal					23	Algeria	3	5.8	0.5	94.3	1115.2
Yallourn	Australia	1.1	Coal					24	Poland	1	5.6	0.5	94.8	1120.9
Mount Pleasant Coal Mine	Australia	1.1	Coal					25	Argentina	1	5.2	0.4	95.2	1126.0
Velkerri Shale	Australia	1.1	Oil&Gas					26	Pakistan	2	4.7	0.4	95.6	1130.8
Blackwater Coal Mine	Australia	1.0	Coal		Australia	23	46.3	27	Turkey	1	4.1	0.3	96.0	1134.9
ACG (Azeri-Chirag-Guneshli Deep W	Azerbaijan	1.7	Oil&Gas		Azerbaijan	1	1.7	28	North Korea	1	3.2	0.3	96.3	1138.1
Central Arabian Offshore	Bahrain	1.4	Oil&Gas		Bahrain	1	1.4	29	Germany	2	3.0	0.3	96.5	1141.1
Phulbari Coal Mine	Bangladesh	1.4	Coal		Bangladesh	1	1.4	30	Norway	2	2.8	0.2	96.8	1144.0
Project Motheo	Botswana	2.2	Coal		Botswana	1	2.2	31	Libya	2	2.7	0.2	97.0	1146.7
Santos Offshore	Brazil	4.3	Oil&Gas					32	Serbia	1	2.5	0.2	97.2	1149.2
Llandovery Shale	Brazil	4.3	Oil&Gas					33	Bulgaria	1	2.5	0.2	97.4	1151.7
Buzios (x-Franco)	Brazil	3.6	Oil&Gas					34	Uzbekistan	1	2.4	0.2	97.6	1154.1
Irati Shale	Brazil	2.7	Oil&Gas					35	Denmark	1	2.2	0.2	97.8	1156.3
Lula (X-Tupi)	Brazil	2.5	Oil&Gas					36	Botswana	1	2.2	0.2	98.0	1158.5
Parnaiba Onshore	Brazil	2.0	Oil&Gas					37	Greece	1	2.2	0.2	98.2	1160.7
Libra	Brazil	1.9	Oil&Gas					38	Guyana	2	2.1	0.2	98.4	1162.8
Candeias Shale	Brazil	1.6	Oil&Gas					39	Ukraine	1	1.7	0.1	98.5	1164.5
Campos Offshore	Brazil	1.6	Oil&Gas					40	Azerbaijan	1	1.7	0.1	98.6	1166.1
Mero (Libra NW)	Brazil	1.3	Oil&Gas		Brazil	10	25.9	41	United Kingdom	1	1.5	0.1	98.8	1167.6
Maritsa Coal Mines	Bulgaria	2.5	Coal		Bulgaria	1	2.5	42	Bahrain	1	1.4	0.1	98.9	1169.0
Montney Play	Canada	13.7	Oil&Gas					43	Bangladesh	1	1.4	0.1	99.0	1170.4
Murray River Coal Mine	Canada	8.5	Coal					44	Syria	1	1.4	0.1	99.1	1171.8
Spirit River (Notikewin, Falher, Wilrich	Canada	3.0	Oil&Gas					45	Israel	1	1.1	0.1	99.2	1172.8
Gething Coal Mine	Canada	2.1	Coal					46	Nigeria	1	1.0	0.1	99.3	1173.9
Horizon Oil Sands Project	Canada	2.0	Oil&Gas					47	Tanzania	1	1.0	0.1	99.4	1174.9
Kearl	Canada	1.9	Oil&Gas					48	Zimbabwe	1	1.0	0.1	99.5	1175.9
Duvernay	Canada	1.9	Oil&Gas							425				
Athabasca Oil Sands Project	Canada	1.4	Oil&Gas											
Christina Lake	Canada	1.2	Oil&Gas											

Name	Country	Potential emissions (Gt CO2)	Fuel		Country	# of Carbon Bombs	Potential Emissions	Rank	Country	# of Carbon Bo	Potenti	%	Cumul	Cumulative GtCO2
Liard Shale	Canada	1.2	Oil&Gas											
Syncrude Mildred Lake/Aurora	Canada	1.2	Oil&Gas											
Fording River	Canada	1.0	Coal		Canada	12	39.0							
Tashan Coal Mine	China	9.0	Coal											
Hongshaquan No.1 Coal Mine	China	9.0	Coal											
Dahaize Coal Mine	China	8.0	Coal											
Jiangjun Gebi No.2 Coal Mine	China	7.8	Coal											
Dananhu No.1 Coal Mine	China	7.2	Coal											
Balasu Coal Mine	China	6.4	Coal											
Hongqinghe Coal Mine	China	5.7	Coal											
Longmaxi Shale	China	5.7	Oil&Gas											
Baijia Haizi Coal Mine	China	5.0	Coal											
Changqing	China	4.9	Oil&Gas											
Xiaojihan Coal Mine	China	4.6	Coal											
Shengli East No.2 Coal Mine	China	4.6	Coal											
Buertai Coal Mine	China	4.5	Coal											
Xinwen Ili No.1 Coal Mine	China	4.5	Coal											
Chahasu Coal Mine	China	4.2	Coal											
Ningtiaota Coal Mine	China	4.0	Coal											
Hulusu Coal Mine	China	4.0	Coal											
Shilawusu Coal Mine	China	3.9	Coal											
Jinjie Coal Mine	China	3.9	Coal											
Xiaobaodang No.1 Coal Mine	China	3.8	Coal											
Yingpanhao Coal Mine	China	3.8	Coal											
Menkeqing Coal Mine	China	3.7	Coal											
Dananhu No. 7 Coal Mine	China	3.6	Coal											
Zhundong Surface Mine	China	3.5	Coal											
Meihuajing Coal Mine	China	3.5	Coal											
Qinghua No.7 Coal Mine	China	3.4	Coal											
Shaanxi Caojiatan Coal Mine	China	3.3	Coal											
Wucaiwan No.1 Coal Mine	China	3.3	Coal											
Majialiang Coal Mine	China	3.2	Coal											
Hongliulin Coal Mine	China	3.1	Coal											
Hetaoyu Coal Mine	China	3.0	Coal											
Taran Gaole Coal Mine	China	2.9	Coal											
Ningxia Hongliu Coal Mine	China	2.9	Coal											
Dalaihushuo Coal Mine	China	2.9	Coal											
Yushuwan Coal Mine	China	2.8	Coal											
Dananhu West No.2 Coal Mine	China	2.7	Coal											
Wangjialing Coal Mine	China	2.7	Coal											
Shenhua Heidaigou Surface Coal Mir	China	2.7	Coal											
Pingshuo East Coal Mine	China	2.6	Coal											
Daqing	China	2.6	Oil&Gas											
Yili No.4 Coal Mine	China	2.6	Coal											
Shitoumei No.1 Coal Mine	China	2.4	Coal											
Cambrian/Silurian Marine Shale	China	2.4	Oil&Gas											
Xinzhuang Coal Mine	China	2.3	Coal											
Sandaogou Coal Mine	China	2.3	Coal											
Huangyuchuan Coal Mine	China	2.3	Coal											
Inner Mongolia Erlintu Coal Mine	China	2.2	Coal											
Shenhua Bulianta Coal Mine	China	2.2	Coal											

Name	Country	Potential emissions (Gt CO2)	Fuel		Country	# of Carbon Bombs	Potential Emissions	Rank	Country	# of Carbon Bo	Potenti	%	Cumul	Cumulative GtCO2
Longmaxi Shale (Sichuan/Changyu)	China	2.2	Oil&Gas											
Zhangji Coal Mine	China	2.2	Coal											
Jinjitan Coal Mine	China	2.2	Coal											
Pangpangta Coal Mine	China	2.2	Coal											
Guojiatan Coal Mine	China	2.2	Coal											
Dongzhouyao Coal Mine	China	2.2	Coal											
Haerwusu Surface Mine	China	2.1	Coal											
Suancigou Coal Mine	China	2.1	Coal											
Yimin Surface Coal Mine	China	2.0	Coal											
Guqiao Coal Mine	China	2.0	Coal											
Boli Coal Mine	China	2.0	Coal											
Gaojialiang No.1 Coal Mine	China	2.0	Coal											
Hongqingliang Coal Mine	China	2.0	Coal											
Tarim (CNPC)	China	2.0	Oil&Gas											
Xiaobaodang No.2 Coal Mine	China	1.9	Coal											
Zhaoshipan Coal Mine	China	1.9	Coal											
Longwanggou Coal Mine	China	1.9	Coal											
Guojiawan Coal Mine	China	1.9	Coal											
Gaotouyao Coal Mine	China	1.9	Coal											
Madaotou Coal Mine	China	1.8	Coal											
Qingshuiying Coal Mine	China	1.8	Coal											
Buliangou Coal Mine	China	1.8	Coal											
Shanxi Lu'an Gucheng Coal Mine	China	1.8	Coal											
Shangwan Coal Mine	China	1.8	Coal											
Hanglaiwan Coal Mine	China	1.8	Coal											
Xiaojiawa Coal Mine	China	1.8	Coal											
Southeast Uplift Onshore Heilongjian	China	1.8	Oil&Gas											
Chagannur No.1 Coal Mine	China	1.7	Coal											
Muduchaideng Coal Mine	China	1.7	Coal											
Qiyuan Coal Mine	China	1.7	Coal											
Weijiamao Open Pit Mine	China	1.7	Coal											
Nalin River No.2 Coal Mine	China	1.7	Coal											
Dingji Coal Mine	China	1.7	Coal											
Baode Coal Mine	China	1.7	Coal											
Wangjiata Coal Mine	China	1.6	Coal											
Wudong Coal Mine	China	1.6	Coal											
Shengli No.1 Open-Pit Coal Mine	China	1.6	Coal											
Baiyinhua No.3 Surface Mine	China	1.6	Coal											
Tongxin Coal Mine	China	1.6	Coal											
Shenhua Baorixile Surface Coal Mine	China	1.6	Coal											
Sijiazhuang Coal Mine	China	1.6	Coal											
Gaohe Coal Mine	China	1.5	Coal											
Xiwan Surface Coal Mine	China	1.5	Coal											
Liuzhuang Coal Mine	China	1.5	Coal											
Shengli	China	1.5	Oil&Gas											
Yadian Coal Mine	China	1.5	Coal											
Lijiahao Coal Mine	China	1.5	Coal											
Shicaocun Coal Mine	China	1.5	Coal											
Shangyuquan Coal Mine	China	1.4	Coal											
Qingchunta Coal Mine	China	1.4	Coal											
Taohe Coal Mine	China	1.4	Coal											

Name	Country	Potential emissions (Gt CO2)	Fuel		Country	# of Carbon Bombs	Potential Emissions	Rank	Country	# of Carbon Bo	Potenti	%	Cumul	Cumulative GtCO2
Xiaozhuang Coal Mine	China	1.4	Coal											
Wucaiwan No.1 Surface Mine	China	1.4	Coal											
Shaqu No.1 Coal Mine	China	1.4	Coal											
Oil shale China	China	1.4	Oil&Gas											
Sanjiao No.1 Coal Mine	China	1.4	Coal											
Zhong Yu Coal Mine	China	1.4	Coal											
Mengcun Coal Mine	China	1.4	Coal											
Huangling No.2 Coal Mine	China	1.4	Coal											
Dafosi Coal Mine	China	1.4	Coal											
Xinjiang (CNPC)	China	1.4	Oil&Gas											
Zhangjiamao Coal Mine	China	1.3	Coal											
Talahao Coal Mine	China	1.3	Coal											
Baishihu Surface Mine	China	1.3	Coal											
Halagou Coal Mine	China	1.3	Coal											
Wenjiazhuang Coal Mine	China	1.3	Coal											
Yuwang No.1 Coal Mine	China	1.3	Coal											
Baiyanghe Coal Mine	China	1.2	Coal											
Yangquan No.1 Coal Mine	China	1.2	Coal											
Daliuta Coal Mine	China	1.2	Coal											
Xinjiang Hongshan Coal Mine	China	1.2	Coal											
Antaibao Surface Mine	China	1.2	Coal											
Shahaiji No.1 Coal Mine	China	1.2	Coal											
Shigetai Coal Mine	China	1.2	Coal											
Fengjiata Coal Mine	China	1.2	Coal											
Gaojiabao Coal Mine	China	1.1	Coal											
Shajihai No.2 Coal Mine	China	1.1	Coal											
Talike District No. 2 Coal Mine	China	1.1	Coal											
Huojitu Well Of Daliuta Coal Mine	China	1.1	Coal											
Changcheng No.3 Coal Mine	China	1.1	Coal											
Yangjiacun Coal Mine	China	1.1	Coal											
Yangchangwan No.1 Well Coal Mine	China	1.1	Coal											
Wangwa Coal Mine	China	1.1	Coal											
Ba Leng Coal Mine	China	1.1	Coal											
Zaoquan Coal Mine	China	1.1	Coal											
Anjialing Open-Pit Mine	China	1.0	Coal											
Central Uplift Onshore Xinjiang Uygu	China	1.0	Oil&Gas											
Longwan Coal Mine	China	1.0	Coal											
Shanxi Dongda Coal Mine	China	1.0	Coal											
Kouzi East Coal Mine	China	1.0	Coal											
Hongshuliang Coal Mine	China	1.0	Coal											
West Well of Faer Second Coal Mine	China	1.0	Coal											
Sihe Coal Mine	China	1.0	Coal		China	143	332.9							
El Descanso Coal Mine	Colombia	4.1	Coal											
Cerrejón Coal Mine	Colombia	2.4	Coal											
San Juan Coal Mine	Colombia	1.6	Coal											
La Luna Shale	Colombia	1.6	Oil&Gas											
Pribbenow Coal Mine	Colombia	1.4	Coal		Colombia	5	11.2							
Kronprins Christian Offshore	Denmark	2.2	Oil&Gas		Denmark	1	2.2							
Hambach Coal Mine	Germany	1.7	Coal											
Garzweiler Coal Mine	Germany	1.3	Coal		Germany	2	3.0							
West Macedonia Lignite Centre (WMI	Greece	2.2	Coal		Greece	1	2.2							

Name	Country	Potential emissions (Gt CO2)	Fuel		Country	# of Carbon Bombs	Potential Emissions	Rank	Country	# of Carbon Bo	Potenti	%	Cumul	Cumulative GtCO2
Greater Turbot (Stabroek)	Guyana	1.1	Oil&Gas											
Greater Liza (Liza)	Guyana	1.0	Oil&Gas		Guyana	2	2.1							
Rajmahal Coal Mine	India	5.8	Coal											
Gevra Coal Mine	India	2.4	Coal											
Barail Shale	India	2.1	Oil&Gas											
Siarmal Coal Mine	India	1.9	Coal											
Kerandari BC	India	1.8	Coal											
Bankui	India	1.6	Coal											
Talaipalli Coal Mine	India	1.5	Coal											
Lakhanpur Coal Mine	India	1.5	Coal											
Integrated Belpahar, Lakhanpur, Lilar	India	1.5	Coal											
Balaram Coal Mine	India	1.4	Coal											
Gare Pelma Sector II	India	1.3	Coal											
Mandakini B	India	1.3	Coal											
Kaniha Coal Mine	India	1.2	Coal											
Dipka Coal Mine	India	1.2	Coal											
Kusmunda Coal Mine	India	1.2	Coal											
Banhardih	India	1.1	Coal											
Saharpur Jamarpani	India	1.0	Coal											
Moher Amlohri Coal Mine	India	1.0	Coal		India	18	31.0							
PTBA Coal Mines	Indonesia	8.9	Coal											
KPC Operation Coal Mine	Indonesia	3.1	Coal											
East Natuna (x-Natuna D-Alpha)	Indonesia	2.2	Oil&Gas											
GAM Coal Mine	Indonesia	1.3	Coal											
Indexim Coalindo Coal Mine	Indonesia	1.1	Coal											
Pakar North Coal Mine	Indonesia	1.1	Coal											
Tutupan Coal Mine	Indonesia	1.1	Coal											
MHU Coal Mine	Indonesia	1.1	Coal											
BIB Coal Mine	Indonesia	1.1	Coal											
Pasir Coal Mine	Indonesia	1.0	Coal		Indonesia	10	21.9							
Marun	Iran	2.4	Oil&Gas											
Azadegan	Iran	2.3	Oil&Gas											
Ahwaz Asmari	Iran	2.2	Oil&Gas											
Central Arabian Offshore	Iran	2.1	Oil&Gas											
Gachsaran	Iran	1.7	Oil&Gas											
Agha Jari	Iran	1.6	Oil&Gas											
Ahwaz Bangestan	Iran	1.4	Oil&Gas											
Pazanan	Iran	1.4	Oil&Gas											
South Pars (Phases 9-10) dry gas	Iran	1.3	Oil&Gas											
Kish Gas Project	Iran	1.2	Oil&Gas											
Pars Southwest	Iran	1.1	Oil&Gas											
South Pars (Phases 4-5) dry gas	Iran	1.1	Oil&Gas											
Mansouri Bangestan	Iran	1.0	Oil&Gas											
South Pars (Phases 22-24)	Iran	1.0	Oil&Gas											
South Pars (Phases 20-21)	Iran	1.0	Oil&Gas											
South Pars (Phases 2-3) dry gas	Iran	1.0	Oil&Gas		Iran	16	23.9							
Rumaila North & South	Iraq	7.8	Oil&Gas											
Qurna West	Iraq	4.0	Oil&Gas											
Baghdad East	Iraq	2.7	Oil&Gas											
Central Arabian Onshore	Iraq	2.6	Oil&Gas											
Majnoon	Iraq	2.5	Oil&Gas											

Name	Country	Potential emissions (Gt CO2)	Fuel		Country	# of Carbon Bombs	Potential Emissions	Rank	Country	# of Carbon Bo	Potenti	%	Cumul	Cumulative GtCO2
Zubair	Iraq	1.7	Oil&Gas											
Qurna West-2	Iraq	1.6	Oil&Gas											
Halfayah	Iraq	1.4	Oil&Gas											
Nahr bin Umar	Iraq	1.3	Oil&Gas											
Ratawi	Iraq	1.1	Oil&Gas											
Basrah Gas project	Iraq	1.0	Oil&Gas		Iraq	11	27.6							
Leviathan	Israel	1.1	Oil&Gas		Israel	1	1.1							
Bogatyr Coal Mine	Kazakhstan	7.3	Coal											
Kashagan	Kazakhstan	5.1	Oil&Gas											
Tengiz	Kazakhstan	3.4	Oil&Gas											
Carboniferous Shale	Kazakhstan	1.3	Oil&Gas											
Karachaganak	Kazakhstan	1.2	Oil&Gas											
Borly Coal Mines	Kazakhstan	1.0	Coal											
Shubarkol Coal Mine	Kazakhstan	1.0	Coal		Kazakhstan	7	20.3							
Greater Burgan	Kuwait	8.3	Oil&Gas											
Project Kuwait	Kuwait	4.4	Oil&Gas											
Central Arabian Onshore	Kuwait	3.6	Oil&Gas											
Khafji	Kuwait-Saudi-Ar	1.4	Oil&Gas		Kuwait	3.5	17.1							
Sirte Shale	Libya	1.7	Oil&Gas											
El Sharara	Libya	1.0	Oil&Gas		Libya	2	2.7							
Eagle Ford Shale	Mexico	5.1	Oil&Gas											
Gulf Deepwater Offshore	Mexico	2.2	Oil&Gas											
Ku-Maloob-Zaap Project	Mexico	2.0	Oil&Gas											
Yucatan Platform Offshore	Mexico	1.0	Oil&Gas		Mexico	4	10.3							
Tavan Tolgoi Coal Mine	Mongolia	16.0	Coal		Mongolia	1	16.0							
Zambezi Coal Mine	Mozambique	4.1	Coal											
Chirodzi Coal Mine	Mozambique	2.9	Coal											
Revuboe Coal Mine	Mozambique	1.4	Coal											
MZLNG Joint Development (T1-T2)	Mozambique	1.3	Oil&Gas											
Area-1 Future Phases	Mozambique	1.0	Oil&Gas											
Area 1 LNG (T1&T2)	Mozambique	1.0	Oil&Gas		Mozambique	6	11.8							
NLNG Base Project	Nigeria	1.0	Oil&Gas		Nigeria	1	1.0							
Saebyol Coal Mining Complex	North Korea	3.2	Coal		North Korea	1	3.2							
Troll	Norway	1.8	Oil&Gas											
Johan Sverdrup	Norway	1.1	Oil&Gas		Norway	2	2.8							
Sembar Shale	Pakistan	2.8	Oil&Gas											
Thar Coal Mine	Pakistan	1.9	Coal		Pakistan	2	4.7							
Lublin Basin Silurian Shale	Poland	5.6	Oil&Gas		Poland	1	5.6							
North Field	Qatar	11.6	Oil&Gas											
North Field C LNG	Qatar	7.8	Oil&Gas											
North Field E	Qatar	4.6	Oil&Gas											
QatarGas LNG T8-T11 (NFE-East)	Qatar	3.4	Oil&Gas											
Barzan	Qatar	3.1	Oil&Gas											
Central Arabian Onshore	Qatar	2.2	Oil&Gas											
Qatargas 2 LNG T4-T5	Qatar	1.8	Oil&Gas											
QatarGas LNG T12-T13 (NFE-South	Qatar	1.8	Oil&Gas											
Dolphin	Qatar	1.6	Oil&Gas											
Rasgas 2 LNG T3-T5	Qatar	1.5	Oil&Gas											
Rasgas 3 LNG T6-T7	Qatar	1.5	Oil&Gas											
QatarGas 1 LNG T1-T3	Qatar	1.3	Oil&Gas											
Al Khaleej Gas project	Qatar	1.1	Oil&Gas		Qatar	13	43.3							

Name	Country	Potential emissions (Gt CO2)	Fuel		Country	# of Carbon Bombs	Potential Emissions	Rank	Country	# of Carbon Bo	Potenti	%	Cumul	Cumulative GtCO2
Bovanenkovo Zone (Yamal Megaproj	Russian Federat	11.2	Oil&Gas											
Gazprom dobycha Yamburg	Russian Federat	8.9	Oil&Gas											
Tunguska Basin CBM	Russian Federat	8.8	Oil&Gas											
Shtokman	Russian Federat	6.1	Oil&Gas											
Urengoyskoye	Russian Federat	5.2	Oil&Gas											
Kuznetsk Depression (Kuzbass) CBM	Russian Federat	4.9	Oil&Gas											
Elga Coal Mine	Russian Federat	4.5	Coal											
Yuganskneftegaz	Russian Federat	4.3	Oil&Gas											
Eastern Gas Program	Russian Federat	4.3	Oil&Gas											
Stepnoy Coal Mine	Russian Federat	3.6	Coal											
West Siberia Offshore	Russian Federat	2.9	Oil&Gas											
Lensky Basin CBM	Russian Federat	2.7	Oil&Gas											
Timan - Pechora Basin Offshore	Russian Federat	2.5	Oil&Gas											
Tambey Zone (Yamal Megaproject)	Russian Federat	2.5	Oil&Gas											
Beisky-Zapadniy Coal Mine	Russian Federat	2.4	Coal											
Raspadskaya Coal Mine	Russian Federat	2.4	Coal											
Listvianskaya Coal Mine	Russian Federat	2.4	Coal											
Timan - Pechora Basin Onshore	Russian Federat	2.4	Oil&Gas											
Elegest Coal Mine	Russian Federat	2.3	Coal											
Taldinsky Coal Mine	Russian Federat	2.2	Coal											
Ulug-Khem Project	Russian Federat	2.2	Coal											
Samotlorneftegaz (TNK-BP)	Russian Federat	1.9	Oil&Gas											
Sugodinsk-Ogodzhinsky Coal Mine	Russian Federat	1.8	Coal											
Leningradskoye (Kara Sea)	Russian Federat	1.8	Oil&Gas											
Arshanovsky Coal Mine	Russian Federat	1.7	Coal											
Usinsk-1 Coal Mine	Russian Federat	1.7	Coal											
Pereyaslovskiy Coal Mine	Russian Federat	1.6	Coal											
Gazprom dobycha Orenburg	Russian Federat	1.6	Oil&Gas											
Pervomaisky Coal Mine	Russian Federat	1.5	Coal											
Arctic LNG 2 T1-3	Russian Federat	1.5	Oil&Gas											
Volga - Urals Onshore	Russian Federat	1.4	Oil&Gas											
Romashkino	Russian Federat	1.3	Oil&Gas											
Rusanovskoye (Kara Sea)	Russian Federat	1.3	Oil&Gas											
Inaglinskaya-2 Mine	Russian Federat	1.3	Coal											
Gazprom dobycha Nadym	Russian Federat	1.3	Oil&Gas											
Taymyr Basin CBM	Russian Federat	1.2	Oil&Gas											
North Kara Sea Offshore	Russian Federat	1.2	Oil&Gas											
West Siberia Onshore	Russian Federat	1.2	Oil&Gas											
SeverEnergia Project	Russian Federat	1.1	Oil&Gas											
Erkovetskiy Coal Mine	Russian Federat	1.0	Coal											
Shurapskaya Coal Mine	Russian Federat	1.0	Coal		Russian Federat	41	117.0							
Ghawar Uthmaniyah	Saudi-Arabia	19.2	Oil&Gas											
Safaniya	Saudi-Arabia	11.9	Oil&Gas											
Khurais project	Saudi-Arabia	7.6	Oil&Gas											
Ghawar Haradh	Saudi-Arabia	7.0	Oil&Gas											
Central Arabian Offshore	Saudi-Arabia	6.9	Oil&Gas											
Ghawar Shedgum	Saudi-Arabia	5.7	Oil&Gas											
Qatif project	Saudi-Arabia	5.1	Oil&Gas											
Manifa (redevelop)	Saudi-Arabia	5.0	Oil&Gas											
Ghawar Hawiyah	Saudi-Arabia	4.6	Oil&Gas											
Central Arabian Onshore	Saudi-Arabia	4.4	Oil&Gas											

Name	Country	Potential emissions (Gt CO2)	Fuel		Country	# of Carbon Bombs	Potential Emissions	Rank	Country	# of Carbon Bo	Potenti	%	Cumul	Cumulative GtCO2
Shaybah	Saudi-Arabia	4.3	Oil&Gas											
Berri	Saudi-Arabia	3.6	Oil&Gas											
Zuluf (CR in field)	Saudi-Arabia	3.5	Oil&Gas											
Zuluf	Saudi-Arabia	2.4	Oil&Gas											
Khursaniyah	Saudi-Arabia	2.4	Oil&Gas											
Ghawar Ain Dar N	Saudi-Arabia	2.1	Oil&Gas											
Marjan	Saudi-Arabia	1.9	Oil&Gas											
Safaniya YTF Concession	Saudi-Arabia	1.8	Oil&Gas											
Zuluf (expansion)	Saudi-Arabia	1.8	Oil&Gas											
Abqaiq	Saudi-Arabia	1.6	Oil&Gas											
Ghawar Ain Dar S	Saudi-Arabia	1.4	Oil&Gas											
Sudair Shale	Saudi-Arabia	1.0	Oil&Gas											
Harmaliyah	Saudi-Arabia	1.0	Oil&Gas		Saudi-Arabia	23.5	107.1							
Kolubara Mine Complex	Serbia	2.5	Coal		Serbia	1	2.5							
Grootegeluk Coal Mine	South Africa	6.9	Coal											
Greater Soutpansberg Coal Project	South Africa	2.8	Coal											
Boikarabelo Coal Mine	South Africa	2.4	Coal											
Collingham Shale	South Africa	1.8	Oil&Gas											
Paardekop Coal Mine	South Africa	1.7	Coal											
New Largo Coal Mine	South Africa	1.4	Coal											
Bernice-Cygnus Coal Mine	South Africa	1.1	Coal		South Africa	7	18.2							
Tanf Shale	Syria	1.4	Oil&Gas		Syria	1	1.4							
Tanzanian Coastal Offshore	Tanzania	1.0	Oil&Gas		Tanzania	1	1.0							
Afşin-Elbistan Coal Mine	Turkey	4.1	Coal		Turkey	1	4.1							
Yolotan (Iolotan) South	Turkmenistan	9.5	Oil&Gas											
Yashlar Vostochnyy (East)	Turkmenistan	2.1	Oil&Gas											
Dovletabad-Donmez	Turkmenistan	1.6	Oil&Gas		Turkmenistan	3	13.3							
Menilite Shale	Ukraine	1.7	Oil&Gas		Ukraine	1	1.7							
Upper Zakum	United Arab Emi	6.4	Oil&Gas											
Bu Hasa	United Arab Emi	4.9	Oil&Gas											
Bab	United Arab Emi	4.2	Oil&Gas											
Lower Zakum	United Arab Emi	2.4	Oil&Gas											
Umm Shaif/Nasr	United Arab Emi	1.9	Oil&Gas											
Bab (Gasco)	United Arab Emi	1.7	Oil&Gas											
Asab	United Arab Emi	1.4	Oil&Gas		United Arab Emi	7	23.0							
Bowland Shale	United Kingdom	1.5	Oil&Gas		United Kingdom	1	1.5							
Permian Delaware Tight	United States	27.8	Oil&Gas											
Marcellus Shale	United States	26.7	Oil&Gas											
Permian Midland Tight	United States	16.6	Oil&Gas											
Haynesville/Bossier Shale	United States	13.2	Oil&Gas											
Utica Shale	United States	7.7	Oil&Gas											
Bakken Shale	United States	5.9	Oil&Gas											
Eagle Ford Shale	United States	5.9	Oil&Gas											
DJ Basin Tight Oil	United States	5.9	Oil&Gas											
Western Gulf Province_Texas	United States	5.1	Oil&Gas											
Woodford Shale	United States	3.4	Oil&Gas											
North Antelope Rochelle Coal Mine	United States	2.9	Coal											
MC #1 Coal Mine	United States	2.9	Coal											
PRB Tight Oil	United States	2.8	Oil&Gas											
Chukchi Sea Offshore	United States	2.5	Oil&Gas											
Meramec Shale	United States	2.4	Oil&Gas											

Name	Country	Potential emissions (Gt CO2)	Fuel		Country	# of Carbon Bombs	Potential Emissions	Rank	Country	# of Carbon Bo	Potenti	%	Cumul	Cumulative GtCO2
Permian Conventional_Texas	United States	2.1	Oil&Gas											
North Slope Onshore	United States	2.0	Oil&Gas											
Cumberland Coal Mine	United States	1.9	Coal											
Anadarko Shelf_Oklahoma	United States	1.8	Oil&Gas											
Baltimore Canyon Offshore	United States	1.6	Oil&Gas											
Austin Chalk Tight	United States	1.4	Oil&Gas											
Barnett Shale	United States	1.4	Oil&Gas											
Black Thunder Coal Mine	United States	1.4	Coal											
Beaufort Sea Offshore	United States	1.3	Oil&Gas											
Hamilton County Mine No.1	United States	1.2	Coal											
Gulf Coast Centre Offshore	United States	1.1	Oil&Gas											
Youngs Creek Coal Mine	United States	1.1	Coal											
West Florida Offshore	United States	1.1	Oil&Gas		United States	28	151.1							
Angren Coal Mine	Uzbekistan	2.4	Coal		Uzbekistan	1	2.4							
Orinoco Joint Ventures	Venezuela	6.7	Oil&Gas											
La Luna Shale	Venezuela	1.1	Oil&Gas		Venezuela	2	7.8							
Sengwe Colliery	Zimbabwe	1.0	Coal		Zimbabwe	1	1.0							
Total		**1182.3**	**425**											
Total Oil&Gas		**646.0**	**195**											
Total Coal		**536.2**	**230**											
Total New Carbon Bombs		**419.0**	**169**											

Appendix 3: Interview guide Mexico case study

ENGLISH:

1. **Introduction**
- Kjell introduction
- Research introduction
- informed consent
- Logistics (recording, time frame)

2. **General questions**
- Person: Name, Job, Job history
- Expertise
- Activities with regards to the question

3. **General panorama of fracking in Mexico**
- The story of fracking in Mexico and the conflict over it so far in their own words.
- Key moments/developments/turning points in policy, economics, discourse/framing, mobilization?
- Key context factors?
- Future outlook?

4. **Activist strategies/choke points**
- Who are the key actors?
- What did opponents do or try to do? (Communications, lawsuits, research, advocacy, community mobilization, etc.?)
- To what degree did it work? What were the results?
- Why did it work or why not?
- Did opponents focus on particular choke points? Which choke points did you focus on?
- Were any choke moments identified that resulted in special efforts?
- How were these choke points or choke moments identified?

5. **Other information**
- Any other relevant things, comments, ideas
- Recommended persons to interview

SPANISH:

Introducción

- Introducción a Kjell
- Introducción a la investigación
- Consentimiento informado
- Logística (grabación, marco de tiempo)

Preguntas generales

- Persona: nombre, trabajo, historial de trabajo
- Expertise
- Actividades con respecto a la pregunta

Panorama general del fracking en México

- La historia del fracking en México y las controversias hasta ahora en sus propias palabras.
- ¿Momentos / desarrollos / puntos de inflexión clave en política, economía, discurso / encuadre, movilización?
- ¿Factores clave del contexto?
- ¿Perspectiva del futuro?

Estrategias de promoventes/opositores

- ¿Quiénes son los actores clave?
- ¿Qué hicieron o intentaron hacer los oponentes? (¿Comunicaciones, juicios, investigación, promoción, movilización comunitaria, etc.?)
- ¿Hasta qué punto funcionó? ¿Cuáles fueron los resultados?
- ¿Por qué funcionó o por qué no?
- ¿Los oponentes se enfocaron en puntos claves particulares?
- ¿Hubo momentos claves que resultaron en esfuerzos especiales?
- ¿Cómo se identificaron estos puntos y momentos?

Otra información

- Cualquier otra cosa, comentario, idea relevante
- Personas recomendadas para entrevistar

Appendix 4 - KING metrics emissions factors

	Amount	Unit	Formula	Source	Comment
Oil reserves					
Oil weight	0.1364	tons per barrel		https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-reviev	
Crude oil energy content	41.868	TJ per ktoe		https://unstats.un.org/unsd/energy/balance/conversion.htm	
Crude oil emissions factor	73300	kg CO2 per TJ		https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf	
Oil reserves CO2 emissions	418,601.288	tCO2 per million barrels	Weight*Energy Content*Emissions Facto	own calculation	
Gas reserves					
Gas energy content	36,000	TJ per bcm		https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-reviev	
Gas emissions factor	56.1	tCO2 per TJ		https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf	
Gas reserves CO2 emissions	2,019,600	t CO2 per bcm	Energy Content*Emissions Factor	own calculation	
Conversion	35.315	Cubic feet per cubic meter		https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-reviev	
Gas reserves CO2 emissions	57,188.164	t CO2 per bcf	Gas Reserves CO2 Emissions/Conversi	own calculation	
Coal reserves					
Coal emissions factor	2.000	ktCO2/kt		SEI et al., 2019, pp.11, Appendix B2, https://productiongap.org/wp-content/uploads/2019/11/Production-Gap-Report-2019-Appe	
Oil pipelines					
Oil reserves CO2 emissions	418,601.288	tCO2 per million barrels		own calculation see "Oil reserves" section above	
Annual emissions	152,789	tCO2 per kbd	Oil Reserves CO2/1000*365		
Monthly emissions	12,732	tCO2 per kbd	Annual emissions/12		
Daily emissions	419	tCO2 per kbd	Oil Reserves CO2/1000		
Gas pipelines					
Gas reserves CO2 emissions	2,019,600	t CO2 per bcm		own calculation see "Gas reserves" section above	
Annual emissions	2,019,600	tCO2 per bcm/year			
Monthly emissions	168,300	tCO2 per bcm/year	Annual emissions/12		
Daily emissions	5,533	tCO2 per bcm/year	Annual emissions/365		
Gas reserves CO2 emissions	57,188.164	t CO2 per bcf		own calculation see "Gas reserves" section above	
Annual emissions	20,874	tCO2 per MMcf/day	Gas Reserves CO2/1000*365		
Monthly emissions	1,739	tCO2 per MMcf/day	Annual emissions/12		
Daily emissions	57	tCO2 per MMcf/day	Gas Reserves CO2/1000		
Coal power plants					
Plant capacity	1	GW			
Annual production	8.76	TWh	Operating hours*capacity		
Heat rate, average coal powe	8,561	btu/KWh		Heat Rate Calculation below	
Conversion	1.05506	TJ per btu		https://unstats.un.org/unsd/energystats/methodology/documents/IRES-web.pdf	
Emissions factor of coal	96.1	tCO2 per TJ		subbitouminous coal https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf	
Annual CO2	7,603,649	tCO2/GW	Annual production*Heat rate*Conversion	own calculation	
Monthly CO2	633,637	tCO2/GW	Annual emissions/12		
Daily CO2	20,832	tCO2/GW	Annual emissions/365		
Hourly CO2	868	tCO2/GWh	Daily emissions/24		
Heat Rate Calculation					
subcritical	8,979	btu/KWh		Global Energy Monitor (2020) Global Coal Plant Tracker. July 2020. availa	58% of global capacity
supercritical	8,124	btu/KWh			26% of global capacity
ultra-supercritical	7,755	btu/KWh			16% of global capacity

Appendix 4 - KING metrics emissions factors

	Amount	Unit	Formula	Source	Comment
Global weighted average hea	8,561	btu/KWh	Subcritical*58%+Supercritical*26%+Ultra	"Plant Combustion Technology (MW)," Global Coal Plant Tracker, July 2020, https://bit.ly/3nVL0lF	
Coal mines					
Coal emissions factor	2.000	ktCO2/kt		SEI et al., 2019, pp.11, Appendix B2, https://productiongap.org/wp-content/uploads/2019/11/Production-Gap-Report-2019-Appe	
Annual emissions	2,000,000	tCO2 per mtpa	Oil Reserves CO2/1000*365		
Monthly emissions	166,667	tCO2 per mtpa	Annual emissions/12		
Daily emissions	5,479	tCO2 per mtpa	Annual emissions/365		
LNG export terminals					
LNG production from gas	0.7692	t LNG per thousand cm		https://www.igu.org/app/uploads-wp/2020/04/2020-World-LNG-Report.pdf	without gas burnt in the liquefaction process
Net gas input	1.3001	thousand cm gas per t	1/LNG Production from Gas	own calculation	without gas burnt in the liquefaction process
Energy use of liquefaction	5.75%	GJ/GJ LNG		https://www.sciencedirect.com/science/article/pii/S1359431119358399#b0	average of the range of energy uses of the typical C3
Gross gas input	1.3748	thousand cm gas per t	Net Gas Input+Energy Use of Liquefactio	own calculation	including gas burnt in the liquefaction process
Gas energy content	36000	TJ per bcm		https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-reviev	
Gas emissions factor	56.1	tCO2 per TJ		https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf	
Direct LNG emissions	2,776,556	tCO2 per million t LNG	Gross Gas Input*Energy Content*Emissi	own calculation	without leakage
Supply chain leakage rate	2.3	%		https://science.sciencemag.org/content/361/6398/186	
Methane CO2 equivalency (G	86	times CO2		https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf	
Supply chain leakage emissic	2,719,364	tCO2e per Mio t LNG p	Gross Gas Input*Leakage Rate*Methane	own calculation	
Total Export LNG emissions	5,495,920	tCO2e per Mio t LNG p	Gas Emissions Intensity+Supply Chain L	own calculation	
per month	457,993	tCO2e per mtpa	Annual emissions/12	own calculation	
per day	15,057	tCO2e per mtpa	Annual emissions/365	own calculation	
LNG import terminals					
Shipping emissions	191,500	tCO2/Mio t LNG		http://lnginitiative.org/wp-content/uploads/2015/10/PACE_Report.pdf, page	average
Total import LNG emissions	5,687,420	tCO2e per Mio t LNG p	Total Export LNG Emissions+Shipping E	own calculation	
per month	473,952	tCO2e per mtpa	Annual emissions/12	own calculation	
per day	15,582	tCO2e per mtpa	Annual emissions/365	own calculation	