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Energy Transition in Saudi Arabia: Oil, Solar and Vision

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Energy Transition in Saudi Arabia:

Oil, Solar and Vision

Senior Project submitted to

The Division of Social Studies
of Bard College

by

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Introduction

1947. Peter Josten was an undergraduate student at Bard studying Political Studies with a particular interest in the Middle East. He knew he wanted to work in the Middle East in the future, but wasn't quite sure what he would do there. Of all the topics he could have written his Senior Project on, he decided on a timely issue: Oil in Saudi Arabia. At the time, WWII had just ended and the US was experiencing phenomenal levels of growth. President Roosevelt had met face to face with Saudi King Abdul Aziz for the first time. The automobile industry was thriving and access to an abundant source of energy was becoming a necessity for every household in the nation. Josten clearly saw the growing importance of oil rich nations like Saudi Arabia. For advice on how to start his project, he approached Dr. Felix Hirsch, a political journalist and historian, who at the time was working as the Bard College Library Director. He likely sought advice from Dr. Hirsch because of his experience as a political journalist, which would have greatly helped Josten discover and explore numerous international sources including news articles from the region. Without the internet or even a fax machine, it would have been essential to have a well-versed journalist by his side. This would be the first and until now, the only Senior Project at Bard College written on energy in Saudi Arabia. The project has not been uploaded to Bard College's online database, so I requested physical access to it through the Bard Library and had to sit, supervised, behind the library information desk in order to turn the pages of what is now a deteriorated brown book.

I found that, through Josten's research, he had become fascinated by the rapid rate of development in the Kingdom and came to believe that oil would transform the entire landscape of the Middle East into a modern geographical hub, connecting all corners of the Earth. The Middle East would become an advanced technological region, leading to endless peace and

harmony.¹ His confidence in oil led him to believe in the possibility of this utopia. He never could have foreseen the events that transpired over the following seven decades. Now in 2018, I intend to carry on the story of energy in Saudi Arabia. With knowledge of the present day, it is easy to criticize or dismiss the vision of Peter Josten. However, I fear that over the next seven decades my Senior Project will be equally vulnerable to test of time.

When I started research for my project in 2017, I thought I would be writing the David and Goliath story of solar energy versus oil. I was excited to see plans for large solar sites announced by the Saudi Arabian government and the sensational headlines that covered the announcements. “The Saudis are going solar”, “Saudi Arabia to build world’s largest solar farm” and “After oil, solar? Saudi Arabia plans ahead” are just a few of the headlines that have grabbed my attention.² Evidently, there is a considerable buzz surrounding innovations in solar energy in general. Yet, a plethora of news organizations, such as Bloomberg News, Reuters, Al Jazeera and Arab News, have been providing a running commentary of solar energy’s rise in Saudi Arabia since early 2017. There are no signs of this coverage slowing down and each new story can provide a new quote from a Saudi government official, an update on solar farm investment or a review of progress so far. It is practically impossible to follow every story. With so many

¹ Peter Josten, “Oil in Saudi Arabia,” Bard College: Senior Projects Spring, (1947).

² Jeffrey Ball, “Why the Saudis are Going Solar,” *The Atlantic*, issue July/August 2015, accessed 24 April, 2018, <https://www.theatlantic.com/magazine/archive/2015/07/saudis-solar-energy/395315/>, Avery Thompson, “Saudi Arabia to Build World’s Largest Solar Farm,” *Popular Mechanics*, last modified 4 April, 2018, accessed 24 April, 2018, <https://www.popularmechanics.com/science/energy/a19685494/saudi-arabia-plans-to-build-worlds-largest-solar-farm>, “After Oil, Solar? Saudi Arabia Plans Ahead,” *Reuters* online, last modified 16 April, 2018, accessed 24 April, 2018, <https://in.reuters.com/video/2018/04/16/after-oil-solar-saudi-arabia-plans-ahead?videoId=418239619>.

new sources of information to draw from, the question arises: Who do we listen to in order to tell the story of energy in Saudi Arabia?

Traditionally, scholars have not taken official statements by the Saudi Arabian government seriously or have at least have been wary of doing so. Robert Vitalis, political scientist and author of *America's Kingdom: Mythmaking on the Saudi Oil Frontier*, is exemplary of this mistrusting approach towards the Kingdom. Specifically, he highlights the similarities between the state-owned oil company, Saudi Aramco and the Saudi state, arguing that they both function as authoritarian regimes. According to Vitalis, they both “keep records hidden. They pay for extravagant hagiographies. They open their archive only to those they hire.”³ The information produced by both Saudi Arabia and Saudi Aramco is either sanctimoniously published or, if the information is found to be unfavorable, dismissed to a hidden filing cabinet. In this case, public statements made by the Saudi Arabian government and Saudi Aramco are not seen as trusted sources of information, but instead, they are seen as targets to be discredited.

This project diverges from this trend and “listens” intently to the official statements and publications of the Saudi Arabian government. Rather than turning them into targets for criticism, I analyze the language used to make these statements and from there, pulls out whatever information is available. I make a concerted effort to provide agency to Saudi Arabia, similar to how each word of a statement made by the US government is not believed to be a campaign of disinformation, but rather is dissected and analyzed.

The central focus of this essay is therefore on Saudi Arabia’s national transformation plan, Vision 2030, announced on 25th April 2016 by Crown Prince Mohammad bin Salman.⁴

³ Robert Vitalis, *America's Kingdom: Mythmaking on the Saudi oil frontier* (Stanford: Stanford University Press, 2007), 12.

⁴ Marwa Rashad, “Saudis Await Prince's Vision of Future with Hope and Concern,” *Reuters* online, last modified April 24, 2016, accessed April 24, 2018, <https://www.reuters.com/article/us-saudi-plan-idUSKCN0XLOB2>.

Through analyzing this plan and its published targets, we can understand the current and future roles of solar energy and oil in Saudi Arabia. The question I attempt to answer in this project is: How does Saudi Arabia intend to utilize solar energy? This is the departure point from which we can begin to understand how Saudi Arabia is engaging with the global climate change discourse, how oil's well-established position will affect the rise of solar energy in Saudi Arabia and what potential social changes may be brought about by a successful energy transition from oil to renewable energies.

Chapter 1 addresses the global climate change discourse and Saudi Arabia's contribution to this discourse. Looking at official Saudi policies submitted to international bodies as well as policies targeting national transformation plans, all of which have been produced in the last ten years, we can see how Saudi Arabia approaches the risks of climate change and how it sees itself contributing to the alleviation of the problem. Specifically, this chapter will look at the Intended Nationally Determined Contributions (INDCs) of the Kingdom of Saudi Arabia under the United Nations Framework Convention on Climate Change (UNFCCC). Then to see this in action, this project will explore the goals of Vision 2030 and its progression from the former Saudi Arabian National Development Plan 2020 (NTP 2020). This will include a discussion of how Saudi Arabia characterizes energy transition and the rationality that lies behind the reflexive task of setting future goals.

Chapter 2 provides an insight into the similarities and differences between oil and solar energy. Guiding this analysis is the work of Bruno Latour, a French philosopher, anthropologist and sociologist, known for his influential contributions to the field of science and technology studies. In his seminal book, *Reassembling the Social*, he argues that social forces alone are too

weak to account for anything like the durable and complex structures that amalgamate society.⁵ Within this description, Latour posits that the human and non-human must be given equal agency if one is to account for all the social factors that form a successful network. Employing this Latourian lens, the obvious distinctions between oil and solar become less clear. We are able to distinguish the material properties of both forms of energy separate from the systems that produce them. The oil field and the solar site are taken as primary examples of the apparent disconnect between a resource's material capabilities and the ways in which certain systems aim to produce them. Furthermore, we can begin to reveal the influence of the incumbent energy sector over the emerging solar energy production systems. This culminates in a discussion of how solar energy can be used as a supplement for the domestic oil consumed in Saudi Arabia, which may ultimately increase the resources and time available for Saudi Arabia to export oil to the global market.

Chapter 3 zooms out to the political decision making of the Saudi Arabian government and explores its ability to make rapid economic changes while tackling energy transition. This includes a discussion of how oil has shaped Saudi Arabia's political position in the world and how an increased interest in solar power marks the ever-growing relationship between Saudi Arabia and China. This section also tackles the roles Saudi citizens and foreign workers have played in Saudi Arabia's energy sector. Saudi Arabia's "Saudization" scheme intends to decrease national unemployment and decrease the number of foreign workers in the nation. However, this raises the question of how willing Saudi Arabia will be to sacrifice its rate of economic transformation for the nationalization of its workforce.

⁵ Bruno Latour, *Reassembling the Social: An introduction to actor-network-theory* (Oxford: Oxford university press, 2005), 3.

To start, we look to the world of climate conferences, in which the nations of the globe come together with the aim of cooperation. They represent the highest order of consensus and the highest power to dictate the trajectory of a global energy transition from fossil fuels to renewable energies. If climate change is a global problem, then these international bodies position themselves to be the global solution.

Chapter I: The Vision for Energy Transition

1. Climate Agreement: Copenhagen 2009

1.1 Ambition and minimalism: The global challenge of consensus

World climate conferences have become the central focus for introducing energy change, a change that requires global consensus and national implementation. Observers were understandably dismayed to learn in December 2009 that the UN Climate Change Conference was a failure.⁶ The forecast for change had never seemed so inevitable. The pressing issue of climate change was well known, liberal governments were optimistic, the voices of NGOs were audible in international media and the assembly of 120 governments for a political conference had never been seen before. After a week of dramatic calls to action and paralyzed debate, the conclusion was to hold another conference and point blame at particular nations for the stalemate.⁷

At the time, the late Hermann Scheer was the former President of Eurosolar (European Association for Renewable Energy) and General Chairman of the World Council for Renewable Energy. Ten years earlier, in 1999, he had been awarded the Right Livelihood Award for his indefatigable work for the promotion of solar energy worldwide.⁸ In his final book, *The Energy Imperative: 100 per cent renewable now*, he remarks that the single guilty party for the failure of the Copenhagen conference was “the idea of a world climate conference itself.”⁹ He explains that

⁶ John Vidal, Stratton Allegra and Suzanne Goldenberg, “Low Targets, Goals Dropped: Copenhagen Ends in Failure,” *The Guardian US* online, last modified 18 December, 2009, accessed 24 April, 2018, <https://www.theguardian.com/environment/2009/dec/18/copenhagen-deal>.

⁷ John Vidal, “Rich and Poor Countries Blame Each Other for Failure of Copenhagen Deal,” *The Guardian US* online, last modified 18 December, 2009, accessed 24 April, 2018, <https://www.theguardian.com/environment/2009/dec/19/copenhagen-blame-game>.

⁸ The Right Livelihood Foundation: A Swedish organization that honors and supports courageous people and organizations that have found practical solutions to the root causes of global problems. For more information see <http://www.rightlivelihoodaward.org/>.

⁹ Hermann Scheer, *The Energy Imperative: 100 percent renewable now* (London: Routledge, 2013), 43.

the idea is based upon two highly questionable assumptions: Firstly, a global solution is required, in which everyone is subject to similar obligations, as this is a global problem. Secondly, climate protection is a burden that nations must equally endure and negotiate.¹⁰ He argues that it is counterproductive to seek rapid change and achieve global consensus. For rapid changes to be enforceable, nations would have to adhere to policies that have the potential to confine their freedom to make economic and social decisions, which is a significant request, especially for a developing nation. The only way to reach global consensus is to sacrifice the speed of the actions required. Therefore, any consensus reached becomes an agreement of, what Scheer terms, 'minimal obligation'.

The Copenhagen conference was an exemplary case of minimalism. The conference agreed that emissions of greenhouse gases should be limited to the heating up of the Earth's atmosphere by no more than 2°C. This notion of a 2°C limit implies that further emissions into the atmosphere are acceptable, but that exceeding this target would potentially mark a point of no return or at least would lead to environmental catastrophe. This type of target is representative of the misunderstanding surrounding the climate change discussion. Rather than actively aiming to start decreasing the already high temperature of the atmosphere, countries are allowed to continue to contribute to increasing atmospheric temperatures. Considering the possible devastation that would be caused by reaching the 2°C target, it seems counterproductive to identify a problem and then willingly continue to contribute to it. It is difficult to find an example of this in any other area of policy making. While not exactly comparable, we could take the UN's goal for tackling the 800 million malnourished and starving people in the world as an example. The policy put forward for this problem is not to allow for the amount of people

¹⁰ Scheer, *The Energy Imperative*, 44.

experiencing starvation to increase to 2 billion. This would make it acceptable for countries to actively contribute to increasing the problem and not have to make major social and economic changes. Centering focus on the 2°C target leads to the conditions that permit toothless regulations and minimal obligations, while in the meantime, nations can continue to contribute to rising atmospheric temperatures. In addition, a false narrative is reinforced that all the problems posed by climate change, from rising sea levels to devastating wildlife habitats, can be reduced to a single measurement.

The 2°C target has become the go to determinant for judging climate change action, a trend that has continued in the November 2016 Paris Agreement, a landmark treaty to challenge the threat of climate change, signed by 195 nations after intense negotiations in 2015. All 195 signatories to the agreement could do so confidently, as there are no defined consequences for nations that do not meet their targets or for nations that decide to withdraw from the agreement. While the Paris Agreement is not enforced, it claims to provide a framework for increasing momentum on greenhouse gas reduction, with some oversight and a surface level of accountability.¹¹ The Paris Agreement marked a new level of global consensus on climate change, but in the process, the speed of action on the issue was sacrificed. It may be argued that global consensus is essential to the strength of the movement. However, the current US President, Donald Trump, has declared his official position to withdraw the US from the agreement, which will likely weaken the it, further highlighting the fragility of international consensus.¹²

¹¹ For more information on the purpose and current progress of the Paris Agreement see <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>.

¹² Valerie Volcovici, "U.S. Submits Formal Notice of Withdrawal from Paris Climate Pact," *Reuters* online, last modified August 4, 2017, accessed 24 April, 2018, <https://www.reuters.com/article/us-un-climate-usa-paris/u-s-submits-formal-notice-of-withdrawal-from-paris-climate-pact-idUSKBN1AK2FM>.

1.2 Successes and contingencies: Saudi National Determined Contribution

This notion of minimal obligation can be observed on the global and national levels. The Intended Nationally Determined Contributions (INDCs) of the Kingdom of Saudi Arabia under the United Nations Framework Convention on Climate Change (UNFCCC) was released in November 2015, 6 years after the Copenhagen conference. After years of no notable participation in the global climate discourse, Saudi Arabia published their official position in regards to climate change. The INDC's document released sets forth their current energy situation, their planned contributions for mitigating climate change, how they will implement change and the timeframe they foresee.

The document starts by stating that economic diversification is of the utmost importance to Saudi Arabia's future climate action. Oil production, processing and export are the primary economic activities of the Kingdom of Saudi Arabia, however there are plausible future opportunities for gas, minerals and their derivatives to contribute to the nation's economy. Secondly, since 1970 the Kingdom has utilized ten five-year national development plans that have guided the nation's development and provided economic and social stability in the long-term. All these plans have centered on diversifying the nation's economy by aiming to increase GDP income from the manufacturing industries, energy and related derivatives, mining, tourism and information technology industries. Thirdly, Saudi Arabia foresees two possible scenarios for their planned diversification: "1. Economic diversification with a robust contribution from oil and its derivatives export revenues. 2. Accelerated domestic industrialization based on sustainable utilization of oil and gas."¹³

¹³ "Intended Nationally Determined Contribution of the Kingdom of Saudi Arabia," UNFCCC, 2015, accessed 13 February, 2018. <http://www4.unfccc.int/ndcregistry/PublishedDocuments/Saudi%20Arabia%20First/KSA-INDCs%20English.pdf>, 2.

The first scenario envisions support being provided from high value sectors, such as tourism, information technology, renewable energies, financial services and medical services. The second scenario envisions a period of economic decline, and that in this case the Kingdom will not be able to finance its INDC ambitions and that they will be lowered if deemed necessary. Utilizing these two possible scenarios, it appears that Saudi Arabia is not committing to a single objective and that their contributions will only be made in reaction to external factors, rather than with being motivated by an impetus to reduce the risks of climate change. After these two scenarios are outlined in the document, it goes onto conclude that Saudi Arabia will not be responsible for the emissions of the fossil fuels they export and that the nation reserves the right to “further elaborate on its INDC and make additional submissions to account for these scenarios.”¹⁴ This final clause marks the toothless nature of Saudi Arabia’s INDC document, in which Saudi Arabia’s goals do not account for their global contribution to emission levels and that their goals are neither fixed nor mandatory.

There are two consistent features in the Saudi Arabian INDC document that differ from the majority of INDCs from other nations. The first is an absence of quantitative goals, they instead state that they intend to implement a number of qualitative measures. If we look at the European Union INDC’s document, we can see a plethora of qualitative goals and targets, such as setting “a binding target of an at least 40% domestic reduction in greenhouse gas emissions by 2030”, aiming to “reduce its emissions by 80-95% by 2050” and planning a reduction of “6 tonnes of CO₂ by 2030.”¹⁵ Due to Saudi Arabia not disclosing qualitative goals it becomes difficult to specifically understand how serious Saudi Arabia’s commitments are. The document

¹⁴ “Intended Nationally Determined Contribution of the Kingdom of Saudi Arabia,” UNFCCC, 2015, 2.

¹⁵ “Intended Nationally Determined Contribution of the EU and its Member States,” UNFCCC, 2015, accessed 13 February, 2018. <http://www4.unfccc.int/Submissions/INDC/Published%20Documents/Latvia/1/LV-03-06-EU%20INDC.pdf>, 3.

may say Saudi Arabia intends to “cooperate on research programmes”, “implement actions that will promote and encourage the reduction, recycle and reuse of water” and “undertake measures to enhance desertification management”¹⁶, yet the document makes no reference to the specific qualitative aspect of these goals, just that they are simply desirable. While we may see more specific outlines for these goals within Saudi Arabia’s own national development programs, their omission from this document shows a level of reserve in relation to the global climate discourse.

The second feature is that their goals are on the whole related to financial interests and do not relate to potential concerns for the environment. From the first paragraph the document states “The Kingdom will engage in actions and plans in pursuit of economic diversification that have co-benefits in the form of greenhouse gas.”¹⁷ The benefits to the environment are therefore a by-product of the changes they intend to make and that any direct activity targeted at solely the environment is considered a financial sacrifice.

1.3 What is a fair climate agreement for Saudi Arabia?

Global emissions have primarily resulted from the industrial progresses and lifestyles of wealthy nations, while developing nations typically contribute much less to climate change. Wealthy nations have plundered and combusted vast quantities of fossil fuels allowing them to exponentially grow their economies and offer higher standards of living for their citizens. Now the effects of this dramatic growth are better understood, it is the wealthy nations that have begun imposing restrictions over poorer nations for the use of the same fuels.

Michael Grubb is one of the first academics to confront the inequality behind the current global climate discourse. He is a Professor of International Energy and Climate Change Policy at

¹⁶ “Intended Nationally Determined Contribution of the Kingdom of Saudi Arabia,” UNFCCC, 4.

¹⁷ “Intended Nationally Determined Contribution of the Kingdom of Saudi Arabia,” UNFCCC, 1.

University College London and editor-in-chief of a leading international peer-reviewed academic journal, *Climate Policy*. In the introduction to his article, "Seeking Fair Weather: Ethics and the International Debate on Climate Change" published in the *International Affairs* journal, he points to the uncertainty felt by developing nations in response to global climate conferences. He states that "Developing countries feared that they would be hurt by a problem that they had played little part in creating, whether by the direct impacts or by the perceived burden of efforts to reduce emissions."¹⁸ In identifying this hypocrisy, he also adds that it will be the developing nations that will be among the first to suffer the consequences of climate change and the many low-lying developing nations that will experience the most severe impacts due to rising sea levels.

It would seem developing nations cannot win. While attempting to grow their economies, the tried and tested ways of doing so are being restricted. In order for there to be fair climate change action, Grubb remarks that nations must accept responsibility on an ethical level for transboundary climate change. He remarks, "One can hardly talk of global order if countries can knowingly and over long periods act in ways that impose environmental damage on others and not accept responsibility for helping victims to cope with those impacts."¹⁹ The Paris Climate Agreement appears to be taking actions upon this basis. Much responsibility for the potential negative outcomes of restricting fossil fuel use has been shifted to the most economically prosperous nations. For example, in the lead up to the Paris Climate Agreement, the US committed to distributing \$860 million a year in aid by 2020 to developing nations for the costs of climate change adaptation.²⁰ Again, similarly to the other provisions of the agreement, this is

¹⁸ Michael Grubb, "Seeking Fair Weather: Ethics and the International Debate on Climate Change," *International Affairs* 71, no. 3 (1995): 463.

¹⁹ Grubb, "Seeking Fair Weather: Ethics and the International Debate on Climate Change," 495.

²⁰ Valerie Volcovici and Lesley Wroughton, "U.S. Doubles Climate Adaption Aid to Nearly \$900 Million," *Reuters* online, last modified 9 December, 2015, accessed 24 April, 2018, <https://www.reuters.com/article/us-climatechange-summit-funding-idUSKBN0TS1Q220151209>.

not an absolute mandate and US President Donald Trump's recent comments seemingly confirm the fragility of this commitment.

On this note, it is arguable that Saudi Arabia has contributed dearly to global emissions by exporting its wealth of fossil fuels, but it would be more precise to say the nation played a more passive role. Saudi Arabia's resources would not have left the ground if not for the large demand for oil coming from the wealthiest nations in the world. The world's demand for oil created the conditions for Saudi Arabia's economy to become so dependent on oil. Hence, Saudi Arabia's INDC does not sacrifice its ability to export oil or make any concessions to its levels of production, however, this does mean the matter of transboundary responsibility is fully settled. The main objectives for Saudi Arabia are termed 'mitigation co-benefits' within the document, solutions that mitigate the effects of climate change while also benefiting the greater wellbeing of the nation. These commitments are deemed acceptable by the agreement, not because they are greatly contributing to solutions for climate change, but because Saudi Arabia's commitments signify a divergence from business as usual.

2. Vision 2030

2.1 Characterization of transition: The variations of what energy transition can mean

The idea of an improved and sustainable future should appeal to everyone. To get there we must transition, a process of gradual change and the expectation of eventual closure. Transition management defines a goal for the future, chooses the subjects and directs the movement. In this regard, we can view Vision 2030 as a tool utilized by the transition management of Saudi Arabia. Vision 2030 is an economic and social transformation plan that addresses broad aspects of Saudi Arabia, but within this program are specific policies to address the nation's energy situation.

To put Vision 2030 into context, we must look at Saudi Arabia's prior future targets set forth in The National Transformation Program (NTP) 2020. The NTP was announced as a national plan for the future in December 2015, however just four months later Vision 2030 was announced. Their close proximity lends itself to confusion. There is a considerable overlap between the goals of both programs and at first glance, it can be difficult to distinguish them from each other. Upon further inspection, the NTP targets were released for the individual governmental ministries of Saudi Arabia, whereas Vision 2030 takes a broader approach by not mentioning the direct ministries involved and instead attached its goals to the large categories of "Society, Economy and Nation".²¹ Soon after the announcement of Vision 2030, the NTP was absorbed to become one of 12 programs within Vision 2030. As a result, many of the government agencies that were originally part of the NTP program are no longer directly involved, including the energy, finance and housing ministries.

The NTP's consequential absorption and its short four-year timeline make the program appear less significant in comparison to the progressive long term changes promised by Vision 2030. Yet, for four short months, the NTP was to be received as the progressive and forward thinking plan for Saudi Arabia. The quick revision of the NTP and its short timeline suggest that the program was rushed and that it may not have represented the full goals of the Saudi Government. However, the NTP provided a careful articulation of the challenges Saudi Arabia wished to address and the methods for implementing this change. For this reason this essay will first explore the characteristics of the NTP and contrast them with that of Vision 2030, in an effort to provide context for the rationale of Saudi Arabia's planned transition.

²¹ Kingdom of Saudi Arabia, "Themes," Saudi *Vision 2030*, 2016, accessed 20 January, 2018. <http://vision2030.gov.sa/en>.

In order to understand the rationale for embarking on any transition, we must precisely identify the sites of interest and the type of transition they are to undergo. To answer this we cannot simply comment on the desired overall social structural change, such as a stronger economy or increased social mobility. For within this change exists layers of transitions that overlap and interconnect various societal subsystems.

James Meadowcroft is a head researcher for the Canada Research Chair who focuses on the ways governments are adjusting their practices and policies to cope with the emergence of problems of the environment and sustainable development. In his recent essay, ‘What about the politics? Sustainable development, transition management, and long term energy transitions’, he offers several changes that he believes can characterize energy transition:

- (a) movement from a fossil fuel based (or dominated) energy system to a non-fossil fuel based (or dominated) energy system; or (b) a shift from a carbon emitting energy system to a carbon neutral (or low carbon) energy system;
 - or (c) a transition from a non-renewable energy system to a renewable energy system.
- Other alternatives are also possible, for example, (d) a movement from an insecure (vulnerable) energy system to a secure (robust) energy system.
- And (e) a change from centralized energy provision to a decentralized energy system.²²

Each of these different transitions require different actions. The underpinning notion of energy transition could incorporate a variety or just one of these characterizations and ultimately Saudi Arabia will regard some of these objectives as a priority over others. These priorities have important consequences for the social and economic condition of Saudi Arabia. For example, if Saudi Arabia was to prioritize energy security within its policy, then the occurrence of militaristic agitation or political instability would likely create further preference for the reliability of the established oil energy system. Consequently, CO₂ output levels would rise and

²² James Meadowcroft, "What About the Politics? Sustainable Development, Transition Management, and Long Term Energy Transitions," *Policy sciences* 42.4 (2009): 323.

investment would continue towards a controllable centralized energy system. In addition, these consequences immediately impact the citizens, industries, cities and regions whose opportunities are intrinsically limited to the energy priorities of their government.

This rubric can be applied to the energy transition goals set forth in the NTP. The program comprises the goals of Saudi Arabia by segmenting the various ministries and departments within the Saudi Government. Within each of these segments are ‘strategic objectives’ that outline the areas that each ministry wishes to improve.²³ The Ministry of Energy lists an order of 15 strategic objectives for the development of its energy sector in a decisive manner. The first objective is to “increase non-oil commodities exports”, this includes an increase in gas and mineral exports, but also establishing ‘specific zones’ of competitive advantage which could potentially include a renewable energies market.²⁴ However, this is not stated explicitly. This first priority for Saudi Arabia reveals less about the intent for a specific characterization of energy transition than it does the economic diversification desired for improving the economy. While this may suggest movement away from oil, out of the following 14 objectives, 10 set out the objective of developing and strengthening the oil sector.²⁵ Whether it be encouraging financial investment, increasing efficiency or investing in energy infrastructure, the Ministry of Energy clearly sets forth a future of continued interest in sustaining the current oil energy system. Furthermore, the Ministry of Energy’s objectives do not mention a comprehensive plan for the integration of renewable energies systems or decreasing its contribution to climate change.

²³ Kingdom of Saudi Arabia. “National Transformation Program,” *Vision 2030*, 2016, accessed 20 January, 2018. http://vision2030.gov.sa/sites/default/files/NTP_En.pdf

²⁴ “National Transformation Program,” *Vision 2030*, 50.

²⁵ “National Transformation Program,” 50.

Separate from the ministries' objectives are a small list of government programs. One of these programs is the King Abdullah City for Atomic and Renewable Energies program (K.A.CARE), whose goals are summarized as 4 strategic objectives. The first objective does not pertain to renewable energies, but sets forth the goal of reaching 100% of atomic energy production, as allowed by "international and national safety and security standards regarding the introduction of atomic energy."²⁶ To implement this, Saudi Arabia announced in 2009 plans to construct 16 nuclear power reactors over the next 20-25 years.²⁷ Up to this moment this objective has resulted only immaterial progress. While Saudi Arabia opened the contract bidding for its first nuclear plant in 2017, they are yet to award a contract, let alone begin construction.²⁸

If we take into consideration the development plans for nuclear energy in other nations, we can see how the K.A.CARE objective is questionable and perhaps, unreasonable. Egypt set up its Atomic Energy Commission in 1955. The government's Nuclear Power Plants Authority was then established in 1976, and in 1978 plans were created for ten reactors by 1999. Ten years later, in May 2009 the government finally awarded the first contract to WorleyParsons, an Australian engineering company, to support the establishment of a large nuclear plant. These plans were put on hold due to the political instability caused during the popular uprisings of 2011. By November 2017, contracts were signed for the first nuclear power plant by Egyptian President Abdel Fattah el-Sisi and Russian President Vladimir Putin. To this date Egypt is yet to produce a watt of power for domestic consumption by the means of a nuclear reactor.²⁹ The slow

²⁶ "National Transformation Program," 72.

²⁷ "Nuclear Power in Saudi Arabia," *World Nuclear Association*, accessed 20 January, 2018. <http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/saudi-arabia.aspx>

²⁸ "Nuclear Power in Saudi Arabia," *World Nuclear Association*.

²⁹ "Nuclear Power in Egypt," *World Nuclear Association*, accessed 20 January, 2018. <http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/egypt.aspx>. See here for a more in depth timeline of Egypt's engagement with nuclear energy.

process Egypt has experienced is not unique to Egypt. Rather, this exemplifies the uncertainty that underpins the development of nuclear energy programs. Hence, the NTP's atomic energy goals for 2020 are unlikely to be fulfilled within the next two years.

Considering atomic energy is the first objective of the K.A.CARE program, it casts a shadow over the ratification of the latter 3 objectives of K.A.CARE. These objectives pertain to enabling renewable energy systems to contribute to the national energy mix, investing in the development of renewable energy technologies and creating the expertise and labor force required for a competitive renewable energy market.³⁰ While nuclear power requires slow negotiation of international safety and disputes over nuclear waste management, global interest has exploded around the recent innovations of renewable energies.³¹ This draws attention to the priorities of the NTP, as global trends appear misaligned with its minor and vague objectives for a renewable energy market. If we were to identify the characterization of Saudi energy transition on the goals and achievements of the NTP, we would conclude that Saudi Arabia is prioritizing the security and strength of its existing centralized energy systems. Furthermore, the transition plan set out by the NTP does not appear to distinctly register with the rubric provided by Meadowcroft. However, the NTP's limelight was short lasting and Vision 2030's hasty absorption of the NTP provides Saudi Arabia with new space to reevaluate the NTP's misalignment of global energy trends.

Vision 2030 extends the trajectory of Saudi's 2020 targets and refocuses the objectives of Saudi transition management. While the NTP was attached to a faceless governmental body,

³⁰ "National Transformation Program," *Vision 2030*, 72.

³¹ For more information on the popular rise of renewables see Pilita Clark, "The Big Green Bang: how renewable energy became unstoppable," *Financial Times*, 18 May, 2017. <https://www.ft.com/content/44ed7e90-3960-11e7-ac89-b01cc67cfeec>.

comprised of ministries and programs, Vision 2030 is the vision of Crown Prince Mohammad bin Salman bin Abdulaziz Al-Saud. The Crown Prince has become a prominent figure within the Saudi regime and is the select successor of the current King. While he may not be the head of state officially yet, he began a process of consolidating his power by arresting powerful economic and political actors, including his own relatives in late 2017. A total of 325 people were reportedly detained at the Ritz-Carlton luxury hotel in the capital, Riyadh. The results of this, so-called, purge led to the recuperation of \$100 billion and the more permanent imprisonment of more than 50 individuals.³² This turmoil is represented as a ‘crackdown’ on corruption, whether this is true or not, it marks the establishment of the Crown Prince’s authority.

Visiting the Vision 2030 website, one is first confronted by multiple images of the Saudi King and Crown Prince squinting their eyes, looking towards a prospective future and behind them a colorful and abstract cloudscape. To articulate the meaning of this image a foreword is provided by the Crown Prince, the current Chairman of the Council of Economic and Development Affairs. His foreword contains a highly informative quote that summarizes the ideology behind Vision 2030, “we cannot help but be optimistic about the decades ahead. We ponder what lies over the horizon rather than worrying about what could be lost.”³³ This quote implies that the concerns of the past are merely unnecessary obstacles in front of getting to the future. In this sense, the lackluster of the NTP’s achievements can be considered irrelevant to the Saudi regime and this allows for focus and energy to be redirected from the NTP towards the long term goals of Vision 2030. While we may not be able to see the future ahead, we are made

³² Martin Chulov, “Saudi Arabia Claims Anti-Corruption Purge Recouped \$100bn,” *The Guardian*, 30 January, 2018, accessed 24 April, 2018. <https://www.theguardian.com/world/2018/jan/30/anti-corruption-purge-nets-more-than-100bn-saudi-arabia-claims>.

³³ “Foreword,” *Saudi Vision 2030*. <http://vision2030.gov.sa/en/foreword>

to feel rest assured that the glimmering pupils of King Abdulaziz and the Crown Prince hold the promise of an inevitably improved future.

Unlike the NTP, it is difficult to discern the precise objectives of Vision 2030. Vision 2030 discusses its aims through the broad themes of “a Thriving Economy, a Vibrant Society and an Ambitious Nation”.³⁴ The methods for achieving these themes are comprised of specific programs and initiatives. While one would assume Vision 2030 is primarily concerned with the year 2030, the NTP 2020 remains the cornerstone program of Vision 2030. Instead of viewing 2020 as the deadline for the NTP, Vision 2030 extends the goals of the NTP, whilst also bolstering it with additional programs. Instead of trying to separate the overlapping goals of the NTP and Vision 2030, they are embraced together and the language of ‘strategic objectives’ is replaced by ‘relevant Vision 2030 objectives’. It is unclear whether the 2020 goals are now set for 2030 or if the Saudi Government will take stock and update its goals in 2020.

To add to the confusion, Vision 2030 has also absorbed the K.A.CARE program. While the K.A.CARE program has not made further targets within the 2030 timeframe, Vision 2030 has repositioned the program’s importance. There are only two short paragraphs in the Vision 2030 document about the work of K.A.CARE, yet they make ambitious commitments. The Vision 2030 document is silent on the details but does commit to 9.5GW of renewable power generation capacity by 2022, specifically mentioning wind and solar.³⁵ This is presented as an effort to offset Saudi Arabia’s current domestic consumption of fossil fuels, which has led Saudis to coin the term ‘yellow oil’. The Vision 2030 document goes on to say, “From inputs such as silica and petrochemicals, to the extensive expertise of our leading Saudi companies in the

³⁴ “Home,” *Vision 2030*. <http://vision2030.gov.sa/en>

³⁵ “A Renewable Energy Market,” *Vision 2030*. <http://vision2030.gov.sa/en/node/87>

production of different forms of energy, we have all the raw ingredients for success.”³⁶ This sentence is quite far reaching and seems to commit the Kingdom to harnessing its natural resources into developing a domestic manufacturing base for solar equipment. It must be noted that at this time, Saudi Arabia neither has a utility scale solar farm nor produces any significant quantity of renewable energy. Nevertheless, renewable energies have gained a pivotal role in the diversification of the Saudi’s oil dominated economy.

In a further contrast to the NTP, Vision 2030 has consistently made the headlines of 2017 and 2018 so far. Specifically, ‘solar’ has become the buzzword for describing Vision 2030. Almost every week a new article is published that embellishes Saudi Arabia’s progress into the field of solar energy. Bloomberg, a business news outlet, published over a dozen articles referring to Vision 2030 during February 2018, Reuters, an international news outlet, has published over 100 articles referring to solar power in Saudi Arabia in the past year and from pro-Saudi Government, Arabic language news outlets, such as Al-Riyadh, Al-Bilad and Al-Madina, the articles published on this subject are even more numerous.³⁷ This publicity frames solar as a new exciting expedition for the world and that Saudi Arabia aims to be at its forefront. The consistent publishing of these articles would suggest that decisive actions are being taken and that progress is continuously being made. However, Vision 2030 has not officially published any further targets than those presented in the two aforementioned paragraphs within the Vision 2030 document, nor have any contracts for solar farms been signed by the Saudi Government.

³⁶ “Investing for the Long-Term,” *Vision 2030*. <http://vision2030.gov.sa/en/node/6>

³⁷ While many of these articles in Bloomberg and Reuters overlap in content or simply provide opinion pieces on the topic, the quantity at which they’re published would suggest that they are highly popular with readers. The pro-Saudi Government news outlets may not publish these articles because of their popularity, it is more likely that this constantly unfolding story is pushed forward by the Saudi Government. A recent headline from Al-Bilad reads, “السعودية تطلق أكبر مشروع للطاقة الشمسية في العالم”. In English: “Saudi Arabia Launches the World’s Largest Solar Project.” (my own translation). Last modified 29 March, 2018, accessed 28 April, 2018, <http://www.albiladpress.com/newspaper/3453/488340.html>.

Often these articles rearticulate the same information, and if they receive a high number of hits, they quickly spread across a plethora of international news outlets. It may be tempting to attach these news outlets' comments within our analysis of Vision 2030, but there simply isn't a justification on behalf of Saudi Arabia's transition management for these attractive headlines.

Returning to Meadowcroft's rubric for transition, we can see that Vision 2030 suggests a movement from a fossil fuel based energy system to a non-fossil fuel based energy system and also, a transition from a non-renewable energy system to a renewable energy system. It is difficult to gauge how far along these transitions Saudi Arabia will be by 2030, but their prominent inclusion in Vision 2030 marks a palpable readjustment from the meager role of renewable energies in the NTP 2020. This is the conclusion presented by Vision 2030, however, it does not fully satisfy many of the tensions that exist between the global rise of renewable energies and the global position of Saudi Arabia as an oil producer.

2.2 Closure and delays: Why 2030 is not the end of transition for Saudi Arabia

By naming Saudi Arabia's transition program Vision 2030, a number of transitional ideologies are evoked. 2030 is made to be the finish line, a point at which a new equilibrium is reached. It is worth reflecting on the extent to which it is possible to anticipate decisive movement towards some form of closure in the large scale systems that concern energy transition management. It is important to note that Vision 2030 does not explicitly state the word 'transition' to describe itself. It is not clear if 'transition' has been purposely omitted from the Vision 2030 document, however, the word 'transformation' has been carried over in some cases from the NTP 2020. Nevertheless, 'transition' most aptly describes the nature of Vision 2030 and is the most prominent term used to describe such a program within the academic field of

sustainable development, especially in regards to energy. The term ‘transition’ evokes the image of a form or state following a passage to emerge as another, which includes not only the idea of movement, but also arrival. Examples of this in the context of energy could be the transition from coal to oil powered ships in the British Royal Navy and maritime transport, or in U.S. households from coal based heating to gas and oil heating systems. While these historic examples display closure in energy transition, the sustainable development of energy systems today will likely be a less satisfying process with many open ends and detours. Energy transition today must engage with much larger sociotechnical systems that have local, national and international ramifications.

Vision 2030 does not hold the promise of just one transition, but a sequence of transitional trajectories. These trajectories are subject to unforeseen external pressures, which may cause Saudi transition management to adjust their goals and targets. It is not unimaginable that climate change could cause an increase in natural disaster frequency and severity, which in turn creates a disruptive landscape for planned transition. An increase in water scarcity and high temperatures for Saudi Arabia would spell catastrophe and motivate increased activity towards alleviating future climate change risks. In this sense, the deterministic title ‘Vision 2030’ is to an extent misleading, as the Vision alone will not provide the final outcome in 2030. From the vantage point of 2100 we may be able to discern the transition pathway that was taken, however while we are currently observing from within the transition timeline it much more difficult to understand what is really happening.

Furthermore, Vision 2030 does not fully reflect the open ended nature of sustainable development that is the source of motivation for energy transition. Since the horizon of the 21st century we can easily observe a plethora of scientific and technological advances in sustainable

development, such as viable solar energy production, smart energy meters in homes and electric cars. This suggests that sustainable development is not simply an endpoint but that it will remain a continuous challenge far into the future. In this sense, the concept of Saudi Arabia arriving at the position of a sustainable society in 2030 differs greatly from the task of sustainable development. While the organization of several sequential or concurrent subsystem transitions may suggest progress, they are only a part of the continuous process of sustainable development.

One of the biggest obstacles facing a successful energy transition in Saudi Arabia is the incumbent state-owned energy company, Aramco. It is no secret that the company stands to benefit greatly from delaying a full transition to renewable energy sources. This company represents the current energy equilibrium for Saudi Arabia and its far reaching influence has caused sociotechnical incapacitation. To an extent the great success experienced by Saudi Arabia in oil production has bound the society within a suboptimal situation. Currently, the incumbent energy systems enjoy the advantages of established infrastructure, networks for consumers and suppliers, developed regulatory systems and low financial risks. All of these elements have developed over time in tandem to create mutual cooperation between other major subsystems within society, such as agriculture and transport. Outcompeting such a dominating structure will likely be difficult.

Outside of their general structure, the specific actions taken by the incumbent energy company to delay their emerging rivals are less visible. Aramco and the government of Saudi Arabia are so tightly entwined that energy transition efforts in Vision 2030 are subject to the influence of the interests of the incumbent energy system. One of these influences could be identified as the attempt to introduce atomic energy. While nuclear power helps to reduce CO₂ emissions, there are additional risks and dangers caused by nuclear energy production and there

are a variety of factors that impact climate change other than CO₂. Aramco is unlikely to feel threatened by Vision 2030's desire to produce nuclear energy and may stand to benefit from time invested into the sector. If Egypt's experience of nuclear energy unfolds similarly for Saudi Arabia, then it will not prove to be a bridge technology for energy transition, but instead, a delay. To understand why Vision 2030's nuclear energy goals represent a delay for Saudi Arabia, we must understand the current global nuclear energy trends.

The World Nuclear Association reports that 450 civil nuclear reactors are operational across 32 countries, with an additional 60 under construction.³⁸ The average lifespan of these nuclear energy plants is 20-25 years, meaning all the plants that became operational before the year 2000 will need to be decommissioned within the next decade. These soon to be decommissioned nuclear plants account for almost half of the operational plants today. While there may be plans (without secured deadlines) for an additional 150-160 reactors, the World Nuclear Status Report 2018 produced by Mycle Schneider reveals how these plans will not be able to sustain current nuclear energy production. His statistics show that for nuclear energy production levels to remain equal to 2018 in 2025, that at least over 140 new plants need to be constructed within this decade.³⁹ This means a new plant needs to become operational approximately every 23 days. If this level of construction was indeed a reality, it would be the highest since 218 nuclear power plants became operational in the 1980's; approximately one every 17 days.⁴⁰

³⁸ "Nuclear Power in the World Today," *Nuclear World Association*. <http://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx>

³⁹ "World Nuclear Industry Status as of 1 January 2018," *World Nuclear Industry Status Report*. <https://www.worldnuclearreport.org/World-Nuclear-Industry-Status-as-of-1-January-2018.html>

⁴⁰ "World Nuclear Industry Status as of 1 January 2018," *World Nuclear Industry Status Report*.

In the long term, even with advancements made concerning the lifespan and efficiency of nuclear reactors, global trends suggest that nuclear energy is a declining factor for energy transition. Vision 2030's objective to diversify their energy sources away from oil for economic security is not progressed by nuclear power, instead it provides a financially beneficial delay for the incumbent energy sector. While time and resources are funneled into nuclear energy, it is the same time and resources that are taken away from developing renewable energies.

2.3 State rationality: Setting future goals in energy transition governance

The concept of a *vision* for future sustainable development involves reforming and creating practices of socio-political governance in an effort to encourage a desired development trajectory. By planning for the future we imply that it is possible to 'steer' society and that if it were left to take its natural course, our limited ability to determine the future would inevitably cause ourselves harm. Our future plans cannot be set in stone, as sustainable development is an interactive process including not just the combination of sectors and their instruments, but also in the broader sense, sustainable development is process of exploration to find the preferred pathway. This points to a state's ability to reflect. Meadowcroft argues that "such reflexivity is arguably important for modern governance generally, sustainable development because of the broad reach, normative foundations, and multilayered uncertainties with which this idea is associated."⁴¹ Modern governance therefore requires continuous self-conscious societal reflection, assessment and readjustment. This notion of reflexivity is of the utmost importance for Saudi Arabia's Vision 2030, as its broad promises and unclear trajectory are a major contribution to feelings of uncertainty within the Kingdom.

⁴¹ James Meadowcroft, "What About the Politics? Sustainable development, transition management, and long term energy transitions," *Policy sciences* 42, no. 4 (2009): 323.

While future planning of the past involved gradual adjustments of taxes, regulations and tariffs, the notion of evolutionary change is becoming increasingly vital to successful energy transition management. Rather than betting on the success of one goal, energy transition management deliberately encourages a variety of technologies and systems combined with selective pressures, allowing for victors and adjustments of future development trajectories. René Kemp in his essay, “Transition management as a model for managing processes of co-evolution towards sustainable development”, introduces the theory that transition management should be viewed as “a new steering concept that relies on 'Darwinistic' processes of guided variation and selection instead of planning.”⁴² Transition management is described as “new” because the previous alternative for nations has been the use of economic incentives within a planning and implementing approach, often weak and too general while simultaneously being disruptive. This suggests that energy transition management is not simply another tool, but a different type of governance model for states.

Transition management offers an array of new features that change our approach to setting future goals. It places a specific emphasis on bringing the future to the center of current decisions by utilizing long term time frames, experimenting with a variety of trajectories and encouraging innovation. Furthermore, it sets its sights on transforming established systems within which unsustainable practices are deeply ingrained. Through this effort they create a network of powerful actors involved in a specific area of production and consumption, within which the actors are given space to define their challenges, discuss their different perspectives

⁴² René Kemp, Derk Loorbach, and Jan Rotmans, "Transition Management as a Model for Managing Processes of Co-Evolution Towards Sustainable Development," *The International Journal of Sustainable Development & World Ecology* 14.1 (2007): 7.

and collaborate on fundamental steps. In transition management, technological and social change are conducted in tandem with the understanding that both forms of progress are essential for successful sustainable development.

We would be remiss not to acknowledge that politics and political processes are deeply embedded within the concept of setting future goals. While transition management concerns itself with the features referred to above, traditional policy tools, such as taxation, regulation and subsidization, remain a vital tool for a government managing sustainable development. This is often understated within discussions of transition management, for example, *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy* by Boelie Elzen, Frank W. Geels and Kenneth Green is a prominent influential piece of literature within the academic discussion of transition management. These transition theorists go to great effort to differentiate themselves from the regulatory, taxation and planning approaches of traditional governance, however it is perhaps more plausible that these approaches are a part of transition management itself, for there's no practical reason for it to limit itself in this way.⁴³

While transition management is not primarily concerned with political interactions, it formulates itself through socially determined goals. This requires continuous public support, even though this social agreement, the negotiation of competing objectives and the distribution of particular resources throughout diverse social spheres may fall outside of transition management's defined scope. This is not to say that deciding on socially defined goals is completely divided from their implementation, as the pursuit of these goals entails numerous

⁴³ Boelie Elzen, Frank W. Geels, and Kenneth Green, *System Innovation and the Transition to Sustainability: theory, evidence and policy* (Edward Elgar Publishing, 2004), 20. In the section "Literature Review and Critical Evaluation", they stress the weakness of economic pathways and emphasize the importance of transformation approaches, in which the new is perceived to be growing out of the old.

decisions that influence how this process eventually unfolds. Nevertheless, it is not expected of transition management to make decisions that allocate benefits and detriments across social and sectoral borders, for this would require some form of political framework for deliberative processes.

Thus, it should be no surprise that transition goals raise new questions for political actors and organizations to consider. Within the political sphere, these questions are subject to a whole host of ideological and institutional factors, such as the public's level of political engagement, the dynamics of party politics, party cooperation and political lobbying. The previous discussion of atomic energy within the NTP of Saudi Arabia demonstrates this clearly. While Saudi Arabia appears to be seeking dramatic progress in this sector, the political problems they face have not been diminished by setting out its goal. Nuclear power, while utilized with success in many nations, is a technology surrounded by uncertainty in general. The immensity of Saudi Arabia's nuclear ambitions seem unattainable within the timeframe they've set themselves and while nuclear power could reduce carbon emissions, it does not address a number of environmental concerns it either does not affect or worsens. Hence, if their nuclear goals are to be achieved, significant investment, subsidization of infrastructure and creating policies that require the energy sector to concede territory to nuclear energy are undeniably essential or else nuclear energy will face continuous delays and pitfalls. However, the time and level of investment required drastically reduces attention to making progress on other energy transition trajectories. For a nation like Saudi Arabia with limited resources, garnering support for and making these decisions will be difficult. Making these decisions along the trajectory of energy transition is clearly a political concern and one that only the political authority of Saudi Arabia can make.

Chapter II: Oil's Role in Energy Transition

1. Replacement without revolution: The design and implementation of solar energy in Saudi Arabia

The scientific consensus on climate change tells us that oil and its externalities have permanently damaged the Earth and if we are to avoid further catastrophe nations must quickly implement technological innovations made in the field of renewable energies. Emerging as one of the most popular forms of renewable energy production is solar farms. In the Middle East they are promised to transform oil economies and create new 'desert economies' in countries like Saudi Arabia. Yet, until the goal of 100% renewable energy is met, oil and solar must operate side by side in a competing market. This raises the question of whether solar projects will be designed to replace oil's role or will these projects create systems for energy that haven't existed before? And to what extent do the pre-existing systems of oil production and distribution influence how solar will be utilized? To answer these questions, this project argues that solar farms are in fact a technological detour on the path to combating climate change. This 'detour' could be considered to be a slight adjustment of the current energy system that produces oil. By way of confining the material properties of solar to the framework of this previous system, the longevity of the system that produces oil is extended.

We must first start with the technical system that defines the current implementation of solar energy on solar farms. While homeowners install several solar panels on their roofs with the aim of generating enough energy to appease their own consumption, large utility-scale solar farms made up of millions of solar cells aim to generate enough energy to appease the energy demand of thousands of businesses and homes. How do solar farms work? A solar farm provides energy to the electric grid much like fossil fuel energy plants, with the exception being that solar

farms produce zero pollution and use considerably less water than traditional power plants. On the ground, photovoltaic (PV) cells manufactured out of amorphous silicon are assembled into panels, each capturing a relatively small amount of the sun's energy. These panels are then installed on top of small posts and can cover thousands of acres, creating a sea of shimmering surfaces.⁴⁴

Solar farms vary in how they place their panels, some fix their PV panels in a static position, while others utilize a tracking system to follow the most efficient angle to the sun for energy production. A single panel produces little energy, it is the culmination of thousands of panels that create significant energy production, and hence solar farms are so large. Solar developers therefore need to buy or lease large amounts of land in order to be productive. Concentrated solar plants (CSP) use less land and utilizes mirrors and lenses to concentrate the sun's rays into heat, which drives a variety of more conventional generator systems. Despite the benefit of taking up less land, PV solar farms are much more popular and outnumber CSPs by 40 to 1.⁴⁵

Energy from the panels does not have to be used immediately. Many recent breakthroughs in solar have been in the technology used to store excess energy produced. The advent of solar batteries allows for energy to be stored for later use and expand the capacity of the solar system itself. During the night there is no source of energy for solar panels to absorb and therefore batteries are essential for providing energy during the unproductive segment of the 24 hour day. As a bonus, the energy stored in solar batteries serves as a short-term backup power source in the event that there's a power outage or shortage in a given area.

⁴⁴ For more in depth description of the technical system that produces solar energy on a solar farm see <https://www.solar-trade.org.uk/solar-farms/>.

⁴⁵ "U.S. solar market insight report 2013 year in review," GTM Research and Solar Energy Industries Association (SEIA), Boston, MA, and Washington, DC (2014).

Expanding out to the larger connectivity of solar farms, two gigantic plans for solar energy, the DESERTEC Project and the North Sea Project, have captured the imagination of the public. The two projects both aim to supply energy to Europe from electricity generated by solar farms located in desert regions of the MENA region. Connecting the regions would be a transcontinental network of new high-voltage transmission lines. These connective systems has been termed the “super-grid”, and is praised as providing a panacea for overcoming all the apparent insoluble problems of solar-generated power.⁴⁶ These projects would take decades to be fully realized and their grand design would cost near a billion dollars, which shows an alignment of the promotion of renewable energies and a desirable profit margin for business interests. Fundamentally, these projects represent the peak of a centralized energy system, perhaps even more centralized than the traditional energy system. They work under the logic that a new centralized structure for delivering renewable energies is needed, despite the decentralized nature of renewable energies being available at their point of consumption. Ultimately, projects like DESERTEC seek to decrease the amount of players involved in renewable energies for the benefit of the power industry and to the disadvantage of the regional and local level. While advance in design and some might say ‘innovative’, the process of limiting the number of players involved and limiting the sites of production allows for a mechanism of spatial concentration of production, commercial concentration of capital and the spatial concentration of value creation to arise as a reflection of the traditional energy system.

Taking an initial glance at the technical processes required to produce oil, we see the differences between solar energy and fossil fuel energy. The story of oil begins hundreds of millions of years ago. Tiny plants and animals died and sank into the sand and mud at the bottom

⁴⁶ Rajiv K. Varma, Shah Arifur Rahman and Tim Vanderheide, "Novel Nighttime Application of PV Solar Farms as STATCOM (PV-STATCOM)," *In Power and Energy Society General Meeting*, 2012 IEEE, 1-2.

of the sea. Over millions of years, the organisms decayed into the sedimentary layers of the Earth. As new sedimentary layers were deposited, they began to exert pressure and heat onto the underlying layers of sand, mud and decaying organisms. This heat and pressure distilled the carbon molecules of decaying organic matter into crude oil and natural gases. As the matter liquidated into oil, it began to flow into more porous layers of limestone and sandstone becoming reservoir rock. The movement of the Earth's tectonic plates trapped oil between layers of impermeable rock and formed vast reservoirs of compressed liquid organic matter.⁴⁷

In order to extract the precious liquid stored below the Earth's surface, a hole is first drilled down to the optimal depth for sustained oil extraction. Once this depth has been reached the drills are removed and a crew assembles a pump at the top of the newly created hole. The pump system consists of an electric motor driving a gear box that moves a lever. The lever pushes and pulls back and forth and moves a large rod up and down. The rod is attached to a large airtight plunger that creates suction. This suction is what draws up the oil from the depths of the newly created well. The crude oil located in the MENA region has a thin viscosity and so this system works exceptionally well. Oil in other areas of the world is much thicker and requires additional drilling and the use of steam pressure to thin the oil in the reservoir. This process is called enhanced oil recovery and is much more costly, making oil in the Middle East an even more profitable endeavor. Once the crude oil is out of the ground it is still not useable. It must first be shipped off to various oil refineries in order to produce the final product. A network of transport links, consisting of trucks, ships and pipes, is utilized to transport the oil to various refining plants and fossil fuel plants that are directly linked to the national power grid.⁴⁸

⁴⁷ For a more in depth description of the processes that form oil see Edwin Cey, Jordan Hanania, Kailyn Stenhouse, "Oil Formation," *Energy Education*, 2010. http://energyeducation.ca/encyclopedia/Oil_formation

⁴⁸ For further information on the technical procedure for extracting oil see Kelvin O'Donahue, "How Do Oil Field Pumps Work?" *Sciencing*, 14 March 2018. <https://sciencing.com/do-oil-field-pumps-work-5557828.html>

In order to compare and contrast the systems for solar farms and oil fields, we must go to the material level for the properties of each form of energy, which are equally important to the structural relations that produce energy networks. As mentioned in the introduction, this analysis is guided by the work of the French anthropologist, Bruno Latour. In his renowned book, *Reassembling the Social*, he argues that social forces alone are too weak to account for anything like the durable and complex structures that amalgamate society.⁴⁹ Within this description, the human and non-human must be given equal agency. Dismissing the agency of the non-human results in describing only part of the social factors that form a successful network.⁵⁰ By following this logic, this analysis begins focused upon the material and then expands to the ideological underpinnings that are co-constructive of the networks that enable oil and solar energy to be produced.

When each form of energy is investigated separately, there appears to be a great difference between the processes involved in the extraction of solar energy and oil. Foremost, there are many less stages that separate the initial ray of solar from the final use of that energy than the amount of time it takes for oil to initially form and the following technical procedures and transport required to finally consume it. This difference comes down to the material attributes of both forms of energy. Crude oil is a thick and heavily contaminated liquid that is only found in specific areas around the world. Secondly, where it is found, it is trapped beneath and between layers of stubborn rock, making oil difficult to find, extract and to make useable. Solar energy on the other hand, is a weightless interaction of highly energized photons that has no physical attributes as such. It is found no matter where you are on the surface of the Earth and

⁴⁹ Bruno Latour, *Reassembling the social: An introduction to actor-network-theory* (Oxford: Oxford university press, 2005), 3.

⁵⁰ Latour, *Reassembling the social: An introduction to actor-network-theory*, 85

is available whenever the sun is shining. Once the energy is captured it can be immediately be used in a vast array of applications.

Despite these material differences, the systems of energy described above are structurally quite similar. As the names suggest, a field and a farm are highly centralized areas of land that in this case have a singular purpose. The field or farm acts as a central hub of energy extraction and is processed by a large team of expertise that seek to create the most efficient yields. They both require considerable financial investment due to their scale and often encounter long delays before ever becoming efficient or profitable. This aspect represents the character of a planned economy that desires to create energy systems along the lines of the already established flows of power supply.

In the Middle East, a similarity in their location is observable too. The majority of the largest oil reservoirs are located in desert regions of the Middle East and similarly the desert regions in the Middle East experience the highest levels of solar energy throughout the year, hence solar is often heralded as holding the key to a potential desert economy. In many aspects these similarities point to the ways that both forms of energy are produced through the same structural network, despite their material differences. Zooming out to larger structural relations, the solar fields of the Middle East face a similar issue of expertise that oil in the Middle East also once faced. The technology and expertise required to create these projects is relatively new and the knowledge production centers for this technology are not currently located within the MENA region.

The expertise of oil was first produced in the US in the late 19th century. Oil rich nations like Saudi Arabia were in need of US oil companies to provide the technical knowhow in order to utilize their most profitable resource. Karl Twitchell was an American geologist who was

convinced there were significant oil deposits located in Saudi Arabia. He arrived in 1942 to start his scientific exploration of Saudi resources and began a close relationship with Saudi leadership. Utilizing funds from the American Standard Oil company, he began widespread expeditions across sparsely populated areas of the Saudi Kingdom.⁵¹ Returning from these trips he would inform the Saudi Government of his hopeful findings and how they may come to greatly benefit the kingdom. Throughout this process, Twitchell would pass on valuable data about water, agriculture and other natural resources, while doing so he would be providing them with a new set of terms and tools by which the Saudi government could understand their environment and how to manage it. The advice provided by early American experts in Saudi Arabia was not only taken into consideration but science itself was embraced and provided a means by which the leadership could justify their management of nature and society.⁵²

Jumping forward to 2017, the knowledge center for solar may be considered to be China. In 2016, China's solar energy production more than doubled. The National Energy Administration (NEA) reported that by the end of the year, China's solar capacity was approximately 77.42 gigawatts.⁵³ This surpasses the previous leader in solar production, Germany. China has made many ambitious plans for renewable energy and its investment in this sector have shown no signs of losing momentum. It will therefore most likely be Chinese expertise that arrive in Saudi Arabia to create highly technological solar farms. This is already evident in the manufacturing plans of JA Solar a leading Chinese manufacturer of solar panels. They are reportedly "redesigning some panels for very hot, dry deserts and others for extreme

⁵¹ Toby Craig Jones, *Desert Kingdom* (Cambridge: Harvard University Press, 2010), 13.

⁵² Jones, *Desert Kingdom*, 13

⁵³ Keith Bradsher, "China Looks to Capitalize on Clean Energy as U.S. Retreats," *The New York Times*, 5 June, 2017, accessed 20 January, 2018. <https://www.nytimes.com/2017/06/05/business/energy-environment/china-clean-energy-coal-pollution.html>

humidity.”⁵⁴ This tailoring of technology will allow them to serve cost effective solutions to the developing markets of solar energy in countries like Saudi Arabia. There is not an inherent problem in acquiring expertise from foreign nations, but it reaffirms the similarities in the early structural development of oil and solar. The first connections to Saudi leadership made by American scientists set the stage for US oil companies to invest in Middle East oil and we will likely see large investments into Saudi Arabian solar from Chinese energy companies.

To a potential investor it may seem promising that solar utilizes the successful structural network of already established energy systems, except this energy requires less stages in production and has the alluring quality of zero pollution. This is evident from the large sums of investment going towards 60 new solar field projects in Saudi Arabia as part of the Vision 2030 national economic plan.⁵⁵ Yet, by applying the same productive apparatus over solar energy production, the material characteristics of solar that make it unique are not fully utilized. In terms of a Latourian analysis, we can see how in this case the agency of solar is subverted and made to conform to the existing energy structure. For Latour this would represent an unsuccessful network, failing to provide equal agency to the material qualities of solar and the pressures of social forces or from the incumbent energy sector’s perspective, the amalgamation of social forces and the material qualities of oil create a successful network capable of suppressing other forms of energy.

2. Points of control: Small scale solar sites

Unlike oil, solar can be found everywhere, which means that a highly centralized structure is not required to produce solar energy. In fact, much of the success in the application

⁵⁴ Bradsher, “China Looks to Capitalize on Clean Energy as U.S. Retreats.”

⁵⁵ “National Transformation Program,” *Vision 2030*.

of solar panels has been from decentralized networks of solar panels installed on top of homes and commercial buildings. Entire neighborhoods have the opportunity to install solar panels on their roofs and completely remove their energy consumption from the national grid, whilst also supplying excess energy back into the grid. The early costs of solar made large investment projects the only viable option for solar production but the rapidly decreasing costs of solar cells has made the possibility for anyone to produce a productive amount of solar energy increasingly viable. This may present the disruptive element of solar for the power industry, but it is a problem they may have an answer to.

In late 2017, the Saudi Government released its policies and regulations for decentralized, small scale solar sites, i.e. solar panels installed on top of homes. At first glance, this shows the Saudi Government's openness to the possibility of decentralized energy production. Under further examination, these policies may in fact represent a consolidation of control over solar energy production. For the power industry, homeowners producing their own energy can pose a major dilemma to the balance of supply and demand meticulously calculated by power grid engineers. In Saudi Arabia you must connect your solar system to the national grid and any surplus of energy you produce is fed into the grid to be used elsewhere. A credit scheme has been adopted to reimburse consumers for their excess production, in which consumers receive energy credits they can use to redeem their contribution, resulting in potentially free electricity. This could be seen as incentive for consumers to invest in establishing their own solar systems, however, this is the only form of incentive consumers receive for their costly and time intensive investment.

Setting up your own solar system in Saudi Arabia costs more than \$10,000, and can go much higher depending on the level of energy production desired and the quality of components

used, not to mention maintenance fees.⁵⁶ After one has chosen their solar contractor, sent in an application for a small scale solar site inquiry to the government, completed a distribution impact survey, paid a fluctuating application fee, received an application validation, applied for a municipal permit for building regulations, received design approval from the national electricity company, undergone an inspection by the national electricity company and installed a net metering system, one can finally begin to watch their hefty investment pay off.⁵⁷ Unfortunately, it is unlikely one would see a return on their investment for decades. For energy credits will only compensate you for energy you don't produce, if you have a highly efficient solar system you will most likely be feeding more energy into the grid than you will receive back. Saudi laws prohibit you from sharing any excess electricity among your community or allocating your surplus to any other home.⁵⁸ This means that the most sensible financial decision would be to invest in a suboptimal solar system that is capable of producing the bare minimum of energy to offset the cost of energy consumed from the grid. This way the minimal costs for set up are incurred and the maximum benefit of free electricity is still received. In the credit system described here, the centralized structure of the traditional energy suppliers is maintained and the disruption caused by those financially able to establish solar systems is minimized. All energy is still connected to the national grid and all decisions related to small scale solar sites are at the discretion of the incumbent national power company.

⁵⁶ Sara Mataci, "How Much Do Solar Panels Cost in the U.S. in 2018?" *Energy Sage*, January, 2018, accessed 24 April 2018. <https://news.energysage.com/how-much-does-the-average-solar-panel-installation-cost-in-the-u-s/>.

⁵⁷ "Small-Scale Solar PV Systems Regulations," Electricity and Cogeneration Authority, Saudi Arabia, 21 August 2017, accessed 10 April, 2018. <http://www.ecra.gov.sa/ar-sa/ECRAREgulations/Regulations/SiteAssets/Pages/Small-Scale-Solar-PV-Net-Metering-Regulations.pdf>, 15.

⁵⁸ "Small-Scale Solar PV Systems Regulations," Electricity and Cogeneration Authority, Saudi Arabia, 13.

3. The timeline of energy transitions: Solar in the context of energy history

How do solar systems fit into the narrative of energy over the course of recent history?

Up until 200 years ago, humans solely enjoyed the use of renewable forms of energy. Since then the human race has transferred its major energy sources from natural photosynthesis, animal and human labor, to coal and then to oil. Each change is referred to as an energy transition or sometimes an energy revolution. Timothy Mitchell, a political scientist, describes a timeline from the humble beginnings of energy to the braggadocios hegemonic role of oil in society today in his book *Carbon Democracy: Political Power in the Age of Oil*. He sets out the abilities to transform society that each new form of carbon enabled and stops short of the perceived upcoming transition to man-made renewable forms of energy.⁵⁹ If he were to continue his exploration, he would likely move onto solar energy as the next fuel for civilization. Interestingly, solar energy could be perceived to derail the timeline he sets forward, as solar marks a return to the original energy source that our ancestors depended on throughout pre-modern history.

However, Mitchell is unlikely to agree with this romanticized view of the advent of solar technology. For Mitchell what allowed for oil to structurally challenge the pre-existing order of a coal based economy was the inherent material qualities that pertain to oil.⁶⁰ Oil's liquid state made it easily transportable in comparison to coal and the ability to mechanize its extraction meant less forms of manual labor were required to produce it. The concentrated locations of oil reservoirs then allowed for the establishment of highly centralized technical zones. He refers to a 'technical zone' as a set of coordinated "regulations, calculative arrangements, infrastructures

⁵⁹ Timothy Mitchell, "Carbon Democracy," *Economy and Society* 38, no. 3 (2009): 399.

⁶⁰ Mitchell, "Carbon democracy," 399.

and technical procedures that render certain objects or flows governable.”⁶¹ In terms of infrastructure, the development of solar farms only offers adjustments and minor improvements to the structures that oil allowed for. Solar energy can be easily transported via electrical wires, its extraction is an entirely mechanized process and the centralized form of solar farms offers the possibility for the same manageable ‘technical zone’. Despite solar energy’s climate neutral impact, solar farms don’t represent anything close to what we can consider a natural production of energy. The intense level of technological knowledge and management needed for solar farms is a vast abstraction from the organic process of photosynthesis. The solar farm is characterized by its ability to control and manage the energy flow from the sun. The fact that solar farms are exclusively funded and managed by large companies and governments only goes to reify the notion that it is the responsibility of a nation to exploit and control its resources.

By viewing solar farms as a natural process that are an inevitable step towards progress, we lose focus of the current network of oil flows and instead wait in anticipation of an improved future. This could be understood as a pacifying ideology that disconnects oil and its far reaching branches, expecting that the narrative of progress and modernity will provide solace.

4. Competing energy: Renewable energies dependency on the future of oil management

Failure to consider the material and systemic differences between traditional energy and renewables will lead us to believe that the incumbent energy sector will only be broken once renewable energy has become “competitive” or cheaper to produce. However, this is clearly an error, as the incumbent sector enjoys a wealth of other revenues from downstream sectors, like

⁶¹ Mitchell, 409.

the petrochemical industry, producing various refined oils, plastics and other carbon based materials. The previous sections under this chapter discussed the technical procedures for solar and oil production, the material qualities of each and the historical context within which solar energy has arisen. These factors provide the basis on which this section will synthesize the perspective of an oil company in relation to the potential of renewable energies for systematic disruption.

The traditional energy system is organized to be in constant parallel to the various streams of energy it produces. For instance, if Saudi Arabia removes one key element, such as the traditional power plant, then replaces it with a renewable energy source, there will be immediate effects to the upstream sector and the downstream sector. The previous source of energy for the power plant will need to find a new customer or it will no longer be in demand and in addition, the price of the previous energy source will be affected with further knock on effects to the economic feasibility of its transportation infrastructure. This disruption continues downstream to the transmission networks, which are individually tailored for each power plant location. It is very rare that renewable energy is produced in the same location as traditional energy, therefore the costly transmission structures would become superfluous. There are no studies that fully evaluate the costs of the entirety of the oil system and its various downstream industries for Saudi Arabia. While we can identify the profits made by oil companies or the oil industry, we are not able to fully grasp every way in which oil has seeped into industries that are seemingly detached from oil companies, but are still very much dependent upon them.

Hence, it is inaccurate to assume that traditional energy companies are considering the transition to renewable energies by examining the costs of production for renewable energies. An energy company like Aramco is instead using a different criteria, in which the system costs

become decisive. The byproducts generated by the system that produces oil, such as lubricants, fertilizers and various plastics are entire industries in themselves and once a location for processing these byproducts is removed, it simply becomes waste. The knock on effects within this chain of production and consumption are so powerful that the power companies become prisoners of their own structures. They struggle to implement renewable energies without majorly disrupting their economic rationality. Thus, all renewable energy movements should be limited and designed to minimize any negative impact on their established system. In this process renewable energies become a cover or a minor adjustment. The biggest threat to the incumbent sector often comes from third parties, where technologies and development can be made outside of their control. Consequently, their hand is forced and in order to maintain control they must be active in the field of renewable energy as not to be left behind. However, all their pursuits must be deemed compatible with their own established system.

This is why large scale solar sites are deemed acceptable, they pose minor changes to the structure of energy flows and they allow for the same level of control that the incumbent sector have over traditional energy supplies. Also, steps toward nuclear energy are made within long-term time frames and again pose little threat to their element of control. Even small scale solar sites are made to conform by protecting the ways in which electricity can be transmitted and by retaining ownership of all energy produced. From the perspective of the incumbent energy sector a rapid energy transition appears impossible, and so it is, unless they are prepared to destroy their own capital.

5. Temporal dilemma: Technology's contribution to the longevity of oil

When confronted by the promises of renewable energies they seem inevitable, as oil is a finite resource. There always will be a finite amount of oil, so why should we care about the

efforts of the incumbent energy sector, when it will clearly all be in vain? While the amount of oil the world can extract is limited, this has never meant there is a scarcity of it. Quite the contrary, many issues arise out of the abundance of oil that's contained in large reservoirs around the world. Saudi Arabia alone holds an estimated 268 billion barrels of oil, which according to OPEC's predictions, would provide the nation with 70 years of continuous production at the current rate of extraction.⁶² These figures are a major source of contention among analysts as British Petroleum (BP) has announced that global oil reserves "would be sufficient to meet 50.6 years of global production at 2016 levels".⁶³ Much of this disparity comes from the questioned transparency of companies' proven oil reserves and the methods for predicting future oil discoveries. Questions arise as to why Saudi Arabia may want to embellish their figures and how such figures are initially reached. Answering these difficult questions would require knowledge and insight into the highest echelons of the Saudi Government that academic literature and external research can't provide. While we cannot truly determine the validity of these figures, these are the same figures used by governments, NGOs and other institutions and represent the public understanding of the state of oil production.

⁶² John Kemp, "Saudi Arabia's Oil: How big are they really," *Reuters*, 5 July, 2016, accessed 25 January, 2018. <https://www.reuters.com/article/us-saudi-oil-kemp/saudi-arabias-oil-reserves-how-big-are-they-really-kemp-idUSKCN0ZL1X6>

⁶³ "Oil Reserves," British Petroleum, 2016, accessed 25 January, 2018. <https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/oil/oil-reserves.html>.

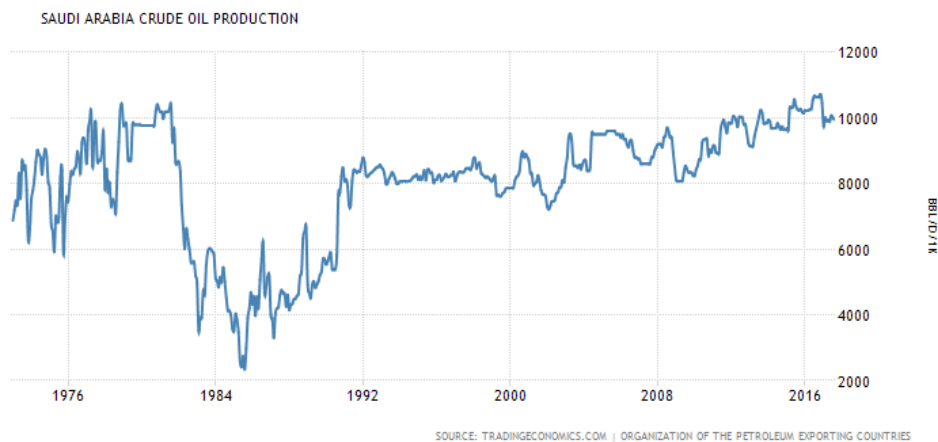


Fig.1 Saudi Arabia crude oil production from 1970-2016. “Saudi Arabia Crude Oil Production.,” *Trading Economics*, accessed 13 March, 2018. <https://tradingeconomics.com/saudi-arabia/crude-oil-production?embed>.

Be that as it may, this essay assumes that the Saudi productive capacity for oil is the second largest in the world and that it has held its positions as one of the world’s top oil producers since the 1970s, excluding drops in production throughout the 80s. Looking at fig.1, if we exclude the data from the 1979 global oil crisis and its resulting price shocks, we can see that Saudi Arabia has been able to consistently produce between 8000-10000 million barrels per day. Even if we take into consideration the plummet in production during the 80s, the quick recovery to the average in 1989 is exemplary of Saudi Arabia’s continuous ability to produce oil at a considerably high rate.

Despite Saudi Arabia’s large capacity for oil production, the oil industry itself is characterized by its historic fluctuations and competitive networks of supply. Oil unlike its predecessor, coal, is fluid and flexible, which presents unique problems for managing its production and distribution networks. Oil’s fluid nature meant that it was easily transportable in large quantities across vast distances, which contrasts bulky and heavy coal. For oil companies in the early days of oil production, it meant that they were always vulnerable to the possibility of cheaper oil being produced somewhere out of their control. Timothy Mitchell argues that the oil

companies' response the issue of global competition was to create new regulatory policies and employ restrictive intervention.⁶⁴ He describes what emerged as a political and technical apparatus: A set of coordinated regulations, meticulous calculations, infrastructures and technical expertise coalescing into a highly governable and sustainable flow of energy. The purpose of this apparatus is to sustain a manufactured system of limited supply. This is a process that to an extent disregards the quantifiably finite amount of oil and instead creates the conditions necessary to retain the profitability of oil.

In Saudi Arabia this apparatus began to emerge at the end of the Second World War in which US oil companies considerably reduced or terminated the production of oil throughout the Middle East. WWII acted as an unofficial regulatory factor, by restricting the flows of oil within the global market and set the stage for official restrictions to be produced. Ibn Saud 1932-1953, the founder of Saudi Arabia, dissatisfied with the loss of revenue throughout WWII, implored the US to compensate the Saudi Monarchy. The threat to the US if they didn't agree would be devastating to their domestic oil production, as Saudi Arabia had the ability to dump cheap oil into the market. This would make oil production less profitable and could potentially force many nations to produce oil at a loss. The US Government responded with the Lend Lease Bill of 1941. As part of the Lend Lease bill, Washington approved payments in the form of aid and military packages to Saudi Arabia for not producing oil.⁶⁵ Mitchell points to this arrangement as the start of "Saudi collaboration in restricting the flow of oil... As though it were a system for 'protecting' the oil against others."⁶⁶ This would mean that Saudi Arabia would not exhaust their resources and that none of the US's adversaries would be able to benefit from a potential bargain

⁶⁴ Timothy Mitchell, "Carbon Democracy," *Economy and Society* 38.3 (2009): 409.

⁶⁵ Mitchell, "Carbon democracy," 409.

⁶⁶ Mitchell, 410.

on price per barrel. In a game theory fashion, the Lend Lease Bill solution allowed for the US and Saudi Arabia to engage in tacit collusion, an agreed upon strategy without explicitly stating it. From then on, Saudi Arabia's oil production would be regulated, restricted and partly funded by the security interests of the US. It must be noted, in the following decade many further constraints would be built upon bill but the Lend Lease bill of 1941 is indicative of the regulations implemented to ensure production is agreeably sustained.

The second method of maintaining oil's manufactured scarcity, or in other words oil's profitability, was to ensure a higher and sustained demand for it. To explain this, Mitchell points to the emergence of carbon-heavy lifestyles in the western world. He describes how the US focused on producing vehicles with V8 engines opposed to the more reliant V2 and V4 European engineered engines. The new V8 engines became the "dream of every middle-class family." Even today, one can look at the latest car magazines and observe the prowess afforded to American muscle cars and the apparent luxury of a 4x4 SUV. Mitchell argues that these gas guzzling vehicles helped to form desirable carbon-heavy American lifestyles that in light of new production regulations in the Middle East "would help the oil companies keep oil scarce enough to allow their profits to thrive."⁶⁷

It is not clear whether there is a causal relationship between the creation of new carbon-heavy lifestyles and the need to manufacture oil scarcity. However, it is undeniable that the US has normalized their extraordinary level of oil consumption. Whether it be the in the car industry or the explosion of domestic electrical appliances, such as refrigerators, food processors and washing machines, everyday middle-class life became fixated on one's engagement with a specific mode of energy consumption. Ultimately, oil companies could be rest assured that the

⁶⁷ Mitchell, 410.

continuous demand for oil would satisfy their desired capacity for oil production. In this framework oil has the appearance of only just meeting global demand or at times being scarce, yet in reality the oil market is benefiting from regulations and policies created to restrain and limit the amount of oil available.

The process of creating a limited supply of oil was operating in an isolated market until recently. The advent of pragmatic renewable energies provides an alternative and therefore the monopolistic manipulations of price and supply for oil become less and less effective. However, renewable energies may not simply abolish the status quo, instead they may have the ability to increase the longevity of the incumbent energy sector. Counterintuitively, renewable energies now have the potential to become a new instrument under the control of the incumbent energy sector, giving them the ability to restrain and limit the amount of oil available for decades to come.

The Kingdom's consumption of its own oil production has steadily been increasing and it currently consumes approximately one quarter of its own production every year.⁶⁸ This means that Saudi Arabia consumes more oil than a heavily industrialized nation like Germany, with over triple the population and an economy five times larger. Citigroup's analyst, Heidy Rehman made the statement in 2012 that "As a result of its subsidies we calculate 'lost' oil and gas revenues to Saudi Arabia in 2011 to be over \$80 billion," essentially stating that Saudi Arabia's profit margin is drastically diminished by their own consumption rates.⁶⁹ If it were possible to wean the Kingdom's population off of oil and instead provide them with renewable energies for

⁶⁸ Dermot Gately, Nourah Al-Yousef, and Hamad MH Al-Sheikh. "The Rapid Growth of Domestic Oil Consumption in Saudi Arabia and the Opportunity Cost of Oil Exports Foregone," *Energy Policy* 47 (2012): 59.

⁶⁹ James Burgess, "Saudi Arabia Could Become a Net Oil Importer by 2030," *Oil Price*, 5 September, 2018, accessed 13 February, 2018. <https://oilprice.com/Latest-Energy-News/World-News/Saudi-Arabia-Could-Become-a-Net-Oil-Importer-by-2030.html>.

domestic consumption, the energy sector would be presented with a number of economic opportunities.

Firstly, if domestic oil consumption can be offset, there will be more oil available for export, a market in which Saudi Arabia does not have to bear the burden of subsidies. They will be able to gain a larger amount of oil revenues by simply selling their commodity elsewhere. However, there are various risks involved in increasing the amount of oil exported, for example, if Aramco were to suddenly redirect all the oil produced for the domestic market to the international market they would flood the global market and cause the price of oil to plummet. Alternatively, they could simply reduce production rates and maintain their current level for oil exports. However, the benefit in this scenario is that every year they are able to hold onto one quarter of their own supply, meaning every four years they gain a year of producing oil at the current rate in the future. Additionally, they will always have a surplus to fall back on if the market dynamics change and require them to export oil at a higher rate. In this situation not only are they able to safely maintain oil exports, but also maintain a surplus in the event of increased global demand for oil.

While Saudi Arabia oil production has traditionally relied on the energy consumption in the West, specifically the US, growth in demand for fossil fuels is largely coming from developing nations in the East, specifically China and India. This is a steadily growing market, one that Saudi Arabia is fully capable of supplying. The International Energy Agency, an autonomous intergovernmental organization established in the wake of the 1973 oil crisis, reports that, “Global energy needs will rise more slowly than in the past but still expand by 30%

between today and 2040. This is the equivalent of adding another China and India to today's global demand."⁷⁰

As one of the largest energy consumers, China's energy choices will play a huge role in determining global trends, and have the potential to influence a faster clean energy transition. China's energy development, technology exports and global investment provide a fundamental determinant of momentum towards a low-carbon energy transition. The IEA reports, "One-third of the world's new wind power and solar PV is installed in China in the New Policies Scenario, and China also accounts for more than 40% of global investment in electric vehicles (EVs)." While China's array of investments into clean energies is a promising move away from fossil fuel dependency, it cannot be ignored that China is predicted to overtake the United States as the largest oil consumer around 2030.⁷¹ It is this growing market that Saudi Arabia will be fully able to exploit, provided they can maintain the profitability of their oil exports and ensure there is continuous production of oil for the decades to come.

⁷⁰ "World Energy Outlook 2017," *International Energy Agency*, 2017, accessed 13 February, 2018. <https://www.iea.org/weo2017/>

⁷¹ "World Energy Outlook 2017," *International Energy Agency*.

Chapter III: Social Energy Transition

1. Political monarchy: Why Saudi Arabia can choose energy transition

Saudi Arabian politics operates within the context of a totalitarian monarchy, in which the King is both the head of state and government. The majority of decisions are made through consultation among the senior leadership of the royal family and the religious establishment. Political activities outside of the royal family are considered to be very limited. Recent internal disputes among the royal family have led to a considerable consolidation of power in the hands of Crown Prince Mohammad bin Salman. He was a relatively insignificant figure until in June 2017 he was elevated to the position of crown prince, replacing his cousin Mohammed bin Nayef.⁷² The most prominent exercise of his power was seen in early November 2017, when the world saw Saudi princes, politicians and businessmen rounded up, arrested and detained at the Ritz-Carlton hotel in Riyadh, as mentioned in chapter 1. It is difficult to gauge whether this event was a true act of intolerance for internal corruption or a scheme to fill the state coffers. Saudi Attorney General Saud al-Mojeb announced that the campaign had brought in more than \$106 billion. This constituted financial settlements, including seized real estate assets, commercial entities and securities and cash from the detainees themselves in exchange for their freedom.⁷³ While we can speculate the reasons behind this event, it is clear that the Crown Prince has accumulated a strong hold on power within the nation.

As the reformer behind the Vision 2030 program, he is expected to shape the nation for decades to come by primarily shifting the economy away from its oil addiction. His vision is

⁷² “Saudi Crown Prince Mohammed bin Salman, power behind the throne,” *BBC News*, 7 March, 2018, accessed 13 April, 2018. <http://www.bbc.com/news/world-middle-east-40354415>.

⁷³ Martin Chulov, “Saudi Arabia Claims Anti-Corruption Purge Recouped \$100bn,” *The Guardian*, 30 January, 2018, accessed 24 April, 2018, <https://www.theguardian.com/world/2018/jan/30/anti-corruption-purge-nets-more-than-100bn-saudi-arabia-claims>.

unlikely to face obstruction, as those who might have contested his decisions are bound to be fearful of retribution. The extent to which Vision 2030's goals are realized and whether or not they impact climate change issues is reliant on the leadership of the Crown Prince. While we may presume the Crown Prince is unlikely to significantly compromise revenues produced from the exportation of oil, this turn of events has taken much of the world by surprise. We only have to look back ten years to see Saudi Arabia's pattern of obstruction towards any policy limiting their abilities to export oil.

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⁷⁴ Parallel progress policies are policies that require advancements to be made in one area under the conditions advancements are made in another. In 2007, Saudi Arabia warned that, if developed countries did not agree to its demands on related to the adverse effects of limiting fossil fuel emissions, this "could result in issues of importance to certain other parties being blocked too". A comment made at the 2007 Vienna climate change talks by the Saudi delegation.

obstructionist to climate change objectives. In her last sentence she summarizes that “for now, any signs of a softening in the Saudi negotiating position remained well hidden.”⁷⁵

If, as Depledge claims, Saudi Arabia has been directly impeding the progress of climate change objectives, then Vision 2030’s and the Saudi INDC goals point to a significant decision made in just the last ten years to work more cooperatively within the climate change discourse. A decision that likely underwent much deliberation, as now they must slowly retreat from their historically hostile approach. Their rapid change of heart over the last ten years suggests the protections they deemed essential are not matched by the agency of Saudi leadership. While some barriers are plausible concerns for Saudi Arabia, like the effects of limiting oil production, their attitude towards these barriers is much more malleable than their past position conveyed.

2. Global aspirations: Saudi Arabia’s energy position between China and the US

As opportunities for investment in solar power open up in Saudi Arabia, it’s resources and knowledge from China that seem most promising for the emerging market. Saudi Arabia and China have a growing strategic relationship and share some common interests in relation to the future of energy supply and demand. Saudi Arabia was historically one of a few nations to recognize and have diplomatic relations with the Republic of China (Taiwan), however these diplomatic ties ended in the early 90s and has, to an extent,⁷⁶ eliminated this point of contention between China and Saudi Arabia. China’s relationship to Taiwan is a tense political conflict, however it appears Saudi Arabia’s historical relationship to Taiwan has become superseded by energy trade between Saudi Arabia and China.⁷⁷ Developments in Saudi Arabia, one of the

⁷⁵ Joanna Depledge, "Striving For No: Saudi Arabia in the climate change regime," *Global Environmental Politics* 8.4 (2008): 35.

⁷⁶ Saudi Arabia and the ROC still maintain economic representative offices and trade relations.

⁷⁷ Muhamad Olimat, *China and the Middle East: from silk road to Arab spring* (Abingdon: Routledge, 2012), 106.

world's largest oil producer, will have major implications for China, the world's largest oil importer. As China's energy demands rapidly increase, their reliance on foreign imported oil will make Saudi Arabia an essential partner for years to come.

Indicative of this tightening relationship, Saudi King Abdullah bin Abdulaziz Al Saud visited China in January 2006, his first official state visit to another country.⁷⁸ The primary focus of this trip was to foster a cooperative spirit between the two nations in relation to oil, gas and mineral trade. Just three months later, President Hu Jintao made his first state visit to Saudi Arabia and this marked the first time China and the Arab world had made such significant high-profile exchanges within such short period of time.⁷⁹ This only reinforces the importance both sides saw of strengthening their energy relationship. These high profile state visits have become increasingly common. In January 2017, China's president Xi Jinping visited Saudi Arabia and stated hopefully he wants to lift "co-operation in various fields to a new level."⁸⁰ In March 2017 this manifested itself, as present King Salman oversaw the signing of deals worth \$65 billion dollars during his visit to Beijing. The deals included the cooperation of the Saudi state oil company, Aramco and China North Industries Group Corp (Norinco) on the construction of oil and chemical refinery plants in China.⁸¹

Aside from oil trade, Saudi Arabia and China may also greatly benefit one and other by pursuing their mutual interests in solar power. China is the world's largest producer of solar energy and Saudi Arabia's geographical position allows them to enjoy a comparative advantage

⁷⁸ Yang Guang, and Mehdi Parvizi Amineh, "Globalization of Energy: China and the European Union," *International comparative social studies*; v. 21. Brill Academic Publishers, (2010): 189.

⁷⁹ Guang and Amineh, "Globalization of Energy: China and the European Union," 190.

⁸⁰ "China's President Xi Visits Saudi Arabia to Improve Tie," *BBC News*, 19 January, 2017, accessed 13 February, 2018. <http://www.bbc.com/news/world-middle-east-35351391>.

⁸¹ Robbie Gramer, "Saudi Arabia, China Sign Deals Worth Up to \$65 Billion," *Foreign Policy*, 16 March, 2017, accessed 13 February, 2018. <http://foreignpolicy.com/2017/03/16/Saudi-arabia-china-sign-deals-worth-65-billion-boost-trade-ties-oil-energy-one-belt-one-road-saudi-vision-2030/>.

in solar production. As stated in chapter 2, section 5, Saudi Arabia's solar production could dramatically reduce the Kingdom's domestic oil consumption, open up oil resources for international export and lower global oil prices. Cooperation in the solar energy field could see China secure foreign oil imports and support the emergence of a large solar industry in Saudi Arabia.

Perhaps even more importantly, developments in Saudi Arabia as part of Vision 2030 will have rippling effects throughout the Islamic world. Saudi Arabia is home to Mecca, Medina and other holy sites, places of great religious and spiritual importance for the approximately 1.6 billion Muslim individuals in the world. Muslims are projected to make up 26.4% of the global population by 2030, approximately 2.2 billion individuals.⁸² China's ever expanding global influence and interaction will likely lead to further and deeper relations with Muslim-majority societies in Malaysia, Indonesia, Pakistan, Iran and others. China's future relations with these nations and Muslim-majority societies will likely be influenced and shaped by their growing relationship with Saudi Arabia.

These recent developments display a directional change in outlook for Saudi Arabia, a nation often noted for its relationship to the US and more generally, the West. The relationship between the US and Saudi Arabia is, perhaps, an unexpected one. On the one hand, Saudi Arabia is an extremely conservative, Islamic, totalitarian monarchy. On the other, the US is a liberal, secular, constitutional republic. Despite this, the two countries have been allies since diplomatic relations were officially established in 1933.⁸³ The most common exchanges between the two nations often relate to regional security in the Middle East and the trade of oil and arms.

⁸² "The Future of the Global Muslim Population," *Pew Research Center*, 27 January, 2011, accessed 13 February, 2018. <http://www.pewforum.org/2011/01/27/the-future-of-the-global-muslim-population/>.

⁸³ Benson Lee Grayson, *Saudi-American relations* (University Press of America, 1982), 38.

This relationship has never been short of tension. Most notably, the US's outrage over the alleged role of Saudi Arabia in the September 11th, 2001, terror attacks on New York City's World Trade Center.⁸⁴ In the aftermath Saudi Arabia's image was tarnished within the U.S. political discourse and US media.⁸⁵ In September 2016, the US Congress passed the Justice Against Sponsors of Terrorism Act that would allow relatives of victims of the September 11 attacks to sue Saudi Arabia for its government's alleged role in the attacks.⁸⁶

This tension points to the major disparity between the two countries, but also the relative small effect this has on the deals between the two governments that continue to be signed. Most recently, US President Donald Trump authorized \$110B in arms deals with Saudi Arabia, worth \$300B over a ten-year period, signed on the 20 May 2017.⁸⁷ The deal includes the use of US military personnel to train Saudi forces and engage in close co-operation with the Saudi Arabian military. On the other side, Saudi Arabia continues to satisfy the US's demand for imported oil.

In regards to renewable energies, the US hasn't shown any major interest. The US Department of Energy's (DOE) Office of International Affairs has a strong relationship with Saudi Arabia's Ministry of Energy, Industry and Minerals, supported by an annual Bilateral Energy Dialogue (BED). BED, according to the DOE, "provides an opportunity to address issues

⁸⁴ While the US has made it possible for 9/11 victims to legally sue Saudi Arabia (see footnote: 60), the publication of a letter written by Nail Al-Jubeir, director of the information office of the Royal Embassy of Saudi Arabia in Washington DC, denies the charge that the government of Saudi Arabia had played a role in the 9/11 terrorist attacks. Nail Al-Jubeir, "Saudi Government Denies Funding 9/11 Attacks," *Politico*, 14 April, 2017. <https://www.politico.com/magazine/story/2017/04/saudi-government-denies-role-in-funding-9-11-attacks-215014>.

⁸⁵ The 28 pages were released in order to quell speculation and conspiracies that had resulted after many of the terrorists involved were identified as Saudi Arabian. Jim Sciutto, Ryan Browne, and Deirdre Walsh, "Congress releases secret '28 pages' on alleged Saudi 9/11 ties," *CNN*, 15 July, 2016, accessed 10 March, 2018. <https://www.cnn.com/2016/07/15/politics/congress-releases-28-pages-saudis-9-11/index.html>.

⁸⁶ Joseph Ax, "Families of Sept. 11 victims sue Saudi Arabia in U.S. court over attacks," *Reuters*, 21 March, 2017, accessed 10 March, 2018. <https://www.reuters.com/article/us-usa-saudi-sept11/families-of-sept-11-victims-sue-saudi-arabia-in-u-s-court-over-attacks-idUSKBN16S29I>.

⁸⁷ David Javirer, "US-Saudi Arabia Seal Weapons Deal Worth Nearly \$110 Billion Immediately, \$350 Billion Over 10 Years," *CNBC*, 20 May, 2017, accessed 10 March, 2018. <https://www.cnbc.com/2017/05/20/us-saudi-arabia-seal-weapons-deal-worth-nearly-110-billion-as-trump-begins-visit.html>.

of mutual interest... an opportunity to exchange information on oil and natural gas outlooks, electricity development plans and potential nuclear power development.”⁸⁸ It would seem the scope of this energy relationship does not contain the development of renewable energies, but rather entails discussions of maintaining the status quo of oil trade.

It appears the rise of renewable energy production in Saudi Arabia will have a minimal effect on US - Saudi Arabian relations, however, China and Saudi Arabia are quickly positioning themselves to work together in regards to the future of energy production in their respective countries. While the US first sent its scientists to Saudi Arabia to find oil and following this US oil companies acquired the ownership of said oil, an arguably exploitative relationship, China’s involvement in Saudi Arabia’s solar production is less likely to result in Chinese energy companies establishing themselves in Saudi Arabia. Instead, it is more probable that China and Saudi Arabia’s common interests in solar and oil will foster a more intimate and cooperative relationship. This is in line with the Vision 2030 foreword made by Crown Prince Mohammed Salman, in which he states that the third pillar of his vision is to transform Saudi Arabia’s unique geographical location into a global hub connecting three continents. The continuation of US-Saudi relations and the creation of strong Chinese-Saudi relations will significantly enable the Kingdom of Saudi Arabia to become “an epicenter of trade and the gateway to the world.”⁸⁹

3. Labor without fossil fuels: Saudi Arabian labor challenges in tandem with economic change

Saudi Arabia first experienced a high influx of foreign workers after oil was discovered in the late 1930s. These foreign workers were primarily Arab and Western technical and

⁸⁸ “U.S.-Saudi Arabia Energy Cooperation,” *Department of Energy: Office of International Affairs*, accessed 10 March, 2018. <https://www.energy.gov/ia/international-affairs-initiatives/us-saudi-arabia-energy-cooperation>.

⁸⁹ “Foreword,” *Vision 2030*, 2016. <http://vision2030.gov.sa/en/foreword>.

professional personnel, however, foreign labor since then has been substantially composed of agricultural, cleaning and domestic services workers from Southeast Asia. According to a G20 Labor Market Report published by Saudi Arabia in 2016, 53% of their total workforce is composed of foreign labor. This percentage is much higher for the private sector, where 89% of employees are foreign workers.⁹⁰ In tandem with Saudi Arabia's planned economic reforms, the nation has launched a voluntary policy called *Nitaqat* (نطاقات), or as it is commonly referred to "Saudization". Since September 2011, this policy has focused on three main goals: "1. Increase employment for Saudi nationals across all sectors of the domestic economy. 2. Reduce and reverse over-reliance on foreign workers. 3. Recapture and reinvest income which otherwise would have flowed overseas as remittances to foreign worker home countries."⁹¹

This policy has the potential to cause major disruptions across many sectors of the Saudi economy. Robert Looney, a distinguished scholar of Middle East economies published an essay on the compatibility of economic reforms and the Saudization policy in *Strategic Insights*, a monthly electronic journal produced by the Center for Contemporary Conflict. In his essay, "Saudization and Sound Economic Reforms: Are the Two Compatible?", he states that, as of now, it is too early to gauge the lasting impacts of Saudization on the economy. The first result he anticipates is that "Saudization will reduce their competitiveness and for that reason may decide to leave the Kingdom for a more business-friendly environment."⁹² This is not a new trend for Saudi Arabia, as can be seen in a report in *World Markets Analysis* from 2003, which

⁹⁰ "Saudi Arabia Labor Market Report 2016," *Ministry of Labor and Social Development*, 3rd edition, July 2016, 10.

⁹¹ Robert Looney, "Saudization and Sound Economic Reforms: Are the two compatible?" Naval Postgraduate School, Monterey CA, *Center for Contemporary Conflict*, (2004): 4.

⁹² Robert Looney, "Saudization and Sound Economic Reforms: Are the two compatible?" 5.

stated that 2,500 Saudi companies planned to establish themselves in Dubai, UAE, instead of in the Kingdom.⁹³

Secondly, he expects that health and safety within the private sector will improve drastically in order to entice the 44% of the population under the age of 24 that make up the highest levels of unemployment for the nation. Looney goes on to identify the compounding problems that contribute to this situation. One aspect is the lack of a robust education system, which has failed to encourage the acquisition of technical skills for Saudi youth. The other factor is that perceptions of what are considered menial jobs, often with low pay and poor working conditions that are refused by Saudi graduates and further create dependency on foreign workers who are less discriminating against less favorable work conditions.⁹⁴ Both the shortage in technical education and Saudi youth's perception of work conditions in technical industries restrict and reduce the potential pool of workers in the nation.

By providing vocational training, encouraging the creation of trainee programs and internships, awarding scholarships and reforming school curricula, Saudi Arabia will be able to increase their supply of technical skills and expertise among potential national workers. However, this only tackles one aspect of the problem. If Saudization targets are to be met in more hazardous and labor intensive sectors, most significantly construction, then drastic improvements are needed in health and safety conditions to attract Saudi nationals. Saudi Arabia's rapid urban developments have been made possible to a large degree by the use of cheap foreign labor and plans for new cities and industrial complexes are showing no signs of

⁹³ Kate Kuxford, "Poor Regulatory Environment in Saudi Arabia Leads Local Companies to Set up in UAE," *World Markets Analysis*, 19 December, 2003.

⁹⁴ Robert Looney, "Saudization and Sound Economic Reforms: Are the two compatible?" 6.

slowing down. Emerging out of Vision 2030, a new so called mega city, NEOM⁹⁵, was announced by the Crown Prince on October 24, 2017.⁹⁶ This is planned to be an even larger project than the King Abdullah Economic City announced in 2005, a project that is still yet to be completed. While the plans and construction deadlines are unclear for NEOM, the question still remains, is Saudi Arabia willing to improve wages and working conditions in the construction sector to entice Saudi nationals, or will progress in this area be sacrificed in order to satisfy the Kingdoms insatiable appetite for new urban and economic centers?

While Looney comments on young Saudi nationals' unfavorable perception of the construction and oil and gas sectors of Saudi Arabia, he does not comment on perceptions of the emerging renewable energy sector. While similar amounts of labor are required for oil field operations on a solar farm project, we can assume that construction of solar sites subjects workers to less hazardous conditions and their operation is certainly less perilous. Construction of solar farms requires less work with large and heavy industrial metal components like oil rigs and maintenance workers don't have the chance of being exposed to flammable and dangerous liquids like oil or have to put up with the unpleasant odor of hydrogen sulfide gas that emanates from crude oil. It would seem plausible that an occupation working on a solar farm would be more appealing on this basis and so renewable energy jobs may be an increasingly attractive proposition for Saudi youth. All of this is subject to the rate at which Saudi Arabia intends to increase its renewable energy production, as Looney remarks, Saudi Arabia's economic growth will likely be disrupted by the aims of Saudization. Arguably, supplying the demand for

⁹⁵ The name NEOM was constructed from two words. The first three letters from the Greek prefix neo- meaning "new". The fourth letter is from the abbreviation of "Mostaqbal" (مستقبل), an Arabic word meaning "future."

⁹⁶ "UPDATE 1-Saudi Awards Contracts to Build Palaces in Huge New Business Zone," *Reuters* staff, 8 February, 2018, accessed 10 March, 2018. <https://www.reuters.com/article/saudi-neom-palaces/update-1-saudi-awards-contracts-to-build-palaces-in-huge-new-business-zone-idUSL8N1PY22T>.

technical expertise in the renewable energy sector will be more challenging in certain aspects than increasing Saudi national employment in the incumbent energy sector. While knowledge and techniques for work in the oil sector have been well developed in Saudi Arabia, the renewable energy sector and its demands are relatively new. Saudi Arabia will need to rapidly develop new knowledge centers to create a viable Saudi national workforce for this sector if they are not to depend heavily on foreign contractors and expertise.

Robert Looney concludes that Saudization does not have to be incompatible with the Kingdom's economic development plans. Most notably, he remarks that the benefits of reducing the wages remitted by foreign labor, roughly \$155 billion dollars over the last ten years, will counteract much of the potential loss in economic productivity.⁹⁷ This conclusion should be taken with a healthy dose of skepticism, as Looney's essay omits a discussion of gender inequalities, a factor that significantly contributes to unemployment in the nation. According to Saudi's G20 Labor Market Report, the unemployment rate among women is 21.8 percent for all women, and 32.8 percent for Saudi nationals, a trend found among most other G20 nations.⁹⁸

While reforms in the Saudi educational system tackle the content of the curricula, what is deemed an appropriate occupation for a woman is engrained at the highest and lowest strata of Saudi society. Saudi Arabia states in the G20 Labor Market Report that "inspiring and training youth and increasing female participation are essential for a young and rapidly growing nation to achieve sustainable economic success."⁹⁹ However, increasing female participation in the sector of emerging technologies is not a problem faced by Saudi Arabia alone. A recent report from law firm Fenwick & West LLP shows that women hold just 11% of executive positions at Silicon

⁹⁷ Robert Looney, "Saudization and Sound Economic Reforms: Are the two compatible?" 9.

⁹⁸ "Saudi Arabia Labor Market Report 2016," *Ministry of Labor and Social Development*, 3rd edition, July, 2016, 11.

⁹⁹ "Saudi Arabia Labor Market Report 2016," *Ministry of Labor and Social Development*.

Valley, California companies. The report also says only 9% of executive officers in Silicon Valley are women.¹⁰⁰ This shows that while Saudi Arabia's gender inequality problems may be more pervasive than developed nations in general, the lack of female representation within emerging technologies is not specific to Saudi Arabia, but rather is a more common trend found around the globe.

However, outside of the emerging technology industries, legislative, social, educational, and occupational constraints further prevent women from fully participating in the Saudi labor market. In September 2017, Saudi women were given the right to obtain a driver's license and this was still met by a considerable public backlash.¹⁰¹ In February 2018, the Saudi General Directorate of Passports said it received 107,000 applications after advertising 140 jobs for women at airports and border crossings.¹⁰² This shows the relative shortage of opportunities for women in relation to the number of women who are willing to work. The issue clearly does not lie in lack of willingness on the behalf of unemployed Saudi women, but rather is a symptom of larger systematic constraints on women. For Saudization to include both men and women, the policy's scope of impact will need to be widened to touch on the gender inequalities pervasive in Saudi institutions and culture. Until then, Saudi women's contribution to the national level of unemployment will continue to be offset with foreign workers. However, even if these problems of inequality are drastically reduced through government incentives and systematic change on

¹⁰⁰ "Gender Diversity in Silicon Valley A Comparison of Silicon Valley Public Companies and Large Public Companies," Fenwick & West LLP, 2014, 5.

¹⁰¹ NY times reports: "Some said that it was inappropriate in Saudi culture for women to drive, or that male drivers would not know how to handle having women in cars next to them. Others argued that allowing women to drive would lead to promiscuity and the collapse of the Saudi family. One cleric claimed — with no evidence — that driving harms women's ovaries." Ben Hubbard, "Saudi Arabia Agrees to Let Women Drive," *New York Times*, 26 September, 2017. <https://www.nytimes.com/2017/09/26/world/middleeast/saudi-arabia-women-drive.html>.

¹⁰² Ivana Kottasová, "107,000 Saudi Women Apply for 140 Passport Control Jobs," *CNN*, 1 February, 2018, accessed 24 April, 2018, <http://money.cnn.com/2018/02/01/news/saudi-arabia-women-jobs-passport-control/index.html>.

the institutional level, the lack of female representation in the emerging technology sectors will remain a global issue.

Lastly, in Looney's discussion of Saudization and within the policy itself, there is a lack of consideration for the perspectives of foreign workers, especially low-skilled laborers. Investigative journalists and labor rights organizations have revealed that low-skilled foreign workers are often unable to leave Saudi Arabia. The Council of Ministers first banned employers from keeping foreign workers' passports seven years ago, however, the response has been slow.¹⁰³ Many foreign workers find themselves in debt from making the expensive flight to Saudi Arabia and are unable to improve their financial situation as they receive low wages and due to their vulnerability, in some instances, no wage at all. While at a glance, Saudi Arabia mediates disputes and alleged abuses of foreign labor, the majority of results in these cases are that the worker is sent home and the issue is left inadequately investigated.¹⁰⁴

Saudization may aim to reduce dependency on foreign labor, however, much uncertainty surrounds the future of the current foreign workers in Saudi Arabia. It is still yet to be seen how willing the Saudi government is to sacrifice their planned rate of economic development for the aims of Saudization. Although, if Saudization is truly effective, the demand for foreign workers will be reduced and we may expect to see mass deportations. If this were the case, the loss of remittances sent to foreign workers' home countries would reduce the amount of money circulating within the home nation's economy. In addition to this, the workers who return will increase the home nation's level of unemployment in an instant. In 2016, more than 2,500 Indian workers lost their jobs in Saudi Arabia and were stranded in labor camps without access to food

¹⁰³ "Saudi Employers Given One Month to Return Passports," *Gulf Business*, 5 March, 2017, accessed 10 March, 2018. <http://gulfbusiness.com/saudi-employers-given-one-month-return-passports/>.

¹⁰⁴ "Saudi Arabia: Foreign Workers Abused," *Human Rights Watch*, 15 July, 2004, accessed 10 March, 2018. <https://www.hrw.org/news/2004/07/15/saudi-arabia-foreign-workers-abused>.

and clean water. With no signs of the Saudi authorities addressing the matter, India evacuated thousands of Indian workers. In this case, not only did India lose the benefits of remittances sent home and receive many unemployed citizens, but also India's government utilized their own resources in order to counteract the lack of support afforded to foreign workers in Saudi Arabia.¹⁰⁵

4. Reorienting the 'threat' of climate change: Why energy transition is an opportunity for Saudi Arabia

The power supply system in Saudi Arabia is entirely based upon conventional energy, meaning the Saudi business management sector sees any energy problem from the perspective of the incumbent energy sector. When the incumbent sector defines something as cost-effective, efficient or viable, their assignment of meaning is generally accepted within and even outside of the industry. Their dominative role can be perceived as near omnipotent and has led to the stark division of energy providers and energy consumers, whilst an intimate relationship exists between Saudi Aramco and the Kingdom of Saudi Arabia's government. These entrenched and systematized developments make it difficult for Saudi Arabia to perceive the opportunities that energy transition may open up to them. The acceptance of renewable energies has the potential to cause fundamental qualitative changes with the Saudi economy and they may never have to deal with the traditional restrictions and consequences of traditional energy growth.

Saudi Arabia's government must invest in renewable energies if they desire for their economy to benefit from the rise of economic synergies between renewables, new products and

¹⁰⁵ Rama Lakshmi, "Thousands of Indian Workers Stranded in Saudi Arabia Without Pay or Provisions," *Washington Post* online, last modified 1 August, 2016, accessed 28 April, 2018, https://www.washingtonpost.com/world/middle_east/thousands-of-indian-workers-stranded-in-saudi-arabia-without-pay-or-provisions/2016/08/01/4cae2d00-a08c-4611-b975-cef59ff83d3a_story.html?noredirect=on&utm_term=.aeb7fd38ed52.

their possible applications. The most prominent example at this present time is changes occurring in the automotive industry. Car designers and manufacturers appear to be breaking their once strong alliance with fossil fuels and are now going electric.¹⁰⁶ While this essay does argue that oil, as a result of particular forms of renewable energies, will see its longevity increased, any price reductions seen for oil will be only in the short-term. Fossil fuels will inevitably become more expensive as their supply decreases, so if the automotive industry wants consumers to be able to afford the running of a car, they must create and capture a market for electric vehicles. Hermann Scheer, a remarkable and renowned contributor to climate change objectives argues that “the electric car is the driving belt of energy change.”¹⁰⁷ Similarly, Timothy Mitchell identifies the fossil fuel engine as a major cause of exponential increase in the demand for oil, in the same respect, the electric vehicle will bring about an exponential increase in demand for renewables. Much of the innovation and increased demand of batteries will likely come from developments in electric vehicles, a further effect of the automotive industry on energy transition. As electric vehicles become affordable for the masses, the costs of mass production will begin to fall quickly and soon electric vehicle manufacturers will be able to undercut the prices of all traditional energy fueled vehicles.

In Vision 2030, we see the first signs of Saudi Arabia preparing for the “time after”, when their energy reserves are finally exhausted. Yet, from investigating the relationship between emerging renewable energy production sites like the solar farm and the continuous production of oil, we see how Saudi Arabia’s current economic interests motivate them to delay energy transition for as long as possible - an objective shared by Saudi Aramco. However,

¹⁰⁶ For information on the automotive industry’s newfound alliance with electric vehicles and renewable technologies see David A. Kirsch, *The electric vehicle and the burden of history* (Rutgers University Press, 2000).

¹⁰⁷ Hermann Scheer, *The Energy Imperative: 100 percent renewable now*, 133.

among developing nations, Saudi Arabia may have the greatest financial space to maneuver in regards to renewable energy investment. If Saudi Arabia is able to offset its domestic oil consumption with renewables, there will still come a day when exporting oil is no longer a viable crutch to support the Kingdom. It is yet to be seen whether or not Saudi Arabia desires to continue its role as a global energy exporter after the era of oil and begin seriously investing in renewables for the future.

This all points to the great irony of energy transition in the 21st century. While Saudi Arabia was never formally colonized like many of its neighbors, it was subject to the colonial manipulation and influence of the British and Americans throughout the 20th century. However, now the roles are seemingly reversed. It is the importing countries that are increasingly dependent upon the extracting countries. Joint solidarity in the form of OPEC, displays a growing confidence among exporting nations and now, we regularly see former colonial powers making high-profile visits to these nations in order to secure their energy demands. Saudi Arabia's position as a holder of global energy supplies has enabled its government to become a proactive member of the global political stage.

If these energy exporting nations wish to retain the power afforded to them by their energy resources, they will need to be on the forefront of the next dominant form of energy. This would mean a country like Saudi Arabia will need to heavily invest in an advanced range of renewable energy investments before the last stages of the traditional energy system arrive. If Saudi Arabia waits for traditional energy supplies to run dry, they may miss the opportunity for retaining their position as a global exporter of energy presented by renewable energies.

Conclusion

This project has examined how Saudi Arabia's perspective on tackling climate change and renewable energies has become increasingly positive since just a decade ago. However, we have seen why this may not be a result of a concern for the amount CO₂ in the atmosphere nor for the desire of creating a 100% renewable energy society. The current prospect for solar energy in Saudi Arabia is that it will be used to supplement the countries overwhelming consumption of their own oil resources and that the oil freed up by this will be globally exported in order to profit the national coffers. No longer will they suffer the burden of state subsidized energy and will instead be able to not only increase their power as an oil exporting nation, but they will further be able to sustain their oil resources throughout this century. Few would argue that renewable energies will not become the future fuel that powers the world, however, advocates of renewable energies are misguided when they portray them as being in competition with fossil fuels. Until major systematic transformations occur that can break the incumbent energy sector's tight grasp of their energy monopoly, renewable energies will remain an alternative, a supplement and a minor adjustment.

I opened this project with an anecdote about Peter Josten and his Senior Project from 1947, in which he made claims about the future of energy over the next century. This proved to be a perilous endeavor. Finishing this project, I am highly aware of how similar my situation is to his. As of now, there is considerable global attention being given to the risks presented by climate change and we can expect the mission of sustainable development to continue into the foreseeable future. However, much has changed during the course of writing this Senior Project. This project has had to tackle the problem of writing a story that hasn't been fully told and has been subject to the changes of daily headlines. While Peter Josten arguably had a more difficult

experience finding sources of information, I have been challenged by my limited access to the inner workings of the Saudi Arabian government. I am aware that the policies published by the Saudi Arabian government may not fully reflect their intent, but my aim remained to ‘listen’ to them intently. Whilst tackling the unfolding nature of this story, much has changed in Saudi Arabia since I first began my project. For example, at the start of 2017, the Crown Prince of Saudi Arabia, Mohammad Bin Salman, was not the influential figure he is today. He was yet to consolidate his political power and had not been seen making pleasant acquaintance with various world leaders. With his current status as Saudi Arabia’s soon to be reformist leader, Vision 2030 will be his major debut achievement. With no current signs of opposition, his vision will become the guiding hand for Saudi Arabia for many decades to come, making Vision 2030 less of an end date, but rather just the beginning of continuous transformation in the country.

Yet, there are also considerable complications that are working for and against this mission. Going against global cooperation on the climate change objectives, Donald Trump, President of the United States, has continuously denounced the Paris Climate Accord during his time in office. June 2017, Trump announced that he intends to withdraw the US from the Paris Climate Accord.¹⁰⁸ He referred to the agreement as unfair, and that the US would suffer from expanding environmental policy. As a large world power, the US holds great influence over the global climate change discourse and this would mark a major setback in global progress. In January 2018, The US president said his country could join the international accord if it had a “completely different deal.”¹⁰⁹ The uncertainty surrounding the future health of our planet that

¹⁰⁸ Valerie Volcovici, “U.S. Submits Formal Notice of Withdrawal from Paris Climate Pact,” *Reuters*, 4 August, 2017, accessed 24 April, 2018. <https://www.reuters.com/article/us-un-climate-usa-paris/u-s-submits-formal-notice-of-withdrawal-from-paris-climate-pact-idUSKBN1AK2FM>.

¹⁰⁹ Graham Ruddick, “Donald Trump says US Could Re-enter Paris Climate Deal,” *The Guardian*, 28 January, 2018, accessed 24 April, 2018. <https://www.theguardian.com/us-news/2018/jan/28/donald-trump-says-us-could-re-enter-paris-climate-deal-itv-interview>.

was quelled by the groundbreaking Paris Climate Accord has since been exacerbated by words of the US president. However, one may argue that this withdrawal will only provide a stronger impetus for other nations to expand their commitments and that future climate arrangements will be made more binding in order to avoid this situation.

The driving force behind the current energy transition is the innovations of technology. While politicians and scientists may take years to draw up and sign important legislature on climate change, innovations in technology provide them with additional opportunities every month. While the solar farm is a pinnacle example of advanced renewable energy technology, their exclusive use by large companies or states makes them less disruptive to the energy status quo. It is third party innovators that pose the greatest disruption and the potential of an energy revolution. Energy storage is currently one of the largest obstacles to renewable energies eventual rise to power. In 2017, we saw energy storage pilot, demonstration and trial projects crop up all around the world. In Texas, a demonstration project sought to develop training and education on storage for utilities, another in Hawaii identified the ways in which aggregated storage can form virtual power plants. In the U.K., a trial began to recycle electric vehicle batteries for residential areas, and in Australia projects are underway to utilize advanced renewable energy storage in remote communities.¹¹⁰ This is just a small selection of ways that energy interests are producing knowledge surrounding the various options for storing energy and

¹¹⁰ Peter Maloney, "Storage or Generation? AEP case could help answer the question in Texas," *Utility Dive*, 24 October, 2017, accessed 24 April, 2018. <https://www.utilitydive.com/news/storage-or-generation-aep-case-could-help-answer-the-question-in-texas/507943/>, Andy Colthorpe, "Stem Connects 1MW Aggregated Virtual Power Plant in Hawaii," *Energy Storage News*, 31 January, 2017, accessed 24 April, 2018. <https://www.energy-storage.news/news/stem-connects-1mw-aggregated-virtual-power-plant-in-hawaii>, "Battery Recycling Market Research Study," *Valpak Consulting*, March, 2010, Andy Colthorpe, "Australia's Northern Territory Deploys 2MWh Battery for Indigenous Community," *Energy Storage News*, 15 August, 2017, accessed 24 April, 2018. <https://www.energy-storage.news/news/australias-northern-territory-deploys-2mwh-battery-for-indigenous-community>.

how storage can support the development of renewables. It should be expected that these projects will only become more common and that these kinds of options will make their way into the hands of policy makers.

This is all to say, that while there is considerable evidence that Saudi Arabia will utilize renewable energies in order to extend the longevity of oil, the global discourse on climate change and global technological innovations may not willingly provide them with this opportunity. This points to the importance of Saudi Arabia setting future goals. Critics may be able to point to how they have not achieved certain goals or how the goals themselves are unclear. However, in regards to energy transition, a certain level of flexibility and willingness to make mistakes is required. Saudi Arabia is in a ready position to either further the expansion of solar energy sites or to develop other alternative renewable energies. By diversifying their economic revenues, they retain their ability to produce revenues from oil but do not make themselves as dependent upon it. If the renewable energy revolution comes, it will not have to leave without them.

Bibliography

Scholarly publications:

- Depledge, Joanna. "Striving for No: Saudi Arabia in the Climate Change Regime." *Global Environmental Politics* 8.4 (2008): 9-35.
- Elzen, Boelie, Geels Frank W. and Kenneth Green. *System Innovation and the Transition to Sustainability: theory, evidence and policy*. Edward Elgar Publishing, 2004.
- Gately, Dermot, Nourah Al-Yousef, and Hamad MH Al-Sheikh. "The Rapid Growth of Domestic Oil Consumption in Saudi Arabia and the Opportunity Cost of Oil Exports Foregone." *Energy Policy* 47 (2012): 57-68.
- Grubb, Michael. "Seeking Fair Weather: ethics and the international debate on climate change." *International Affairs* 71, no. 3 (1995): 463-496.
https://www.jstor.org/stable/2624836?seq=1#page_scan_tab_contents.
- Grayson, Benson Lee. *Saudi-American relations*. Maryland: University Press of America, 1982.
- Guang, Yang and Mehdi Parvizi Amineh. "Globalization of Energy: China and the European Union." *International comparative social studies; v. 21*. Brill Academic Publishers, (2010).
- Josten, Peter. "Oil in Saudi Arabia." Bard College: Senior Projects Spring, 1947.
- Jones, Toby Craig. *Desert Kingdom*. Cambridge: Harvard University Press, 2010
- Kemp, René, Derk Loorbach, and Jan Rotmans. "Transition Management as a Model for Managing Processes of Co-Evolution Towards Sustainable Development." *The International Journal of Sustainable Development & World*, 14, no. 1 (2007): 78-79.
- Kuxford, Kate. "Poor Regulatory Environment in Saudi Arabia Leads Local Companies to Set up in UAE." *World Markets Analysis*, 19 December, 2003.
- Latour, Bruno. *Reassembling the Social: An introduction to actor-network-theory*. Oxford: Oxford university press, 2005.
- Looney, Robert. "Saudization and Sound Economic Reforms: Are the two compatible?" *Strategic Insights*. Center for Contemporary Conflict, Naval Postgraduate School, Monterey CA. (2004). <http://www.dtic.mil/dtic/tr/fulltext/u2/a524846.pdf>
- Olimat, Muhamad. *China and the Middle East: from silk road to Arab spring*. Abingdon: Routledge, 2012.

Meadowcroft, James. "What About the Politics? Sustainable development, transition management, and long term energy transitions." *Policy sciences* 42.4 (2009): 323.

Mitchell, Timothy. "Carbon Democracy." *Economy and Society* 38.3 (2009): 399-432.

Scheer, Hermann. *The Energy Imperative: 100 percent renewable now*. London: Routledge, 2013.

Varma, Rajiv K., Shah Arifur Rahman and Tim Vanderheide. "Novel Nighttime Application of PV Solar Farms as STATCOM (PV-STATCOM)." *In Power and Energy Society General Meeting*, 2012 IEEE. 1-8.

Vitalis, Robert. *America's kingdom: Mythmaking on the Saudi oil frontier*. Stanford: Stanford University Press, 2007.

Journalistic sources:

"After oil, solar? Saudi Arabia plans ahead." *Reuters* online. Last modified 16 April, 2018. Accessed 24 April, 2018. <https://in.reuters.com/video/2018/04/16/after-oil-solar-saudi-arabia-plans-ahead?videoId=418239619>.

Ax, Joseph. "Families of Sept. 11 Victims Sue Saudi Arabia in U.S. Court Over Attacks." *Reuters* online. Last modified 21 March, 2017. Accessed 10 March, 2018. <https://www.reuters.com/article/us-usa-saudi-sept11/families-of-sept-11-victims-sue-saudi-arabia-in-u-s-court-over-attacks-idUSKBN16S29I>.

Ball, Jeffrey. "Why the Saudis are Going Solar." *The Atlantic*, issue July/August 2015. Accessed 24 April, 2018. <https://www.theatlantic.com/magazine/archive/2015/07/saudis-solar-energy/395315/>.

Bradsher, Keith. "China Looks to Capitalize on Clean Energy as U.S. Retreats." *The New York Times* online. Last modified 5 June, 2017. Accessed 20 January, 2018. <https://www.nytimes.com/2017/06/05/business/energy-environment/china-clean-energy-coal-pollution.html>.

Burgess, James. "Saudi Arabia Could Become a Net Oil Importer by 2030." *Oil Price*. Last modified 5 September, 2018. Accessed 13 February, 2018. <https://oilprice.com/Latest-Energy-News/World-News/Saudi-Arabia-Could-Become-a-Net-Oil-Importer-by-2030.html>.

"China's President Xi Visits Saudi Arabia to Improve Tie." *BBC News* online. Last modified 19 January, 2017. Accessed 13 February, 2018. <http://www.bbc.com/news/world-middle-east-35351391>.

- Chulov, Martin. "Saudi Arabia Claims Anti-Corruption Purge Recouped \$100bn." *The Guardian* online. Last modified 30 January, 2018. Accessed 24 April, 2018. <https://www.theguardian.com/world/2018/jan/30/anti-corruption-purge-nets-more-than-100bn-saudi-arabia-claims>.
- Colthorpe, Andy. "Australia's Northern Territory Deploys 2MWh Battery for Indigenous Community." *Energy Storage News*. Last modified 15 August, 2017. Accessed 24 April, 2018. <https://www.energy-storage.news/news/australias-northern-territory-deploys-2mwh-battery-for-indigenous-community>.
- Colthorpe, Andy. "Stem Connects 1MW Aggregated Virtual Power Plant in Hawaii." *Energy Storage News*. Last modified 31 January, 2017. Accessed 24 April, 2018. <https://www.energy-storage.news/news/stem-connects-1mw-aggregated-virtual-power-plant-in-hawaii>.
- Gramer, Robbie. "Saudi Arabia, China Sign Deals Worth Up to \$65 Billion." *Foreign Policy*. Last Modified 16 March, 2017. Accessed 13 February, 2018. <http://foreignpolicy.com/2017/03/16/Saudi-arabia-china-sign-deals-worth-65-billion-boost-trade-ties-oil-energy-one-belt-one-road-saudi-vision-2030/>.
- Javirer, David. "US-Saudi Arabia Seal Weapons Deal Worth Nearly \$110 Billion Immediately, \$350 Billion Over 10 Years." *CNBC* online. Last modified, 20 May, 2017. Accessed 10 March, 2018. <https://www.cnn.com/2017/05/20/us-saudi-arabia-seal-weapons-deal-worth-nearly-110-billion-as-trump-begins-visit.html>.
- Kemp, John. "Saudi Arabia's Oil: How big are they really?" *Reuters* online. Last modified 5 July, 2016. Accessed 25 January, 2018. <https://www.reuters.com/article/us-saudi-oil-kemp/saudi-arabias-oil-reserves-how-big-are-they-really-kemp-idUSKCN0ZL1X6>.
- Kottasová, Ivana. "107,000 Saudi Women Apply for 140 Passport Control Jobs." *CNN* online. Last modified 1 February, 2018. Accessed 24 April, 2018. <http://money.cnn.com/2018/02/01/news/saudi-arabia-women-jobs-passport-control/index.html>.
- Lakshmi, Rama. "Thousands of Indian Workers Stranded in Saudi Arabia Without Pay or Provisions." *Washington Post* online. Last modified 1 August, 2016. Accessed 28 April, 2018. https://www.washingtonpost.com/world/middle_east/thousands-of-indian-workers-stranded-in-saudi-arabia-without-pay-or-provisions/2016/08/01/4cae2d00-a08c-4611-b975-cef59ff83d3a_story.html?noredirect=on&utm_term=.aeb7fd38ed52.
- Maloney, Peter. "Storage or Generation? AEP case could help answer the question in Texas." *Utility Dive*. Last modified 24 October, 2017. Accessed 24 April, 2018. <https://www.utilitydive.com/news/storage-or-generation-aep-case-could-help-answer-the-question-in-texas/507943/>.

- Mataci, Sara. "How Much Do Solar Panels Cost in the U.S. in 2018?" *Energy Sage*, January, 2018. Accessed 24 April, 2018. <https://news.energysage.com/how-much-does-the-average-solar-panel-installation-cost-in-the-u-s/>.
- Rashad, Marwa. "Saudis Await Prince's Vision of Future with Hope and Concern." *Reuters* online. Last modified April 24, 2016. Accessed April 24, 2018. <https://www.reuters.com/article/us-saudi-plan-idUSKCN0XL0B2>.
- Ruddick, Graham. "Donald Trump Says US Could Re-enter Paris Climate Deal." *The Guardian UK* online. Last modified 28 January, 2018. Accessed 24 April, 2018. <https://www.theguardian.com/us-news/2018/jan/28/donald-trump-says-us-could-re-enter-paris-climate-deal-itv-interview>.
- "Saudi Employers Given One Month to Return Passports." *Gulf Business*. Last modified 5 March, 2017. Accessed 10 March, 2018. <http://gulfbusiness.com/saudi-employers-given-one-month-return-passports/>.
- "Saudi Crown Prince Mohammed bin Salman, power behind the throne." *BBC News* online. Last modified 7 March, 2018. Accessed 13 April, 2018. <http://www.bbc.com/news/world-middle-east-40354415>.
- Sciutto, Jim, Ryan Browne, and Deirdre Walsh. "Congress Releases Secret '28 pages' on Alleged Saudi 9/11 Ties." *CNN* online. Last modified 15 July, 2016. Accessed 10 March, 2018. <https://www.cnn.com/2016/07/15/politics/congress-releases-28-pages-saudis-9-11/index.html>.
- "The Future of the Global Muslim Population." Pew Research Center, 27 January, 2011. Accessed 13 February, 2018. <http://www.pewforum.org/2011/01/27/the-future-of-the-global-muslim-population/>.
- Thompson, Avery. "Saudi Arabia to Build World's Largest Solar Farm." *Popular Mechanics*. Last modified 4 April, 2018. Accessed 24 April, 2018. <https://www.popularmechanics.com/science/energy/a19685494/saudi-arabia-plans-to-build-worlds-largest-solar-farm>.
- "UPDATE 1-Saudi Awards Contracts to Build Palaces in Huge New Business Zone." *Reuters* online. Last modified 8 February, 2018. Accessed 10 March, 2018. <https://www.reuters.com/article/saudi-neom-palaces/update-1-saudi-awards-contracts-to-build-palaces-in-huge-new-business-zone-idUSL8N1PY22T>.
- Vidal, John. "Rich and Poor Countries Blame Each Other for Failure of Copenhagen Deal." *The Guardian US* online. Last Modified 18 December, 2009. Accessed 24 April, 2018. <https://www.theguardian.com/environment/2009/dec/19/copenhagen-blame-game>.

Vidal, John, Stratton Allegra and Suzanne Goldenberg. “Low Targets, Goals Dropped: Copenhagen Ends in Failure.” *The Guardian US* online. Last modified 18 December, 2009. Accessed 24 April, 2018. <https://www.theguardian.com/environment/2009/dec/18/copenhagen-deal>.

Volcovici, Valerie. “U.S. Submits Formal Notice of Withdrawal from Paris Climate Pact.” *Reuters* online. Last modified August 4, 2017. Accessed 24 April, 2018. <https://www.reuters.com/article/us-un-climate-usa-paris/u-s-submits-formal-notice-of-withdrawal-from-paris-climate-pact-idUSKBN1AK2FM>.

Volcovici, Valerie and Lesley Wroughton. “U.S. Doubles Climate Adaption Aid to Nearly \$900 Million.” *Reuters* online. Last modified 9 December, 2015. Accessed 24 April, 2018. <https://www.reuters.com/article/us-climatechange-summit-funding-idUSKBN0TS1Q220151209>.

Reports:

“Battery Recycling Market Research Study.” *Valpak Consulting*, March, 2010.

“Gender Diversity in Silicon Valley A Comparison of Silicon Valley Public Companies and Large Public Companies.” Fenwick & West LLP, 2014.

“Intended Nationally Determined Contribution of the EU and its Member States.” UNFCCC, 2015. Accessed 13 February, 2018. <http://www4.unfccc.int/Submissions/INDC/Published%20Documents/Latvia/1/LV-03-06-EU%20INDC.pdf>.

“Oil Reserves.” British Petroleum, 2016. Accessed 25 January, 2018. <https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/oil/oil-reserves.html>.

“Nuclear Power in Saudi Arabia.” World Nuclear Association. Accessed 20 January, 2018. <http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/saudi-arabia.aspx>.

“Nuclear Power in the World Today.” Nuclear World Association. Accessed 20 January, 2018. <http://www.worldnuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx>.

“Nuclear Power in Egypt.” World Nuclear Association. Accessed 20 January, 2018. <http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/egypt.aspx>.

“Saudi Arabia: Foreign Workers Abused.” *Human Rights Watch*, 15 July, 2004. Accessed 10 March, 2018. <https://www.hrw.org/news/2004/07/15/saudi-arabia-foreign-workers-abused>.

“World Energy Outlook 2017.” International Energy Agency, 2017. Accessed 13 February, 2018. <https://www.iea.org/weo2017/>

“World Nuclear Industry Status as of 1 January 2018.” *World Nuclear Industry Status Report*, 1 January, 2018. <https://www.worldnuclearreport.org/World-Nuclear-Industry-Status-as-of-1-January-2018.html>.

United States Department of Energy. “U.S.-Saudi Arabia Energy Cooperation.” Office of International Affairs. Accessed 10 March, 2018. <https://www.energy.gov/ia/international-affairs-initiatives/us-saudi-arabia-energy-cooperation>.

“U.S. Solar Market Insight Report 2013 Year in Review.” GTM Research and Solar Energy Industries Association (SEIA). Boston, MA, and Washington, DC, 2014.

Official Saudi documents:

“Intended Nationally Determined Contribution of the Kingdom of Saudi Arabia.” UNFCCC, 2015. Accessed 13 February, 2018. <http://www4.unfccc.int/ndcregistry/PublishedDocuments/Saudi%20Arabia%20First/KSA-INDCs%20English.pdf>.

“Saudi Arabia Labor Market Report 2016.” Ministry of Labor and Social Development, 3rd edition, July, 2016.

“Small-Scale Solar PV Systems Regulations.” Electricity and Cogeneration Authority, 21 August 2017. Accessed 10 April, 2018. <http://www.ecra.gov.sa/ar-sa/ECRARegulations/Regulations/SiteAssets/Pages/Small-Scale-Solar-PV-Net-Metering-Regulations.pdf>.

Saudi Vision 2030, 2016. Accessed 20 January, 2018. <http://vision2030.gov.sa/en>.

———. “A Renewable Energy Market.” *Saudi Vision 2030*, 2016. <http://vision2030.gov.sa/en/node/87>.

———. “Foreword.” *Saudi Vision 2030*, 2016. <http://vision2030.gov.sa/en/foreword>.

———. “Home.” *Saudi Vision 2030*, 2016. <http://vision2030.gov.sa/en>.

———. “Investing for the Long-Term.” *Saudi Vision 2030*, 2016. <http://vision2030.gov.sa/en/node/6>.

———. “National Transformation Program.” *Saudi Vision 2030*, 2016. http://vision2030.gov.sa/sites/default/files/NTP_En.pdf.

———.“Themes.” *Saudi Vision 2030*, 2016. <http://vision2030.gov.sa/en>.