THE PROSPECT OF PEAK OIL

Peak oil describes an economic concept in which the world's production of crude oil has reached its maximum potential, and oil production reaches a peak. Conceptually, peak oil represents the point in which the world will be forced to transition away from the era of oil reliance and towards a new, economic mode (Murphy and Hall 2011: 57). The inevitable transition away from crude oil presents several challenges, both economic and environmental, as well as to the human condition and global structures. As crude oil is a finite resource, peak oil is predicted to occur within the next 50 years – if it has not already occurred. The first predicted global peak oil date was 1995, but there has since been proposed a number of new peak oil times, ranging from 2001-2050 (Chapman 2014: 94). Peak oil theory was initially created by geographer and economist Hubbert, who created the 'Hubbert's curve' to predict the occurrence of peak oil across American states. Economists have used the same prediction curve to anticipate peak oil on a global scale (Fusco 2006: 2). Peak oil will have a significant impact on the planet, the economy and human life, as there the dependency on oil has continued to grow over several decades and become rooted in the vast majority of societies. This assumes that oil production and consumptions follow the predicted trajectory, without any major innovation or transformation in the energy market.

This report will outline the concept, calculation and history of peak oil, before analysing the current main contributors to the rapid transition towards peak oil. This is primarily vested corporate and state interests that disincentivise structural transitions. Then, peak oil's impacts will be evaluated. This will be done through recognising the complex nature of vulnerability. The primary emphasis is on the planetary boundaries, the global economic system and lastly the local level human and community impacts of peak oil. Finally, the report looks at two scenarios leading up to and following peak oil: business as usual (BAU) and positive transformations, i.e. ways society can adapt to be less dependent on oil whilst reducing inequality.

STATES AND PRESSURES

Peak oil is calculated based on the production of crude oil. Crude oil can also be referred to as conventional oil, defined as "the high-quality, easily-flowing hydrocarbons that have extensively permeated social and economic life over the last century" (Bridge 2010: 523). This then excludes tare sand, shale oil, oil shales, and refined oils. Peak oil is methodologically distinct from the end of oil scenario, preferred by oil production companies, which is calculated through the ratio of reserves to the production of oil. By using end of oil predictions, the level of oil production is assumed to be stable, and there is no consideration for the decreasing quality of oil found in newer reserves. However, it should be noted, that end of oil is predicted to be reached from around 2050, and the consequences are generally theorised to be the same as those of peak oil (Fusco 2006: 1). Peak oil is reached, when the cost of producing a barrel of oil is higher than the USD price per barrel of oil. This will affect the energy return of investment (EROI) of oil production, making energy more expensive (Murphy and Hall 2011: 64). EROI refers to the balance between the amount of energy produced, divided by the amount of energy one needs to invest to produce energy with an economic surplus. This differs from net energy, which represents a finite amount of energy with a defined unit. Both EROI and net energy will be impacted by peak oil, as energy, will be harder to get hold of.

Peak oil = cost of producing 1Gbo > price of 1Gbo

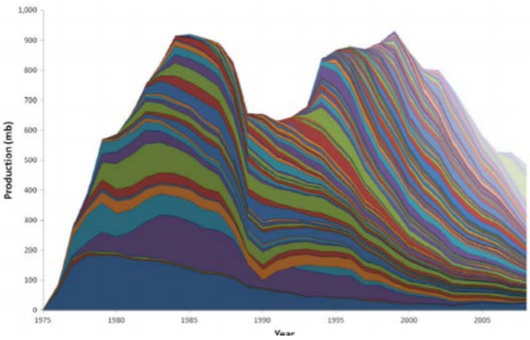
EROI = Gross energy produced / energy invested to get that energy

Net energy: Gross energy produced – energy invested to get that energy

THE HISTORY OF OIL AND THE PROSPECT OF TRANSITION

Oil was discovered in the 1850's and would become an integral part in fuelling the industrial shift across Europe (Fusco 2006: 1). By utilising oil, factories, manufacturing companies and transportation services could effectively produce and distribute goods, which would become an integral part of the rapid economic development in the next 150 years. When Hubbert initially proposed the idea of peak oil, it was centred the US, and when the individual states would face their peaks. He accurately predicted peak oil to occur throughout the 1970's. In turn, the global prediction of peak oil failed to remain accurate (Chapman 2014). The initial predictions started in the early 1990's, but we are in reality reaching peak oil in this or the following decade. This underpins the uncertainty of peak oil's impact however; the trend is continuously pointing towards a world in which oil is unprofitable, as more and more countries reach their peak oil. In the past decades, there has been a continuous shift towards unconventional oils, such as deep-water reserves, oil-sand and fracking (Murphy and Hall 2011: 68). These oils are either more expensive to extract or is of significantly worse quality than traditional oil. Both conditions will decrease the profit margins of oil production. The proponents of peak oil are insistent on the need for radical action by governments across the globe to respond to the peak oil paradigm.

There are, however, several critiques against the theory. Firstly, transition to other energy sources. Secondly, we will find more oil in unexplored areas, such as the arctic. The trajectory for alternative energy sources such as solar is looking unlikely due to the slow developments in battery capacity and longevity (Lewis and Nocera 2006), and there is still a great deal of fear connected to nuclear, due to incidents such as the Three Mile Island meltdown (Perrow 1999; Hopkins 2001), Fukushima (Perrow 2011; Wang et al 2013) etc. Furthermore, the alternative sources for energy are not yet an integrated part of the energy network that exists, meaning that power plants, the electric net and other infrastructures in society would require a significant transformation in order to suffice a transition away from oil and to alternative resources. Although the continuous change of the global peak oil date is pushed back, it is highly unlikely that the second objection will remain true for the foreseeable future. "As crude oil is a finite non-renewable resource, by definition it cannot continue to meet ongoing demand. Of particular interest is the point at which oil production becomes limited by the capacity of extraction technology, causing supply and demand curves to diverge" (Owen, Inderwildi and King 2010: 4743). As Sorrell points out, there has been a significant transformation in the oil industry, away from large oil fields, to smaller but more reserves. This highly impacts the EROI, as the searching, exploring, and determining the quality of new oil reserves is a highly cost-intensive process. Not to mention the establishment of new platforms etc., which take years to build. There must be a threshold level of high quality crude oil for new establishments to be profitable.



"Fig: Oil production in the UKCS by field "The mid-1980s peak was linked to the safety work following the Piper Alpha disaster. The 1999 peak was driven by the declining size of newly discovered fields" (Sorrell et al 2010 pp. 5291)

Furthermore, the rate of new reserve discoveries is significantly decreasing. Thus, peak oil is an inevitability. This is especially evident when looking at the rate at which new oil reserves are being discovered. The discovery of new, major oil fields is rapidly declining. To underpin this pressure, the consumption of oil has been outweighing the discovery of oil for the past 25 years (Fusco 2006: 2). The trends described here are likely to continue, especially in light of the economic growth and population growth that is currently occurring across the globe.

Thus, it seems obvious that peak oil will occur regardless of the action taken today. Depending on the efforts taken by global governance institutions, the impact will be of significant, and possibly detrimental character. This will be discussed in the impacts analysis, with special emphasis on how peak oil will exacerbate pre-existing inequalities, harming both efforts to alleviate poverty, create global sustainability and ensure a fair, economic system. First, however, it is vital to understand the drivers of peak oil.

DRIVERS OF CHANGE

Because oil is a finite resource, peak oil is inevitable (Owen, Inderwildi and King 2010). Although the peaking of oil is inevitable, exactly when it peaks is highly disputed. Some states, such as Norway, has already had a peak in oil production (Höök and Aleklett 2008). Hubbert predicted that global peak oil would be reached around the turn of the millennium. This turned out not to be the case, but it is presumably not far off, as peak discovery was in the late 1960's and no new mega-reserves have been found since the 1970's (Sorrell et al 2010).

Oil companies have a vested interest in denying the occurrence of peak oil, due to shareholder obligation and profit maximisation. Peak oil will drive up the price of oil, which will lead to a higher EROI on existing fields and increase the number of fields that are profitable. To extract the maximum amount of oil possible will not only increase profits short-term, but the profit from oil can be used in diversifying the areas in which traditional oil companies operate. Whilst upholding oil and gas production, the companies can retrain their engineers and build expertise in other energy areas. The Norwegian national oil company recently changed their name from Statoil to Equinor for this exact reason – they wanted to signal the future change in the company as a direct response to peak oil and climate change (Walsgard and Holter 2018).

Similarly, net oil-exporting states, such as OPEC, has interest in maximising the income from oil reserves for as long as possible. States whose main income comes from oil would encourage higher levels of oil dependencies across the world in order to reap the benefits of the price surge after peak oil. Because there is this vested interest in keeping oil a cornerstone of modern society, neither oil companies nor states have any interest in reporting developments in crude oil production or profitability calculations:

> "Ambiguity in public data mostly arises from: (1) a lack of binding international standards to report oil reserve volume and grade; (2) the point at which resources may be classified as commercially exploitable reserves; (3) intentional mis-reporting to further a financial or political agenda; and (4) inherent technical assessment uncertainty" (Owen, Inderwildi and King 2010: 4744)

Although reporting is poor on the international level, there are some indication that peak oil is very close (Sorrell et al 2010; Murphy and Hall 2011). By looking at the rate of discovery versus the rate of consumption (ten years later, as production lags discovery with approximately ten years), the world is currently consuming more than double of oil production. By consuming two barrels for every barrel found will push us towards peak oil quicker would have otherwise been the case (Murphy and Hall 2011: 60). Further analysis on single states oil production and consumption indicates that consumption will increase, whereas oil production will decrease, leaving less oil for oil export.

> "In 2008, the domestic Norwegian oil consumption was 226 175 bpd. By applying a 1% annual increase in the oil consumption, which is reasonable for a continued economic growth, the domestic oil consumption in 2030 will be 281 524 bpd. By subtracting the domestic consumption from the total production a rough estimate of the export can be found. Only around 200 000 bpd will be available for export in this case. This is a dramatic decrease from today's export volume well over 2 Mbpd." (Höök and Aleklett 2008: 4269)

Smaller quantities for exports will leave states with smaller profit margins. Pushing this decline in oil export back will be heavily incentivised for politicians, as cuts, deficits and increased levels of unemployment carries a high political cost. Politicians have a high incentive to please their electorate, especially right before elections. This is at the expense of long-term strategic planning, because short-term electoral gains are prioritised ahead of societal stability and longevity (Blais and Nadeau 1992).

IMPACT OF PEAK OIL

The impacts of peak oil will primarily manifest itself in three spheres. It will impact the planet, the economy and people and communities. These three tiers will be discussed in the upcoming section. Before the explanation of each impacted area, one must understand the nature of vulnerability.

Vulnerability can be understood through two primary lenses: the scientific approach and the social structures approach (Füssel and Klein, 2006: 306). Both stem from research on climate change and the impacts climate change is thought to have on different populations across the world. The risk and science framework for understanding vulnerability assesses climate change and the threats it produces, depending on numeric, quantitative, and rigorous models to predict the adverse outcomes of increased greenhouse gas (GHS) emissions. Within this perspective, people are secondary considerations, with their role limited to emitters, not complex individuals and communities affected by climate change. Therefore, the consideration for people's suffering due to climate change is not a paramount issue. Resultantly, the framing of climate change debates – and the role people play within climate change – occurs with the outcome vulnerability discourse (O'Brien et al, 2007: 76). "[Outcome] vulnerability concerns the processes by which individuals, societies and ecosystems are susceptible to harm as a result of climate change" (Adger, 2010: 276). As such, outcome vulnerability does not emphasise the different situations of people, but rather the predicted effect of climate change on a global scale. In the context of peak oil, this would translate to a global approach to assessing impacts, both planetary, economic and humanitarian, dismissing the local, low-level difficulties that can be identified when analysing peak oil.

The social structures framework of climate change and vulnerability changes the focal point towards the human and communities' vulnerabilities. This approach provides a wholly different understanding of how climate change ought to be tackled and the position of the human. Stemming from social ecology, this approach to assessing biological fallacy and its connection to vulnerability asserts that there must be a connection between the social and the ecological (Bookchin 2009), thus rejecting the dialectical naturalism. By approaching climate change through regionality and a desire to preserve local perspectives, the social structures discourse allows for a breath of responses to climate change, which would have been overlooked in the risk and science discourse (Pelling, 2011). This occurs largely due to a transformation of the vulnerability discourse. Rather than looking at vulnerability as an outcome, this approach questions *why* some are more susceptible to adverse climate change impacts and *who* these people are (Eakin and Luers, 2006: 370). In the realm of peak oil and the future of energy dependency and continued world-wide development, this become central to configure how societies must be transformed at different rates and in different manners in order to accommodate the pending transition away from crude oil.

By asking questions about the inequal ability to respond to systemic changes, there is room to recognise "a function of sensitivity to climatic change, adaptive capacity and exposure to climate hazards" (Laukkonen et al, 2009: 288). Thus, rather than looking exclusively at the negative consequences resulting from climate change, or in this case peak oil, the social structures framing emphasises several different structures that impact people's vulnerabilities. This amounts to a holistic understanding of complex vulnerability: "Vulnerability is considered to be influenced not only by changing biophysical conditions, but by dynamic social, economic, political, institutional and technological structures and processes; i.e. contextual conditions" (O'Brien et al, 2007: 76). Due to the emphasis on how peak oil, climate change, poverty, and other social factors are interlinked, complex vulnerabilities emphasise a combination of adaptation and mitigation factors in order to limit the impact that climate change will have on people. By focusing on both mitigation and adaptation, it bypasses the challenges social scientists identify in the science perspective of climate change, where adaptation is largely foregone.

By using complex vulnerability, one can assess the impacts of peak oil – on a global, economic and humanitarian scale to a much greater extent. In the upcoming section, the three levels of impacts will be assessed: (1) planetary; (2) economic; and (3) humanitarian and local communities. All of these three scenarios of impacts will be based assuming that the global oil trajectory remains stable, i.e. business as usual (BaU)

PLANETARY IMPACT

Planetary impact can be measured in relation to the planetary boundaries. The boundaries measure the capacity for natural resources to regenerate in spite of anthropocentric consumption. With measurements such as the nitrogen and phosphorous cycle and biodiversity loss, one can measure the extent to which human activity is having a detrimental effect on the planet (Rockström et at 2009). There are nine measurements of planetary boundaries, which again can be divided into three overarching categories:

> "1. Boundaries defining a safe global level of depleting non-renewable fossil resources, such as energy (coal, oil, gas), and fossil groundwater;
>
> 2. Boundaries defining a safe global level of using the living biosphere, including exploitation of ecosystems, protection of biodiversity and consuming renewable resources, such as land use;
>
> 3. Boundaries providing a safe global level of Earth's capacity to absorb and dissipate human waste flows, including carbon, nitrogen, phosphorus, and toxic chemicals such as pesticides" (Rockström and Sachs 2013: 4)

Thus, it is clear from the first point that planetary boundaries and anthropocentric oil production is interlinked, and that human extraction of oil and gas has lead to irreversible changes in the biosphere. Until now on the planet has primarily manifested itself through the impact it has had in the acceleration of climate change. Although the exact impact of oil and gas has had on climate change is difficult to quantify, the IPCC working group 3 argues that GHS emission from fossil fuels account for 62 % of total emission (IPCC 2014: 7). This manifest itself throughout a variety of sectors. As of 2015, agriculture and land use made up 24 % of all GHG emissions, industry accounted for 21 % and transport an additional 14 % of direct GHG emissions (IPCC 2014: 8). When peak oil occurs then, there will be a shift in how these sectors operate. The alternatives to oil has traditionally been thought to be coal and gas,

> "but the need to reduce carbon emissions would suggest that we cannot afford to release the carbon locked up in high emission alternatives like tar sands, and more coal burning could have catastrophic affects on the climate, contributing to the loss of land suitable for

> agriculture through desertification, the loss of fresh water through glacial melt, and loss of fish resources through ocean acidification" (North 2010: 586)

Thus, the transition cannot be to other fossil fuels, but it should rather be a focus on changing renewable resources. This, however, has not occurred in states that have reached peak oil already. As the world is highly dependent on oil, the initial years of peak oil is likely to see, not only the decline in conventional oils, but also the increase of unconventional oils, as the price of oil will increase. This development is evident in the case of the US, where peak oil was reached throughout the 1970's. They are currently producing similar amounts of oil today as in the 1970's and have managed to maintain a high rate of production because of the influx of new, more efficient technologies (Financial Times 2018). Shale oil, also referred to as tight oil, is oil contained in rocks which are not porous enough to be easily extracted through traditional drilling. By using highly invasive methods, this oil can be extracted, but it has a high environmental impact, especially to surrounding groundwater (Vidic et al 2013). The same goes for other oil extraction methods such as fracking and tare sand will also play a significant role in this development towards untraditional, lower quality oils. Common for all unconventional oil extraction is the high levels of invasiveness. Unconventional oils have, over all, a far higher impact on environmental health than conventional oils (Werner et al 2015). Shale oil's impact on water resources, is likely to have a significant impact not only on human water supplies, but also the health of soil and by extension the biodiversity in surrounding areas (Vengosh et al 2014). The negative effect on the environment is further extrapolated by the decreased air quality that also stems from extraction of unconventional oil (Field and Murphy 2014).

Alternatively, the transition away from conventional oils can lead to a transition to alternative sources of energy, such as renewables and nuclear. There are already significant strides towards alternative resources, with developing countries to a larger extent seeking to develop adequate grids for solar (World Bank 2018). Although there have been significant strides towards renewable energy in recent years, there is no technology which could support a full transition. The major benefit of refined oil is the relative ease with which its energy can be stored.

ECONOMIC IMPACT

The economic impact of peak oil will be profound. In rankings of economic risks, the World Economic Forum ranked the prospect of peak oil as posing a risk equally great to climate change and another financial crash (Hopkins et al 2012: 74). This is largely due to the high reliance on oil across all economic sectors. "The centrality of cheap conventional oil to modern ways of life – and the economic and political dependencies that have been built around it – have ensured that the prospect of peaking and depletion have garnered considerable international attention" (Bridge 2010: 524). The attention to peak oil, as discussed above, however, is not singlehandedly focused on finding effective solutions, as most big oil companies are reluctant to acknowledge its existence, let alone proactively act to transform their businesses away from oil dependency. "Speaking at the Geological Society Bicentenary Conference in London in 2007, the company's Global Vice President for Exploration said ''I believe [peak oil] is a metaphor for a deeper anxiety about energy security in the western world, rooted in politics and concern about climate change, not fundamental limits of geology or resources" (BP 2007 in Bridge and Woods 2010: 569). This embodies the big oil companies' stance on peak oil, and the profound belief in technological progress enabling continued extraction of oil. The discursive strategy of minimising the scope of peak oil has been found across all big oil companies. Not only does public meetings and speeches categorically minimize or skip the issue entirely, but it remains in the "margins of strategic action. Investment portfolios remain dominated by conventional oil projects, and the industry has dedicated only limited financial resources to influencing public debate on peaking" (Bridge and Woods 2010: 571). In fact, both Exxon and BP are reluctant to account and strategize for peak oil at all. Shell accounts for a 'plateau' of oil production but are still on not acknowledging the prospect of falling production (ibid).

The failure to prepare for peak oil could lead to a significant hit on the global financial market. Economically, peak oil will lead to a shift in the supply of oil, causing the demand to heavily outweigh supply. Thus, the 'age of cheap oil' will come to an end, as oil prices will increase (Bridge and Wood 2010: 567). Historically, any significant shift in oil prices has had a negative effect on the global economy, in both oil-importing and oil-exporting states (Filis, Deginnakis and Floros 2011; Miller and Ratti 2009). This is largely because oil prices strongly influence global stock markets. The effect of peak oil on stock markets will be two-fold. Firstly, it effects the sectors directly connected to oil production, e.g. the companies discussed above, but also contracting companies working to produce technology for oil companies. This section also includes state owned companies, that will be equally affected by the economic shift. The second is the impact peak oil will have on all other sectors, even those that are not obviously reliant on oil. This will have the strongest impact, mainly because it impacts the transport sector (Lutz, Lehr and Wiebe 2012). Impacts of the economic impact of peak oil will be of similar magnitude to the great financial crisis, so it is important that societies are able to adapt to the pending market change.

The capacity to adapt to these big, structural changes are largely dependent on the socio-economic prosperity and stability in a country. In a study assessing Germany's adaptive capacity, Lutz and Mayer found that a successful transition away from oil and liquid fuels was highly reliant a high level of political will, in addition to a transition away from the traditional energy market (Lutz and Meyer 2009). This will contribute to their ability to ensure that productivity levels can remain high, despite significant changes in the transportation sector (Lutz, Lehr and Wiebe 2012). A further measure that can limit the adverse economic impacts of peak oil is the efficient use of monetary and fiscal stimuli as peak oil is approaching (Miller and Ratti 2009). This will, again, ensure a higher level of productivity in the economy.

Both of these measures are dependent on a high level of planning, stability and well-functioning, pre-existing systems that are able to adapt to significant changes. In states where there are higher levels of institutional instability the market is already unstable. This, in combination with lower levels of education, higher levels of poverty, makes these smooth transitions more difficult to enforce. Thus, it is reasonable to expect that peak oil will exacerbate pre-existing global inequalities in the long run.

HUMAN IMPACT

The final major paradigm in which peak oil will manifest itself is in human well-being. Although the impact of peak oil is likely to manifest itself in a great number of ways, this report will focus on how it can cause fuel poverty, it's impact on agriculture and thus global hunger, and the transition towards more resource nationalism, which has been proven to cause social and political unrest.

The most straight forward way humans will be impacted is through the increased rates of fuel poverty. The general definition of fuel poverty is “the inability to afford adequate warmth at home” (Bradshaw and Hutton 1983: 249). There is no specific, global, measurable threshold for when someone lives in fuel poverty, so a global comparison of levels of fuel poverty cannot be done. The consequences of fuel poverty however, are well documented. When a household lives in fuel poverty people’s health, educational capabilities and life prospects are adversely affected. In the UK, the effect of fuel poverty has been connected to excess winter deaths, meaning loss of life due to inadequate living conditions (Braubach et al 2010: 88). Those affected by this are often elderly people, who are often pre-exposed to other health threats and lack access or the capability to access government run support systems. Children are also more vulnerable to feel the impact of fuel poverty. Children living in cold homes, for instance, are twice as likely to suffer from respiratory illness (Marmott et al 2011: 30). As fuel prices increase, the rate of fuel poverty is likely to increase, as a bigger portion of more people’s total income will go towards heating or cooling houses. This trend has been observed already. In urban Nigeria, firewood has been preferred as a method of fuel to a much greater extent than it used to, largely due to high prices of oil. The preference is purely since firewood is cheaper than other sources of fuel. This causes a significant impact on the surrounding forests in the area (Maconachie, Tanko and Zakariya 2009: 1092). Continuous strain on forests will have negative impact on the surrounding biodiversity.

The other impact peak oil, and thus rising fuel prices, will have on people is in agriculture and thus global food supply. The correlation between food and oil prices has been subject to several studies, with results varying greatly. When looking at single states and a single sub-group of commodities, most studies do not find any significant correlation between the food and oil prices (e.g. Nazlioglu and Soytas 2010). When assessing the aggregate effect, however, it becomes clear that there is a strong correlation, especially when looking at larger groups of states (Nazlioglu and Soytaz 2012: 1098). This stems from the high reliance of fuel when transporting food, but also the dependency on fuel in large scale food production. Modern agriculture is highly dependent on fuel driven tools. Thus, spikes in oil prices, regardless of the cause, has an impact on food production. The outcome of this trend is likely to be presented in one of two ways, food production will decline due to reduced efficiency or produce will be distributed less effectively, both of which would result in increased food prices. These patterns have been observed in previous oil price spikes (Baffes 2007, 2010; von Braun and Torero 2009). Consequently, the distribution of food will further underpin current structural inequalities. Distribution of produce is already significantly skewed along socio-economic lines, with the global North receiving far more food than necessary, whilst there is a simultaneous deficit in the global south. This deepening of pre-existing distributive patterns can, in the worst-case scenario lead to famines in the global south. As Sen points out, famine is a question of distribution and entitlement, not necessarily net availability (Sen 1981). Even if food production remains high and of similar efficiency as today, the transportation of food will be more expensive, meaning that poor people will struggle to get access to food. This showcases again how poor, rural or indigenous people are less capable of transforming and reducing their reliability on cheap oil. On a larger scale, societies with high levels complex vulnerability it is highly unlikely that adaptation a post-peak oil society will run smoothly. In societies with low complex vulnerability, there is a much higher chance that they will be capable of having a full transformation and increase resilience. Thus, peak-oil, because of the changing price point, will cause major systemic disruption, causing the majority of harm to people already living in poverty.

The history of oil governance indicates that BAU will encourage resource nationalism to a much greater extent than it already is. At is simplest, “[resource Nationalism] encompasses efforts by resource-rich nations to shift political and economic control of their energy and mining sectors from foreign and private interests to domestic and state-controlled companies” (Bremmer and Johnston 2009: 149). Resource nationalism is primarily comprised through two components. The first is the limitation of international oil companies scope and total production. Secondly, it requires increased domestic assertion of domestic natural resource developments (Stevens 2008: 5). As the price of oil increases, the incentive to nationalise and regulate global oil supplies increases (Vivoda 2009). Transforming the domestic oil market to these criteria does not only allow for higher domestic levels of energy security, despite global market shifts, but is also utilised as a political engagement tool. From historical cases of resource nationalism, oil falls to a discourse of national power, superiority and self-proficiency (Kohl and Farthing 2012). The discourse of self-proficiency is often overly utilised and blown up by regimes in order to justify the rationing of extraction and the skewed distribution. In turn, this has historically led to social and political unrest (ibid). In Venezuela, assumed to have the highest level of petroleum reserves, the renationalisation of oil reserves perfectly reflects this theoretical hypothesis. During the renationalisation of large oil reserves, the political elites were promising a transition to a fairer and more redistributive effect of oil money in society. However, the transition caused lower efficiency of oil extraction and a reiteration of negative social divisions (Bremmer and Johnston 2009; Stevens 2008). Although oil prices were rising throughout the beginning of this millennium, the net income of Venezuelan people declined, and inflation rose. The renationalisation of oil failed to counteract these and there were quick upheavals Thus, the political risks of peak oil are essentially linked to the market risk and market stability of oil (Click and Weiner 2009) This is especially true for states where people's vulnerability is high, as states such as Canada and Norway have better institutional preconditions for resource management and distribution.

RESPONSES

BUSINESS AS USUAL

Business as usual (BAU) is a scenario for the future, where the development remains on the same trajectory as today. The model is often used to predict climate change impacts. In terms of peak oil, it refers to both the policies in place to tackle and prepare for peak oil, current oil consumption and oil production. Together, this will estimate the planetary, economic and human impacts peak oil will have. The current trajectory is tainted by inaction, rather than action against peak oil implications, and little is indicating a transition away from BAU (Rockström and Sachs 2013: 6).

When oil companies describe BAU of oil production, they tend predict the outcome based on oil availability and current rates of consumption. This is incorrect in two ways. Firstly, it assumes that all oil is equally accessible and can be extracted with the same ease. Secondly, there is rarely an account of growing consumption, meaning that their predicted 30 to 40 year prediction is a gross underestimation of when BAU would lead to the depletion of oil (Newman 2007: 16). The outcome of this inaction will have catastrophic implications for the planet and developing states:

> "In the absence of a shared global framework individual countries fail to acknowledge planetary boundaries in national policymaking. They each scramble for scarce resources.

> Fossil fuel and food prices soar, and planetary boundaries are exceeded as the middle-income countries catch up with the high-income countries. The weakest countries find themselves pushed out of the marketplace and fail to develop. This zero-sum or negative-sum struggle can easily turn nasty. Richer countries will guard their advantage with military force if necessary" (Rockström and Sachs 2013: 5-6)

Another part of BAU is the expansion of where conventional oil is thought to be profitable. As oil prices increase, the EROI will be increased, meaning that previously unprofitable oil reserves will become desirable development projects for oil companies. The prospect of oil production in the former arctic, the Barents Sea etc. pose dramatic environmental threats, but would delay the most immediate impacts of peak oil on humans, at least in the wealthy states who can afford to pay the higher price. With business as usual, the implications described above are likely to occur as described, meaning that the risk of higher economic inequality both within states and between states.

POSITIVE TRANSFORMATIONS AND THE ROLE OF THE CITY

As peak oil has become a more universally accepted concept, societies across the world must find ways of adapting to the changes. But what is adaptation, and what and who must be considered for a successful adaptation in accordance with principles of justice? Adaptation refers to the dynamic process which aims to limit the impacts of an external threat to a population (Eriksen, Nightingale and Eakin 2015). Akin to the discussion on vulnerability above, those who benefit and suffer due to adaptations are determined by pre-existing power asymmetries in society (Pelling 2011). Unless careful, the transition to fuel-free solutions will be contained amongst elites, leaving the poor even more exposed to the adverse effects of peak oil. Inequality has already had a manifested effect on transition to more modern technologies. In the transition towards electric cars for instance, well-off people are already ahead in having invested in electric cars, meaning that they will not be as affected by fuel price increases. In the long run, having electric cars will be the most cost-efficient car to own, but the lack of good electric cars in the used car market and the immediate cost of electricity is disincentivising people from low-income households to invest in one (Andrich, Imberger and Oxburgh 2013). Knowing that this is likely to manifest itself in more technologies than just the electric car market, it is crucial for cities to engage not only in adaptation, but in resilience building and transformation of society. Resilience is a systems ability to absorb disturbances and external shocks and attempted enforced changes (Hopkins 2008). Whereas adaptation is mainly about minimizing the direct negative impact, resilience building implies that the function of society will remain high, in spite of external shocks. Adaptation against climate change, for instance, would be efforts to plant more trees, in order to absorb CO2 emissions. Although it limits the impacts of some GHG is it not a holistic approach and would still leave people vulnerable due to other GHG and the effects from historical emissions. When understanding the vulnerabilities of the planet, the economy and people as complex and intersecting with other issues, it becomes clear that adaptation must be taken a step further to ensure a just societal development. This just, more radical adaptation is resilience. Resilience building requires a transformation of society towards a more self-reliant, equal and just society (Hopkins 2008: 55).

One approach to transformation which could be taken is localisation. Localisation refers to the ‘de-globalisation’ of commodities, livelihoods etc. The process can be divided to several sub-groups, with political localisation on the one hand, and economic or ecological localisation on the other (North 2010: 585). Political localisation is mainly concerned with the progression of local governance and autonomy of councils. Economic and ecological localisation is more concerned with the local community’s relationship and interactions with the wider world, be that in terms of commodity trading or environmental impacts and ecological spill-over effects. Thus, the remaining discussion will focus on the latter form, and will henceforth be referred to as localisation. At “the core of localisation is a claim that economic dimensions should focus not on profit maximisation and economic efficiency to the exclusion of all else, but on meeting needs as locally as possible” (North 2010: 587) This does not advocate or aspire for the exclusion of the global, but rather a balance between local, regional, national and global dependencies. Where it makes sense that production is national and global – such as in the production of technologies, this should be the case. However, local production of food, of energy, etc. should be prioritised to a much greater extent than it is today.

Localisation can take place in two primary forms: immanent and intentional. Immanent localisation is the transformation of society which occurs as an unintended result of external factors, e.g. the increased price of oil. When prices of oil increase, transportation becomes more expensive, so states seek closer collaboration of production with regional partners. Thus, an increase in oil price is likely to strengthen the relationship between the northern American states, eastern and western Europe, etc (North 2010: 590). Although causing changes that are more environmentally friendly, does not ensure increased resilience to peak oil in communities. Immanent localisation leaves society vulnerable to further exogenous market shocks, and is thus an unstable, short term transition, rather than a transformation. Intentional localisation is the deliberative localisation of cities and towns. By localising landscapes to be more self-proficient, well developed and planned out, one can overcome exclusion of low-income households in the localisation process as well as prepare for the forthcoming impacts of peak oil. Long-lasting community changes demands taking a systemic approach to the climate, biosphere and immediate neighbours to identify where transformations are the most urgent (North 2010).

It is vital to note, that localisation and ruralisation of urban areas is not a call for the dismissal of technology and returning to pre-technological roots. “The environmental discourse has long been split in two camps: one technophilic, the other techno-sceptic. The former suggests that technical solutions are the primary fix to environmental problems, while the latter favours changes in behaviour over technological remedies” (Brand and Fischer 2013: 235). When looking at environmental discourses, Brand and Fisher found that eco-communities and the greening of cities was frequently used with a discourse which rejects modern technologies (2013). However, the making of ecological lives and houses does not mean firewood, no travel nor only eating locally produced foods. Rather, it means that there must be a shift in how commodities and energy is viewed, a normative shift in societal values and interconnectedness. Only by doing this, one can build resilience.

Resilient cities is perhaps the most important part of localisation movements. 50 % of the global population are currently living in urban areas, and it is quickly increasing. Some developing states are experiencing urbanization rates upwards of 80 % growth per year (Grimm et al 2008: 756). This transition requires towards urban living combined with peak oil means that there must be a significant transformation in how cities operate.

The first, and perhaps most obvious example of fossil fuel dependencies is in a city’s transportation network. In a study from 2007, it was found that Eastern European cities use public transport the most, with some cities getting close to 50 % of all trips, whereas the US cities were closer to 3 % of all trips on average (Kenworthy 2007: 48-50). This leaves cities with significant room to cut back on their citizens fuel dependencies by ensuring that public transport grows. By improving the public transport networks – and ensuring that it is fairly priced – more people will have the ability to live urban lives without private cars. However, any transformative measure against car dependency must be aware of the social structures of a city. “Car dependence is the problem that drives oil vulnerability; thus, cities must plan and build to overcome car dependence” (Newman 2007: 22). This is seen, for instance in where families choose to settle within a city. Increasingly, high-income families are living in central hubs with walkable distancing (Newman 2007). Therefore, heavy taxation on personal cars will is not a good measure to ensure declining use of personal cars. Similarly, the electrification of areas must not be done with regards to the highest initial demand, rather based on ensuring that low-income household have enough time and assets to adapt.

Whereas the previous status quo was to consider cities as an absent part of the biological sphere, or simply without nature (Grimm et al 2008), biologists are starting to realise that cities have an enormous potential in supporting food production, sustaining biodiversity etc. In the case of Bristol, UK, food is one of the key issues that will be impacted by peak oil, as every calorie of food supplied in the city requires 7-10 calories of conventional oil to be produced (Bristol Green Capital 2014)). By encouraging more innovation, such as high-rise farms, utilisation of gardens, more connectedness with surrounding areas and lower food waste, the city can help mitigate the impact of peak oil. By prioritizing this transition, cities would be ‘*ruralized’* (Newman 2007: 19). Ruralisation is the stripping back of urban luxuries and abundancies, in place for more collective gardens, small scale farming and co-dependence across farms. These issues must be incentivised by local governments, to bypass the issues of unjust distribution. Although transforming the food supply to cities would impact the range of goods available at any given time, the transformation is necessary to uphold a society where no-one falls behind. The ruralisation can only get cities a small, supplementary part of the way.

Even though there are promising technologies such as vertical farming (Besthorn 2012), the main transformation must occur in the rural areas and on farms. “Agriculture will need to adapt by growing its own biodiesel, using gas, and switching to more efficient rail transport rather than trucks" (Newman 2007: 24). By changing away from fossil fuels, food will inevitably need to be sourced more locally to maintain freshness. The current infrastructure would not support the full electrification of transport. This does not mean excluding all global trades in food, as some commodities are better grown in specialist areas, but a turn to reshape and diversify local agriculture will in many cases be the best. Furthermore, farmers must embrace technological advances to maximise the production of food on la local scale. Over a long period, especially after the green revolution in the 1960's, agricultural debates have been ridden with techno-scepticism and reluctance to innovate.

> "The unifying factor to techno-scepticism is the belief that changes to human values, attitudes, decisions and behaviours should be at the heart of any environmental analysis and activism. In other words, problems should be addressed through a cultural or social fix" (Brand and Fischer 2013: 241).

Although the change to a more environmentally conscious population would be welcome, there are few trends that indicate this is actually occurring. As peak oil is occurring fairly soon, or has already occurred, one must be prepared to integrate new, radical technologies to ensure that vulnerable people are less hit by the change. However, by combining technological advances and the change in people's behaviour whilst encouraging connectivity to the earth, to food and to our local communities, cities could pose a significant, positive response to peak oil.

CONCLUSION

Peak oil is inevitable and it likely to occur in the near future. Whereas the peaking of oil does not mean that we will run out, it does imply that demand increasingly will outweigh the supply. The drivers of peak oil have vested interest in the continued production of conventional oils, either to increase their profit margins or due to the electoral cycle. Because oil companies and states continue to extract oil, peak oil will likely happen soon and without much preparation. The effects of peak oil will manifest itself in the biosphere, the economy and socially. Because oil prices are likely to increase, the EROI on unconventional oil will be positive, meaning that the production of unconventional oils will see a temporary rise. The outcome is likely to be long-term negative effects on the regional environment. The economic impacts will largely be due to economic interconnectedness. As oil is such a vital part for all economic sectors through transportation, plastics etc. the stock market will likely be negatively impacted. When it comes to human implications, the impact of peak oil will manifest itself in increased fuel poverty, rising food prices and increased resource nationalism. The scope of the impact is largely determined by pre-existing vulnerabilities. Although peak oil's consequences are apparent and well-known, business as usual is the most likely trajectory. However, if politicians, communities and companies wanted there could be a reduction in oil dependency. Proposed in this report is the localisation of cities, meaning increased resilience and self-reliance.

BIBLIOGRAPHY

Adger, W.N. (2010): 'Climate Change, Human Well-Being and Insecurity', *New Political Economy,* vol. 15(2) pp. 275-292

Andrich, M.A., Imberger, J. and Oxburgh, E.R. (2013): 'Inequality as an Obstacle to Sustainable Electricity and Transport Energy Use', *Energy for Sustainable Development*, vol. 17(4)

Baffes, J. (2007): 'Oil Spills on Other Commodities', *Resource Policy*, vol. 32. 126-134

Baffes, J. (2010): 'More on the Energy/ Nonenergy Price Link', *Applied Economics Letter,* vol. 17, pp. 1555-1558

Besthorn, F.H. (2012): 'Vertical Farming: Social Work and Sustainable Urban Agriculture in an Age of Global Food Crises', *Australian Social Work*, vol. 66 (2) pp. 187-203

Blais, A. and Nadeau, R. (1992): 'The Electoral Budget Cycle', *Public Choice*, vol. 74(4) pp. 389-403

Bookchin, M. (2009): 'Social Ecology Versus Deep Ecology: A Challenge for the Ecology Movement', *Green Perspectives* nos. 3-4 pp. 1-20

Bradshaw. J. and Hutton, S. (1983): 'Social Policy Options and Fuel Poverty', *Journal of Economic Psychology,* vol. 3(3-4), pp. 249-266

Brand, R. and Fischer, J. (2013) 'Overcoming the technophilia / technophobia split in environmental discourse', Environmental Politics, 22(2), pp. 235 – 254.

Braubach, J., Jacobs, D.E. and Ormandy, D. (eds) (2011): *Environmental Burden of Disease Associated with Indadequate Housing,* Copengagen, DK: WHO Regional Office for Europe

Bremmer, I. and Johnston, R. (2009): 'The Rise and Fall of Resource Nationalism', *Global Politics and Strategy,* vol. 51 (2) pp. 149-158

Bridge, G. (2010): ‘Geographies of Peak Oil: The Other Carbon Problem’, *Geoforum* vol. 41(4) pp. 523-530

Bridge, G. and Wood, A. (2010): ‘Less is More: Spectres of Scarcity and the Politics of Resource Access in the Upstream Oil Sector’, *Geoforum*, vol. 41(4) pp. 565-576

Bristol Green Capital (2014): ‘Building a Positive future for Bristol after peak oil’ [online] available at: http://bristolgreencapital.org/report-building-a-positive-future-for-bristol-after-peak-oil/ accessed: 09.06.2018

Chapman, I. (2014): ‘The End of Peak Oil? Why this Topic is Still Relevant Despite Recent Denials’, *Energy Policy,* vol. 64(1) pp. 93-101

Click, R.W. and Weiner, R.J. (2009): ‘Resource Nationalism Meets the Market: Political Risk and the Value of Petroleum Reserves’, *Journal of International Business Studies*, vol. 41 (5) pp. 783-803

Eakin, H. and Luers, A.L. (2006): ‘Assessing the Vulnerability of Social-Environmental Systems’, *Annual Review of Environmental Resources,* vol. 31(1) pp. 365-394

Eriksen, S.H., Nightingale, A.J. and Eakin, H. (2015): ‘Reframing Adaptation: The Political Nature of Climate Change’, *Global Environmental Change,* vol. 35(1) pp. 523-533

Field, R.A., Soltis, J. and Murphy, S. (2014): ‘Air Quality Concerns of Unconventional Oil and Natural Gas Production’, *Environmental Science Process Impact,* vol. 16 pp. 954-969

Filis, G., Degiannakis, S. and Floros, C. (2011): ‘Dynamic Correlation Between Stock Market and Oil Prices: The Case of Oil-Importing and Oil-Exporting Countries’, *International Review of Financial Analysis,* vol. 20(3) pp. 152-164

Financial Times (2018): ‘The Remarkable Revival of US Oil Production’ available at: https://www.ft.com/content/a8314d06-0741-11e8-9650-9c0ad2d7c5b5 accessed 04.06.2018

Fusco, L. (2006): ‘Peak Oil Theory’, [online] available at: www.ucs.mun.ca/~oilpower/documents/Peakoil2-1.doc.pdf accessed: 10.06.2018

Füssel, H. and Klein, R.J.T. (2006): ‘Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking’ in *Climactic Change,* vol. 75(3) pp. 301-329

Grimm, N.B., Faeth, S.H., Golubiewski, N.E., Redman, C.L., Wu, J., Bai, X., Briggs, J.M. (2008): ‘Global Change and the Ecology of Cities’, *Science*, vol. 319(5864) pp. 756-760

Höök, M. and Aleklett, K. (2008): ‘A Decline Rate Study of Norwegian Oil Production’, *Energy Policy*, vol 36 pp.4262-4271

Hopkins, A. (2001): ‘Was the Three Mile Island a Normal Accident?’, *Journal of Contingencies and Crisis Management*, 9(2) pp. 65-72.

Hopkins, R. (2008): *The Transition Handbook*, Green Books

Hopkins, Rob et al (2012) 'Peak Oil and Transition Towns', *Architectural Design*, 82(4), pp. 72 – 77.

IPCC (2014): 'Climate Change 2014: Synthesis Report, Summary for Policymakers' [online] available at: http://www.ipcc.ch/report/ar5/syr/ accessed 10.06.2018

IPCC WG3 (2001): 'Summary for Policymakers' [online] available at: http://www.grida.no/publications/267 accessed 10.06.2018

Kenworthy, J. (2007): 'Urban Planning and Transport Paradigm Shifts for Cities of the Post-Petroleum Age', *Journal of Urban Technology,* vol. 14(2) pp. 47-70

Kohl, B. and Farthing, L. (2012): 'Material Constraints to popular Imaginaries: The Extractive Economy and Resource Nationalism in Bolivia', *Political Geography,* vol. 31 (4) pp. 225-235

Laukkonen, J., Blanco, P.K., Lenhart, J., Keiner, M., Carvic, B. and Kinuthia-Njenga, C. (2009): 'Combining Climate Change Adaptation and Mitigation Measures at the Local Level', *Habitat International,* vol. 33(3) pp. 287-292

Lewis, N.S. and Nocera, D.G. (2006): 'Powering the Planet: Chemical Challenges in Solar Energy Utilization', *Proceedings of the National Academy of Sciences of the United States of America*, vol. 103(43) pp. 15729-15735

Lutz, C. and Meyer, B. (2009): 'Economic Impacts of Higher Oil and Gas Prices: The Role of International Trade for Germany', *Energy Economics*, vol. 31(6) pp. 882-887

Lutz, C., Lehr, U. and Wiebe, K.S. (2012): 'Economic Effects of Peak Oil' *Energy Policy*, vol. 48 pp. 829-834

Maconachie, R., Tanko, A. and Zakariya, M. (2009): 'Descending the Energy Ladder? Oil Price Shocks and Domestic Fuel Choices in Kano, Nigeria', *Land Use Policy* vol. 26(4) pp. 1090-1099

Marmot, M., Geddes, I., Bloomer, E., Allen, J. and Goldblatt, P. (2011) *The Health Impacts of Cold Homes and Fuel Poverty*, available at: http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf accessed: 10.06.2018

Miller, I.J. and Ratti, R.A. (2009): 'Crude Oil and Stock Markets: Stability, Instability and Bubbles', *Energy Economics*, vol. 31(4) pp. 559-568

Murphy, D.J. and Hall, C.A.S. (2011): 'Energy Return on Investment, Peak Oil, and the End of Economic Growth', *Annals of the New York Academy of Sciences*, 1219 pp. 52-72

Nazlioglu, S. and Soytas, U. (2010): 'World Oil Prices and Agricultural Commodity Prices: Evidence from an Emerging Market', *Energy Economics* vol. 33(3) pp. 488-496

Nazlioglu, S. and Soytas, U. (2012): ‘Oil Price, Agricultural Commodity Prices, and the Dollar: A Panel Cointegration and Causality Analysis’, *Energy Economics*, vol. 34(4) pp. 1098-1104

Newman, P. (2007): ‘Beyond Peak Oil: Will Our Cities Collapse?’, *Journal of Urban Technology,* vol. 14(2) pp. 15-30

North, P. (2010): ‘Eco-Localisation as a Progressive Response to Peak Oil and Climate Change – A Sympathetic Critique’, *Geoforum*, vol. 41 (4) pp. 585-594

North, P. (2010): ‘Eco-Localisation as a Progressive Response to Peak Oil and Climate Change – A Sympathetic Critique’, *Geoforum*, vol. 41 (4) pp. 585-594

O’Brien, K., Eriksen, S. Nygaard, L.P, and Schjolden, A. (2007): ‘Why Different Interpretations of Vulnerability Matter in Climate Change Discourses’, *Climate Policy,* vol. 7(1) pp. 73-88

Owen, N.A., Inderwildi, O.R., King, D.A. (2010): ‘The Status of Conventional World Oil Reserves – Hype or Cause for Concern?’, *Energy Policy,* vol. 38(8) pp. 4743-4749

Pelling, M. (2011): *Adaptation to Climate Change: From Resilience to Transformation.* New York: Routledge

Perrow, C. (1999): *Normal Accidents. Living with High Risk Technologies,* Princeton, NJ: Princeton University Press.

Perrow, C. (2011): Fukushima and the Inevitability of Accidents’, *Bulletin on the Atomic Scientists*, 67(6), pp. 44-52.

Rockstrom, J., Sachs, J.D (2013): ‘Sustainable Development and Planetary Boundaries, Draft for Discussion’, *High Level Panel on the Post-2015 Development Agenda*

Rockström, Johan et al (2009): ‘A Safe Operating Space for Humanity’, in *Nature*, 461

Sen, A. (1981): ‘Ingredients of Famine Analysis: Availability and Entitlements’, *The Quarterly Journal of Economics,* vol. 96(3) pp. 433-464

Sorrell, S., Speirs, J., Bentley, R., Brandt, A. and Miller, R. (2010): ‘Global Oil Depletion: A Review of the Evidence’, *Energy Policy,* vol. 38(9) pp. 5290-5295

Stevens, P. (2008): ‘National Oil Companies and International Oil Companies in the Middle East: Under the Shadow of Government and the Resource Nationalism Cycle’, *Journal of World Energy Law and Business*, vol. 1(1) pp. 5-30

Vengosh, A., Jackson, R.B., Warner, N., Darrah, T.H. and Kondash, A. (2014): ‘A Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States’, *Environmental Science Technology,* vol. 45(15) pp. 8334-8348

Vidic, R.D., Brantley, S.L., Vandenbossche, L.M., Yoxtheimer, D. and Abad, J.D. (2013): 'Impact of Shale Gas Development on Regional Water Quality', *Science*, vol. 340 (6134) pp. 826-837

Vivoda, V. (2009): 'Resource Nationalism, Bargaining and the International Oil Companies: Challenges and Change in the New Millennium', *New Political Economy*, vol. 14(4) pp. 517-534

Von Braun, J. and Torero M. (2009): 'Implementing Physical and Virtual Food Reserves to Protect the Poor ad Prevent Market Failure', *International Food Policy Research Institute,* Policy Brief 10, Washington DC

Walsgard, J.C. and Holter, M. (2018): 'Climate Changed: Statoil No Longer Wants Oil in Its Name' [online] available at: https://www.bloomberg.com/news/articles/2018-03-15/statoil-changes-name-to-remove-oil-in-renewable-energy-push accessed: 10/06/18

Wang, Q., Chan, X. and Yi-Chong, X. (2013): 'Accidents like the Fukushima unlikely in a Country with effective nuclear regulation: Literature review and proposed guidelines', *Renewable and Sustainable Energy Reviews*, 17(1), pp. 126-146.

Werner, A.K., Vink, S., Watt, K. and Jagals, P. (2015): 'Environmental Health Impacts of Unconventional Natural Gas Development: A Review of the Current Strength of Evidence', *Science of the Total Environment*, vol. 505(1) pp. 1127-1141

World Bank (2018): 'Solar Powers India's Clean Energy Revolution' [online] available at: http://www.worldbank.org/en/news/immersive-story/2017/06/29/solar-powers-india-s-clean-energy-revolution accessed: 06.06.2018