Strategic Portfolio Management of Upstream Oil Companies; Based on a Carbon-Constrained World and Stranded Oil Reserves

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Abstract
The oil industry is currently experiences hard times with low oil prices, increasing environmental awareness and the breakthrough of the Paris Agreements that are aimed to limit the emission from fossil fuels. These developments pose a threat for the oil industry and the companies active in the industry by changing the outlook for the oil industry and therewith compromising the strategies of upstream oil companies. If climate change is actively addressed oil may become abundant resulting in a large amount of oil reserves that will not get exploited. This research aims on determining which developments will influence the business of upstream oil companies and analyze which reserves have the highest chance of getting stranded by the developments. Based on the outcomes from the analysis strategic measures are composed to increase the competitiveness of oil reserves and portfolios of reserves to reduce the potential for the reserves to get stranded. To increase the competitiveness upstream oil companies should focus on competitive growth by acquiring and developing reserve that are competitive when climate change is actively addressed. Moreover upstream oil companies added value to the reserves by increasing the quality of the production processes and reducing the cost and emissions associated with the exploitation of a reserve.

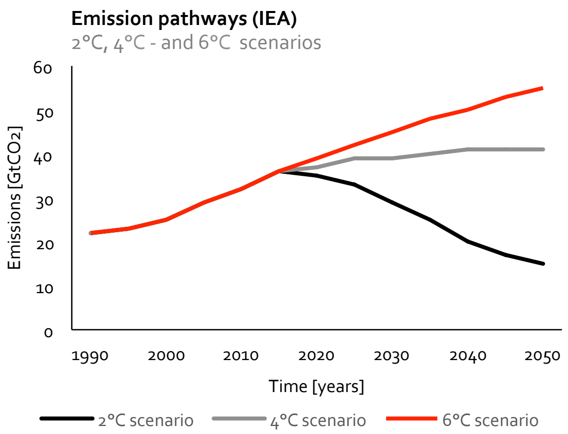
Keywords: Paris Agreement, Emission Pathways, Stranded reserves, Abundance, Peak oil demand, Competitive growth, Added value.

1. Introduction

In the previous decades the upstream oil and gas market has flourished. High oil prices and the full support of governments grew national oil companies (NOCs) and international (or integrated) oil companies (IOCs) to some of the largest companies in the world.

Until recently, many oil companies and oil-producing countries assumed that society would gradually use all the available oil resources. OPEC (Organization of Petroleum Exporting Countries) believed that the oil-constrained world had arrived and due to the limited amount of reserves, the oil was more valuable under the ground than on the market, since the prices would gradually increase over time as the result of scarcity (van der Veer & Myers Jaffe, 2016). Hence, the last two decades, oil companies used a revenue-oriented strategy, under the perception that oil would become scarce. Part of this revenue-oriented strategy was to optimize the amount of reserves on the balance sheet of upstream oil companies, which occurred through many expensive exploration projects (Myers Jaffe & Van der Veer, 2016).

However, the market is changing, in December 2015, 197 countries have dedicated to limit global warming to well below 2°C and to even pursue attempts to limit global warming to 1.5°C. The Paris Agreement may change the perspective on the future of oil companies and may change how oil producers will operate. This dedication of the governments implies that governments will actively limit the emission of GHG. In order to meet the goals of the Paris Agreements emissions should be significantly reduced to be able to stay on track to meet the 2°C pathway of the IEA.



Beside the Paris Agreement that limit the emissions originating from fossil fuels there are other developments that influence the business of upstream oil companies. The last decade there has been increasing activity using different type of oil reserves. The share of unconventional oil reserves in the market is rapidly growing. The shale oil boom in the US is an example of the growing possibilities with unconventional oil reserves. The US shale oil boom is among the main causes that resulted in the oil price slum that started since mid-2014 (Baumeister & Kilian, 2016). The fairly new opportunities with unconventional oils add many additional resources to the total resource base (Gordon, Brandt, Bergerson, & Koomey, 2015).

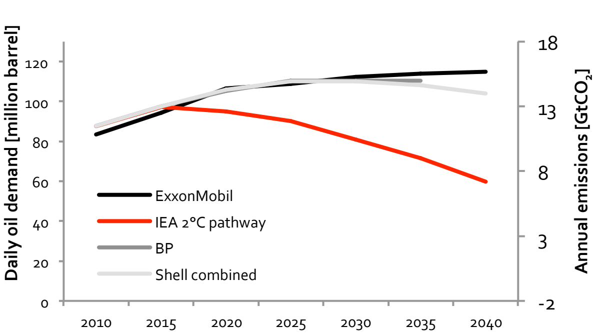
The prospect that the global usage of oil should decrease in order to meet the Climate Agreement is in contrast with the increasing possibilities with unconventional oil reserves and the growing resource base as the result of the development of new technologies. These developments have resulted in a significant large resource base while the demand for oil should decline to be able to meet the goals set in the Paris Agreement.

This article will emphasize on the strategic changes that oil companies should imply to be able to cope with the developments in the upstream oil sector. Scenario-based impact analysis is used to determine the competitiveness of different type of reserves under different market scenarios. This way oil companies can be assisted to determine in which type of oil reserves oil companies should invest and from which they should divest to be able to meet competitive growth and enhance their strategy.

2. Mismatch between company outlooks and the Paris Agreements

The 2°C emissions pathway of the IEA represents the emissions of the entire energy system. Of the entire energy system, approximately 36% of the emissions are caused by the production and use of oil (EIA, 2015). Therefore, large improvements should be made in the oil sector to stay on track of the 2°C pathway and to be able to reduce global emissions. The 2°C pathway of the IEA projects that global demand should peak in 2020 at 93,7 million barrels of oil per day after which it falls to 74,1 million barrels per day in 2040. To be able to stay within the carbon budget and comply with the goals from the Paris Agreements, the emissions and the demand in the oil sector should stop growing and start to decline in 2020 if the world wants to meet the goals and stay on track of the 2°C pathway. This implies that the entire oil sector that has been growing for decades has to meet its peak supply in 2020 and then starts to decline as an ex-growth sector (Van de Graaf & Verbruggen, 2015).

Oil demand pathways with associated emissions
By oil majors, measured in $GtCO_2$



3. The effects of environmental regulation

To be able to meet the goals of the climate agreements and to stay on track of the 2°C pathway, governments must set the right incentives for companies and individuals in order to change the current course of action from a pathway between 4°C to 6°C to a 2°C pathway. To set these right incentives it is inevitable that governments should implement policies and climate regulation that guide companies and individuals to limit the emission of GHG by changing their behavior regarding the environment. These policies and regulations should assure; security of supply, affordability of energy and environmental sustainability, (Cherp, Jewell, Vinichenko, Bauer, & De Cian, 2013)while emissions of GHGs are discouraged and the adoption of low carbon technologies are incentivized.

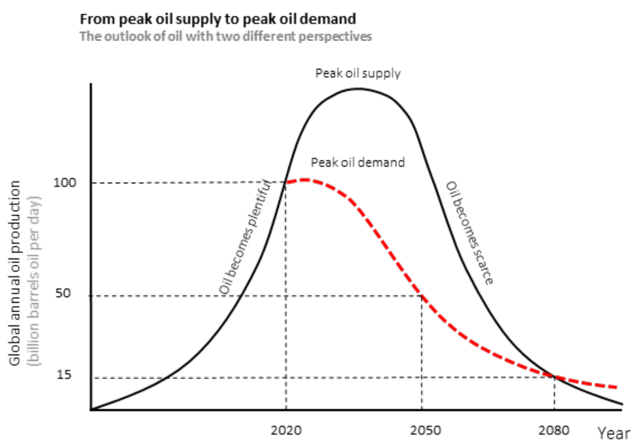
With regard to the oil sector, there are two sides at which environmental regulation can be implied, at the supply and at the demand side. Regulation at the supply side should focus on discouraging supply by taxing the emissions of GHG. The most effective method of taxing these emissions is through explicit carbon pricing (Baranzini et al., 2015). Likewise, regulation imposed at the demand side, should incentivize user to adopt sustainable or low carbon technologies as an alternative for oil by means of subsidies.

Explicit carbon pricing is seen as more effective than implicit carbon pricing because it produces the preferred incentives by directly taxing the negative unwanted effects (Baranzini et al., 2015). The implementation of a carbon pricing mechanism will cause a shift in the competitiveness amount different type of oil projects, the more polluting forms of oil will become more expensive relatively to the cleaner forms of oil (Jenkins, 2014). This will change the relative prices of products and results in a new cost ranking of reserves with the cleaner oil reserves becoming economically more attractive. The new cost ranking of oil reserves, based on their emission footprint, will set a positive incentive for oil companies to switch from dirty oil reserves to cleaner oil reserves, and incentivizes companies to invest in technologies that reduce the emissions from the reserves (Shell, 2016). These incentives for reducing the emission from the production of oil are currently absent or only on small scale due to the lack of thorough environmental policies.

In a system with carbon pricing the dirtier oil reserves will face higher cost and become less attractive and may even disappear from the market when there are sufficient reserves available (Jenkins, 2014). Hence, the dirtier oil reserves have a chance of getting stranded when oil is abundant and environmental policies are implied. The types of oil reserves that are mostly hit when carbon pricing is implemented are the (extra-) heavy oils, oil shale and tar sands (Gordon et al., 2015). Thus, dirty oil reserves may, when environmental policy is implied and in a world where oil is abundant, get pushed out of the market. Hence, adequate incentives implied by policies and regulation should set the start of a change in pathway towards the goal of 2°C.

4. The abundance of oil

The world always thought that there would be a race between oil producers to extract the last oil resources available (Klare, 2012). In this worldview (peak oil supply) oil prices were about to increase until the last drop of oil was extracted from the ground. Vast price increase due to scarcity is a common phenomenon in economics when markets rely on a scarce product. M. King Hubbert was the first who considered the rate of production of oil as a Bell-curve. This Bell-curve depicts the oil production over time with in the middle peak oil that characterizes the switch from plenty of oil to scarce oil (Verbruggen & Marchohi, 2010). At peak oil the production of oil is at its peak as the result of explorations that add to the resource base. When in time additional discoveries decline due to scarcity the production decreases and oil gets more expensive, up until oil gets more scarce and price skyrocket (Verbruggen & Van De Graaf, 2015).



A change in the paradigm from peak oil to peak demand also changes the perception and the policy in the market. First, under peak oil, the perception was that oil in the ground would be much more worth in the future due to price increase and scarcity. However, with a change in the perception from peak oil supply to peak oil demand, the tide will turn and oil in the ground is not like 'money in the bank' because these resources may someday be less valuable than oil that is already sold (Van de Graaf & Verbruggen, 2015). This change in perception will increase the competition and may trigger a "race to sell oil" among oil producers with large oil reserves such as petroleum states like Saudi Arabia, Iraq, Iran, Kuwait, United Arab Emirates etc. (Helm, 2016).

The vision that oil in the ground is not as much worth as oil that is produced and that this view will trigger a global race to sell oil is shared by multiple scientists (Helm, 2016) (Klare, 2012) (Myers Jaffe, 2016) (Van de Graaf & Verbruggen, 2015). This race to sell oil has a high potential to result in low and volatile oil prices due to oversupply caused by the race to sell oil. Oil producers with large amounts of potentially stranded reserves (mainly petro states) want to get rid of as much as oil as possible before the demand has declined to a point where the reserves become worthless (Van de Graaf & Verbruggen, 2015). Therefore, they flood the market with oil to try to sell as much as they have left and increase their market share with a lowering oil price as the result. This market share driven policy is hard to sustain for longer periods, only oil producers with low breakeven cost of oil production or companies with the largest bank accounts will be able to compete the longest in the race to sell oil (BP Group, 2017). Due to their large and relatively cheap reserves, Cherp, Jewell, Vinichenko, Bauer, & De Cian (2013) predict, that the market share of the main petro states will increase and especially the share of the Gulf states. This vision is shared in the latest energy outlook of BP (BP Group, 2017). Such a market share driven policy will become more common in the scenario where oil reserves face the chance of getting potentially stranded, oil producers want to prevent this by opening the valves. The only party that may be able to prevent the race to sell oil is OPEC. OPEC has a history of setting production quotas for oil producing countries. However, the oil producing countries also have a history of undermining the agreements they have made because each member of OPEC will benefit most by not complying to the production quotas.

The abundance of oil implies that in the end, oil should remain in the ground without further purpose. This situation can only be achieved if the demand declines, otherwise oil would not get abundant. When the demand declines, the supply has two possibilities, one, stay on the same level, this will inflate the oil price and may lead to bottom prices, and two, the supply declines with the demand to balance the oil price but this will result in reserves getting obsolete and in other words, stranded. Beside a decline in the supply of oil there are more causes that can make reserves get stranded. Increased competition in the market that follows from the abundance of oil and declining oil demand may results in lower oil prices and makes reserves with high breakeven cost get stranded. Reserves with high breakeven cost are for instance, arctic oil, (extra) heavy oil, tar sands and ultra-deep water oil.

5. Scenario-based impact analysis

There are three consequences of the developments that are currently at play as the previous sections imply. First, regulation will make dirtier types of oil reserve more expensive compared to the cleaner reserves. Second, the abundance of oil will make oil reserves with long lifetimes get stranded due to declining demand for oil. And third, the abundance of oil and the declining demand increase the competition among oil producers, resulting in oversupply and low oil prices. These three consequences of the developments may result in oil reserves to get stranded. To determine for which market conditions the reserves get stranded, scenarios are formulated for each of the three stranding causes (regulation, oil demand and oil price), which are tested on the reserves for the characteristics of oil reserves that are vulnerable for these three stranding causes. These characteristics are technology, lifetime and breakeven cost. Technology reflects the footprint of a reserve on the environment (the production technology is one of the main indicators for the emissions and land use of a reserve). Lifetime represents the time till the end of production and breakeven cost, the level of cost at which a reserve will start to make profit. The scenario-based impact analysis is carried out using methodologies of Rounsevell & Metzger (2013) and Swart, Raskin, & Robinson (2004).

The goal of the scenario-based impact analysis is to enhance the resilience and to reduce the impact of the scenarios on the reserves (Hiete, Merz, & Schultmann, 2011).
The scenario-based impact analysis can identify the long-term risk for oil reserves with certain characteristics. Moreover, the results from the analysis can assist in the formulation of strategies to reduce the vulnerability to stranding risk. By monitoring and steering on the characteristics that will make oil reserves get stranded. Therewith decreasing the risk and increasing the optionality of a reserve (Alessandri, Ford, Lander, Leggio, & Taylor, 2004). The result from the scenario-based impact analysis shows the competitiveness of different type of oil reserves and shows in which type to invest in or divest from which can strengthen a company's portfolio.

Using the results makes it possible to shift through the table with competitiveness by implementing technologies that for instance reduce emissions or reduce the breakeven cost, making reserves more competitive and decreasing the chance that reserves end stranded. An example of measure that could make reserves shift through the table is the adoption of carbon capture and storage (CCS) or investments in a cleaner more environmental friendly production technique. This will reduce the environmental footprint of the reserve and can make a reserve shift from a being a dirty reserve to a medium dirty reserve.

6. Insights provided by the analysis

The growing chance for stricter environmental regulation, the urge for a declining oil market and the lower oil prices as the result of competition will have their effect on the value of oil reserves. If companies want be able to compete when the market conditions change, then they should focus on their position in the market. Which includes an analysis of the reserves in their portfolio. The scenario-based impact analysis is able to assist herein by showing the differences in competitiveness among oil reserves. The insights provided by the scenario-based impact analysis are the following:

To be able to strengthen their competitive position, oil companies should divest from dirty and expensive oil reserves such as tar sands (oil sands), extra heavy oil, heavy oil and arctic oil. These are the least competitive reserves based on breakeven cost and technology. They are vulnerable to get stranded when oil prices fall and environmental regulation is implemented. When environmental regulation gets implied it's too late to sell the dirty reserve, therefore a quick shift to less polluting reserves is advised. Likewise, reserves with long lifetimes also have an elevated potential to get stranded should the demand for oil decline and society switches to low or no carbon substitutes. The only types of reserves with long lifetimes that can be maintained are the reserves that have low breakeven cost. These will remain necessary to produce plastics and other materials.

Due to the uncertainty and increased volatility in the market, oil companies should focus on reserves that have lower upfront capital costs and shorter lifetimes.

		Technology								
Techn.		Clean reserves			Medium dirty reserves			Dirty reserves		
Cost	High	3	3		3	3		4, 6, 7, 8	4, 6, 7, 8	4, 6, 7, 8
	Mid	2, 3	2, 3		2, 3, 5	2, 3		6	6	6
	Low	1	1	1						
		S	M	L	S	M	L	S	M	L
		Lifetime			Lifetime			Lifetime		

Most competitive reserves | Medium competitive reserves | Least competitive reserves

#	Type of reserves	Technology [$kgCO_2$ eq./barrel]		Lifetime [years]		Price [$/barrel]	
	Conventional	Type	Emission range	Type	R/P range	Type	Price range
1.	Onshore	Clean	0 – 50	Short - long	0 – 100	Low	0 – 40
2.	Deep water	Clean - mid	0 – 100	Short - mid	0 – 50	Mid	40 – 75
3.	Ultra deep water	Clean - mid	0 – 100	Short - mid	0 – 50	Mid - high	40 – 100
4.	Arctic oil	Dirty	100+	Short - long	0 – 100	High	75 – 100
	Unconventional						
5.	Shale oil	Mid	50 – 100	Short	0 – 25	Mid	40 – 75
6.	Heavy oil	Dirty	100+	Short - long	0 – 100	Mid - high	40 – 100
7.	Extra heavy oil	Dirty	100+	Short - long	0 – 100	High	75 – 100
8.	Tar sands	Dirty	100+	Mid - long	0 – 100	High	75 – 100

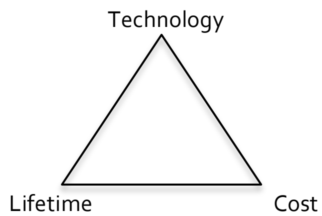
This will prevent oil companies from getting entrapped in their previous policies and keeps the companies dynamic.

New oil exploration should only be carried out when the reserve that might be found is able to compete in a low price environment with increased forms of regulation such as carbon pricing mechanisms. Hence exploration projects that are aimed at discovering forms of oil such as artic oil and ultra-deep oil are advised to abandon.

7. Strategic implications

In a dynamic environment with increasing uncertainties and risks, oil companies should focus on enhancing their flexibility in the market. This makes them able to quickly and efficiently shift their focus from underperforming reserves with high stranding risk to reserves with better performance in a dynamic market (Alvarez, Velarde, & Hache, 2015). This so called optionality (flexible and adaptable) is what oil companies usually are not due to the long lead times and capital-intensive projects. Reason is that today's oil companies where developed in a time of resources scarcity, which has lead to large, complex, centralized companies that are not able to cope with uncertainty and change (Handscomb, Sharabura, & Woxholth, 2016).

To be able to create optionality, oil companies should focus on competitive growth and on added value (Munro, 2016). Competitive growth implies that oil companies should emphasize on growth that is compatible with the future and based on possible future scenarios. This entails that portfolios and reserves of oil companies should be made less vulnerable to get stranded and therewith increasing the resilience of the portfolio. To be able to accomplish this competitive growth, the growth space is limited in three areas; technology, lifetime and breakeven cost. In which technology represents the environmental footprint of the production process, lifetime reflects the duration till the end of production and breakeven cost, the cost at which the reserve will start making profit.



These three characteristics of oil reserves are leading to determine the potential for the reserve to get stranded and therefore also determining the sustainability of the growth of oil reserves. The characteristics have to be combined and assessed to determine the competitiveness of a reserve. Hence reducing the emissions of a reserve can be accomplished by installing more advanced production technologies but when this advanced production severely increases the cost of a reserve then the growth is still not competitive. Hence the three areas must be in balance to achieve competitive growth.

The creation of added value is important because when oil is abundant, there are only few companies that are able to grow. Thus, oil companies should primarily aim on getting more with less. This implies that companies should emphasize on increasing their efficiency as a whole by means of more advanced production-, and business processes. Added value also emphasize on making the company leaner and more agile to be able to be more resilient and able to adapt in a changing market. The companies that create the most added value will be able to grow through managing the cost side of projects, which result in the generation of higher returns on the invested capital (Munro, 2016).

8. Strategic makeover

Oil companies should focus on positioning themselves to be able to cope with changes in the market and future market conditions. Otherwise they will not be able to adapt to the changing market conditions in an increasingly dynamic and uncertain market. Hence they should focus on competitive growth and increasing added value in their business, which they can incorporate in the following ways for the three different characteristics.

Technology
Competitive growth in terms of technology implies that oil companies should invest and develop reserves that are not vulnerable to get stranded or heavily affected by environmental regulation. Hence, companies should emphasize on reserves that produce less emissions or invest in cleaner production technologies (Garcia, Lessard, & Singh, 2014). Competitive growth and added value can be achieved in the following ways:

- Divest from dirty oil reserves because implementation of regulation will increase the cost or even prohibit the technology.
- Increase investments in natural gas reserves and LNG projects to shift from polluting oil to less polluting natural gas.
- Invest in more advanced technologies that reduce the emission of GHG.

Lifetime
Competitive growth reflected on lifetime implies that oil companies should focus projects that have shorter lifetimes. Hence, enormous projects with very long lead times and extremely high capital costs are less preferable than shale oil reserves, which can be quickly exploited, have early cash returns and relatively low capital cost. These types of oil reserves fit much better in a future with higher uncertainties regarding oil prices and in a scenario where oil is abundant. (Alvarez et al., 2015).

- Don't invest in and divest from long-term high capital-intensive projects, which make oil companies static instead of dynamic.
- Invest in projects with shorter lifecycles such as shale oil.
- Use smart contracting based on short durations to be able to get out of oil projects before the end of production to cope with changing market conditions.

Breakeven cost
Competitive growth based on breakeven cost means that in order to remain competitive when oil is abundant, oil companies should exploit reserves that are at the lower end of the breakeven-cost-curve to prevent stranding in low price scenarios. These types of reserves are the conventional oils, oil reserves in shallow water and the most competitive shale oil reserves.

- Divest from expensive reserves such as arctic, ultra-deep and extra heavy
- Focus on cost reductions through strategic alliances and partnerships (Groves & Melville, 2015).
- Focus on cost reductions through cost decreasing technologies (enhanced oil recovery, digitalization, internet of things)

9. Discussion

This paper reflects on a future situation in which governments actively address climate change according to the goals set by the Paris Agreements. The course of action may in reality be different from what is argued in this article, which may result in different outcomes. If for instance climate change is not actively addressed and the demand for oil is not reduced than there is no direct need to enhance the competitive position of the company and reserve will probably not get stranded. However, when obtaining the view that oil is abundant and the world will try to achieve the goals formulated in the Paris Agreement, then the outcome of this article may assist oil companies to cope with the challenges that lay when the demand for oil declines and competitiveness in the market is needed.

10. Conclusions

Oil turns out to be abundant instead of scarce when climate change is actively addressed. Oil companies should focus on reducing the potential of their reserves to get stranded by increasing the competitiveness of their reserves and their portfolio. This increasing competitiveness should be realized by focusing on the technology, lifetime and the breakeven cost of a reserve. These characteristics relate to the stranding causes regulation, demand and oil price hence increasing the technology, lifetime and breakeven cost reduces the stranding potential of a reserve. Increasing the competitiveness of the portfolios should be achieved in two ways. By focusing on competitive growth through acquiring and developing competitive reserves while divesting from reserves that are not competitive. And by adding value to the reserves through increasing the quality of the production processes reducing the cost and emissions associated with the exploitation of a reserve.

Bibliography

Alessandri, T. M., Ford, D. N., Lander, D. M., Leggio, K. B., & Taylor, M. (2004). Managing risk and uncertainty in complex capital projects. *Quarterly Review of Economics and Finance*, *44*(5 SPEC.ISS.), 751–767. http://doi.org/10.1016/j.qref.2004.05.010

Alvarez, A., Velarde, O. L., & Hache, O. (2015). Portfolio management in oil and gas Building and preserving optionality. *Ernst & Young Publications*, *Oil and Ga*, 1–24. Retrieved from http://www.ey.com/Publication/vwLUAssets/EY-portfolio-management-in-oil-and-gas/$FILE/EY-portfolio-management-in-oil-and-gas.pdf

Baranzini, A., Bergh, J. Van Den, Carattini, S., Howarth, R. B., Padilla, E., & Roca, J. (2015). Seven reasons to use carbon pricing in climate policy. *Centre for Climate Change Economics and Policy Working Paper No. 253*, (253), 1–14.

Baumeister, C., & Kilian, L. (2016). Understanding the Decline in the Price of Oil Since June 2014. *CFS Working Paper*, (february), 1–41. http://doi.org/10.1086/684160

BP Group. (2017). Energy Outlook 2017. *BP Statistical Review*.

Cherp, A., Jewell, J., Vinichenko, V., Bauer, N., & De Cian, E. (2013). Global energy security under different climate policies, GDP growth rates and fossil resource availabilities. *Climatic Change*, 1–12. http://doi.org/10.1007/s10584-013-0950-x

Garcia, R., Lessard, D., & Singh, A. (2014). Strategic partnering in oil and gas: A capabilities perspective. *Energy Strategy Reviews*, *3*(C), 21–29. http://doi.org/10.1016/j.esr.2014.07.004

Gordon, D., Brandt, A., Bergerson, J., & Koomey, J. (2015). Know Your Oil. *Carnegie Endowment for International Peace*, 1–72.

Groves, S., & Melville, J. L. (2015). Strategic Alliances in Upstream Oil and Gas Getting Serious About Collaboration. *BCG Perspectives*.

Handscomb, C., Sharabura, S., & Woxholth, J. (2016). The oil and gas organization of the future. *McKinsey & Company*.

Helm, D. (2016). The future of fossil fuels – is it the end?, *January*, 1–24.

Hiete, M., Merz, M., & Schultmann, F. (2011). Scenario-based impact analysis of a power outage on healthcare facilities in Germany. *International Journal of Disaster Resilience in the Built Environment*, *2*(3), 222–244. http://doi.org/10.1108/17595901111167105

Jenkins, J. D. (2014). Political economy constraints on carbon pricing policies: What are the implications for economic efficiency, environmental efficacy, and climate policy design? *Energy Policy*, *69*, 467–477. http://doi.org/10.1016/j.enpol.2014.02.003

Myers Jaffe, A., & Van der Veer, J. (2016). Future Oil Demand Scenarios. *World Economic Forum, the*

Global Agenda Council, (April), 1–10.
Rounsevell, M. D. A., & Metzger, M. J. (2013). Developing qualitative scenario storylines for Developing qualitative scenario storylines for environmental change assessment, (December). http://doi.org/10.1002/wcc.63
Shell. (2016). A better life with a healthy planet Pathways to net-zero emissions. *Shell Scenarios*.
Swart, R. J., Raskin, P., & Robinson, J. (2004). The problem of the future : sustainability science and scenario analysis. *Global Environmental Change*, *14*, 137–146. http://doi.org/10.1016/j.gloenvcha.2003.10.002
Van de Graaf, T., & Verbruggen, A. (2015). The oil endgame: Strategies of oil exporters in a carbon-constrained world. *Environmental Science and Policy*, *54*, 456–462. http://doi.org/10.1016/j.envsci.2015.08.004
van der Veer, J., & Myers Jaffe, A. (2016). The Future of Oil & Gas. *World Economic Forum, the Global Agenda Council*, (April).
Verbruggen, A., & Marchohi, M. Al. (2010). Views on peak oil and its relation to climate change policy. *Energy Policy*, *38*(10), 5572–5581. http://doi.org/10.1016/j.enpol.2010.05.002
Verbruggen, A., & Van De Graaf, T. (2015). The Geopolitics of Oil in a Carbon-Constrained World. *International Association for Energy Economics*, *2*, 21–24.