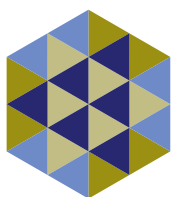


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CRUDE AWAKENING: MAKING OIL MAJOR BUSINESS MODELS CLIMATE-COMPATIBLE

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EXECUTIVE SUMMARY

- > The low carbon transition to deliver global warming increases of no more than 1.5/2°C in line with the Paris Agreement on climate change is happening. It can be actively managed by societal actors including governments, regulators, investors, banks and companies in an orderly fashion or left to unfold in a disorderly fashion.
- > One group of companies affected by the transition – the international oil and gas companies (IOCs) – are already operating at the margins of profitability and some are largely funding their dividend payments to shareholders via borrowing from capital markets. Profitability challenges for the IOCs are likely to be further intensified by several structural factors relating to national oil company (NOC) competition and shifts in demand for oil and gas driven by the global transition process.
- > Public and private actors have significant interests in the financial health of these oil and gas majors – and in seeing them transition to become 1.5/2°C-compatible in manner that minimises wasted capital expenditure and/or likelihood of bad debts accumulating.
- > The objective of this research was to demonstrate a robust and credible pathway for the oil and gas majors to achieve this under a range of transition scenarios. The authors of this report are of the view that the IOCs and those with financial interests in them must come to grips with a future that will not look like the past. The lesson of 2017 is that climate impacts will be increasingly influential in the decision-making of governments and investors. More specifically, climate events are likely to accelerate the demise of the IOCs current business models as governments face growing pressure to respond to a changing climate and protect the public from even more extreme events.
- > There is uncertainty around the timing and severity of future climate change events and government responses to them, but the risks are increasing not decreasing. Uncertainty should not be an excuse for a business as usual approach by the IOCs.

- > To start to 'unpack' how IOCs might respond to such uncertainty, E3G, the Oxford Sustainable Finance Programme at the University of Oxford Smith School of Enterprise and the Environment and Chatham House worked together to set out some of the dynamics being faced by, and options available to, the IOCs. The Oxford Sustainable Finance Programme and E3G then worked together to design an online wargame that simulated the global low carbon transition process. The wargame – entitled the '2 Degree Pathways decision support tool' – was then used to explore the different pathways companies could take in transitioning to 1.5°C/2°C-compatibility and model their impact on shareholder value.
- > The wargaming tool was developed and deployed in two stages: first to explore the impact of the climate transition on the IOCs only; second to add the NOCs into the wargame.

KEY FINDINGS

- > **The wargaming sessions indicated that of the five plausible 1.5°C/2°C-compatible business strategies originally identified for the IOCs in the research phase of this project, only two – named First one out and Planned transformation – had the potential to be commercially viable.** Taking the 'wrong path' will be expensive for the IOCs. Similarly, the NOCs, given they control between 80% and 90% of proven global oil reserves, also face significant risks of undeveloped high and medium cost reserves being stranded in the coming decades.
- > **The IOCs are already responding to changing market and policy dynamics.** However, to date in the real world the overwhelming influence on the companies has been the collapse of the oil price from its high of US\$116 bbl in July 2014 to US\$70 bbl January 2018. The IOCs should 'bank' current changes to their operational models but further work must be done to adapt their current business strategies to manage the growing risks of changing demand patterns and oil price volatility. Over the next 2 decades, flexibility and resilience will be the most important factors in company business planning.
- > **The wargaming revealed that there is significant path dependency to the IOCs successfully changing current business strategies i.e. decisions made in the early years of the game had a significant impact on later outcomes for the IOCs.** For example, we consistently found that initial trading of assets is a critical factor to enable First one out and Planned transformation strategies to be delivered.
- > **In addition, the size and shape of company portfolios will limit the strategies open to the IOCs. An early and realistic consideration of company options going forward is needed.**

- > **The wargaming also revealed there is significant path dependency to managing IOC debt levels.** In some years of the game debt quickly spiralled out of control and players effectively bankrupted their companies by failing to pay attention to and then address this. Conversely, we found that those players that focused on paying down debt in the early years gained a clear advantage in later years.
- > **The wargaming revealed risks posed by herd behaviour among the IOCs, especially with regard to the accumulation of green assets with a view to executing a Planned transformation strategy.** For example, in the most aggressive decarbonisation scenarios, once it became clear how fast oil demand was falling, there was often a 'run for green' in the mid to late 2020's. This fierce competition for green resources was also found to prevent companies from successfully completing the transition process. Players that performed best at the Planned transformation strategy started investing in green assets early (pre-2020) and in a sustained manner, thus achieving a significant level of transition before the herd behaviour kicked in.
- > **The IOC-only wargaming showed the for the IOCs a Last one standing strategy is viable but requires other companies to choose an early exit (First one out strategy).** In other words, it is a "game of chicken" between IOCs that results in lost economic value for those attempting but not successfully achieving a Last one standing strategy. **In addition, once the NOCs were added into the wargame, it was clear the Last one standing would not be an IOC.**

KEY CONCLUSIONS

- > **The best IOC long term strategy (Planned transformation or First one out) is likely to be the most difficult choice for companies to make.** It will require shifting investor attitudes and expectations to allow for planning beyond typical 1 to 3-year period. Current moves both in the UK and the EU to clarify that the obligation of institutional investors and asset managers to explicitly integrate material environmental, social and governance factors into investment decisions creates a cultural context more conducive to this happening.
- > **The current dynamics driving oil and gas prices need to be better understood by the market and modeling needs to be improved upon.** All mainstream modeling relies on an average oil price, with a lower price assumed for green scenarios. However, this doesn't adequately reflect uncertainty in the real world. Market volatility is what really matters – and is why higher oil prices in particular are possible even with falling demand. Volatility risks capital misallocation because it perpetuates the myth demand and the sector will recover. Managing these misallocation risks will require IOCs to hold their nerve as transition scenarios unfold.

- > **Considerable oil and gas price volatility may be present in a decarbonising world, which can result in very high prices even at much lower levels of demand.** The stress placed on companies and events in NOC countries can still lead to the market being undersupplied, presenting opportunities for the IOCs to monetise higher cost reserves. The urge by IOCs to interpret these moments as a return to oil demand growth in particular and a signal to invest in further exploration should be resisted. There is a key role for civil society, asset managers, asset owners, investment consultants and the commentariat to play in ensuring this message is heard loud and clear. A first step would be for key stakeholders to build a public conversation around understanding the limits of current oil and gas sector analysis and modeling.
- > **IOCs should work quickly to implement the recommendations of the Taskforce on Climate-related Financial Disclosures (TCFD) as a key instrument to facilitate an orderly transition to 1.5/2°C-compatible business models.** Meaningful disclosure and communication of a longer-term strategy is integral to giving the IOCs 'breathing space' to open effective dialogue with investors over how to address the disruption to the oil and gas sector and truly become part of delivering an orderly transition to 1.5/2°C. To address competitiveness concerns and the disincentives to public disclosure that currently drive corporate behaviour, governments beyond those of the UK, France and Sweden should seriously consider the case for making climate risk disclosure mandatory.
- > **Stress testing IOC and indeed NOC business planning against a variety of climate scenarios will aid the process of understanding path dependencies and increase the chances of a successful transition that maximises value for shareholders with the minimum negative impacts on society.** The wargaming tool we have developed offers an example of what meaningful TCFD implementation looks like – and interested stakeholders are encouraged to use and build upon the findings of this decision support tool.
- > **Across all the scenarios run it was clear that timing will be critical in successful decision-making, that IOCs have limited options available to them and that these options are highly dependent on the actions of their peers.** In the IOC-only game, much more value was lost in the late transition scenario than the orderly one. This means governments have a clear responsibility to investors and the societies they govern to set out an early and orderly 1.5/2°C transition pathway as required by the Paris Agreement on Climate Change. 2018 is the year when countries have agreed to convene a facilitative dialogue to ratchet up national ambition to reduce greenhouse gas emissions. Governments need to make it count.

1. INTRODUCTION

Major oil and gas companies face an existential threat from the transition to a low-carbon economy consistent with the Paris Agreement and a 1.5°C or well below 2°C global warming limit. Up to US\$2.3tr of potential oil and gas industry capex to 2025 is inconsistent with a 2°C target¹. New technologies, uncertain energy demand, rising energy efficiency, competitive resource landscapes, and policy and regulatory changes all have potential to disrupt oil and gas company business models and strand assets.

Public and private actors including savers, governments, regulators and financial institutions have significant interests in the financial health of these companies. **In the UK in the first quarter of 2017, for example, Shell and BP alone were responsible for £4.8bn of the £12.5bn of total FTSE 100 dividends**². Other global markets are less exposed – but still face risks from the transition to a low-carbon economy. Given the financial heft of these companies, figuring out how they can best respond to the challenges and opportunities raised by the global low carbon transition should be a matter for urgent consideration.

*“Energy is changing faster than we had ever thought possible and investors need to take action today to prepare for the future world”:
Anton Essar, Chief Investment Officer, Legal and General Investment
Management.*³

Analysis by Oil Change International neatly sets out the challenge faced by the major oil and gas companies in relation to climate change policy and competitive resource landscapes (Chart 1). It shows that **business models predicated on oil and gas production are fundamentally unsustainable in a world where most if not all governments are committed to tackling climate change**. In addition, the very large market share Saudi Arabia has of global oil reserves, shown in Chart 1 and elaborated in Chart 2, means that in a world of declining demand only the lowest cost oil (and

¹ <https://www.carbontracker.org/reports/2-degrees-of-separation-transition-risk-for-oil-and-gas-in-a-low-carbon-world-2/>

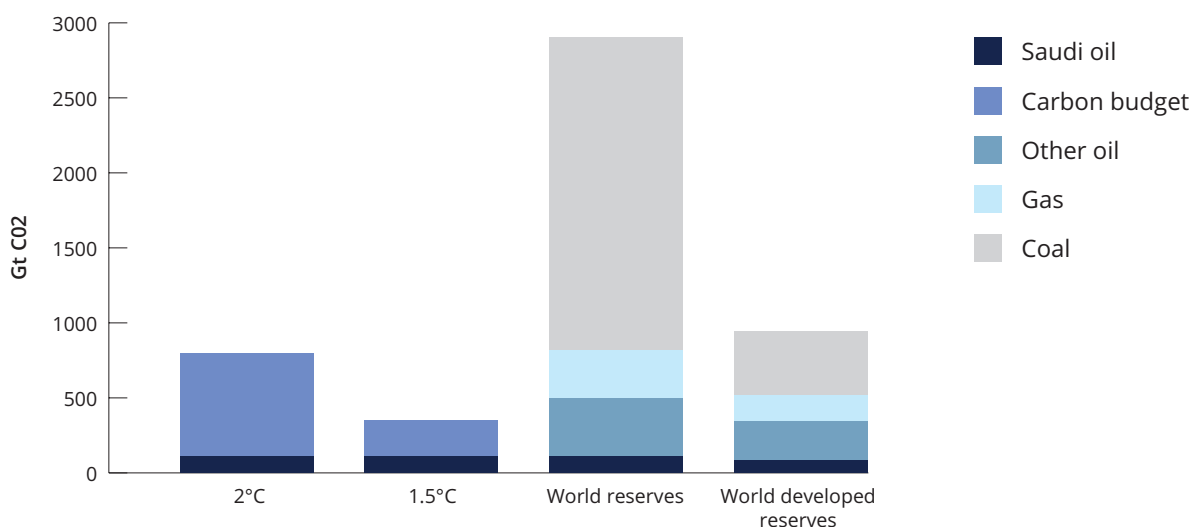
² See http://www.capitaassetservices.com/sites/default/files/7955_Capita_DM_Report_April_2017_v5.0.pdf It should be noted the composition of the FTSE100 is structured to be particularly exposed to companies whose value derives from selling fossil fuels

³ Anton Essar (4 Jan 2018) “Wake up and get ready for a Revolution in Renewable Energy” Financial Times

gas) producer will be the 'last one standing' in international markets, unless home grown demand overtakes their capacity to produce.

CHART 1. GLOBAL FOSSIL RESERVES VERSUS GLOBAL CARBON BUDGETS

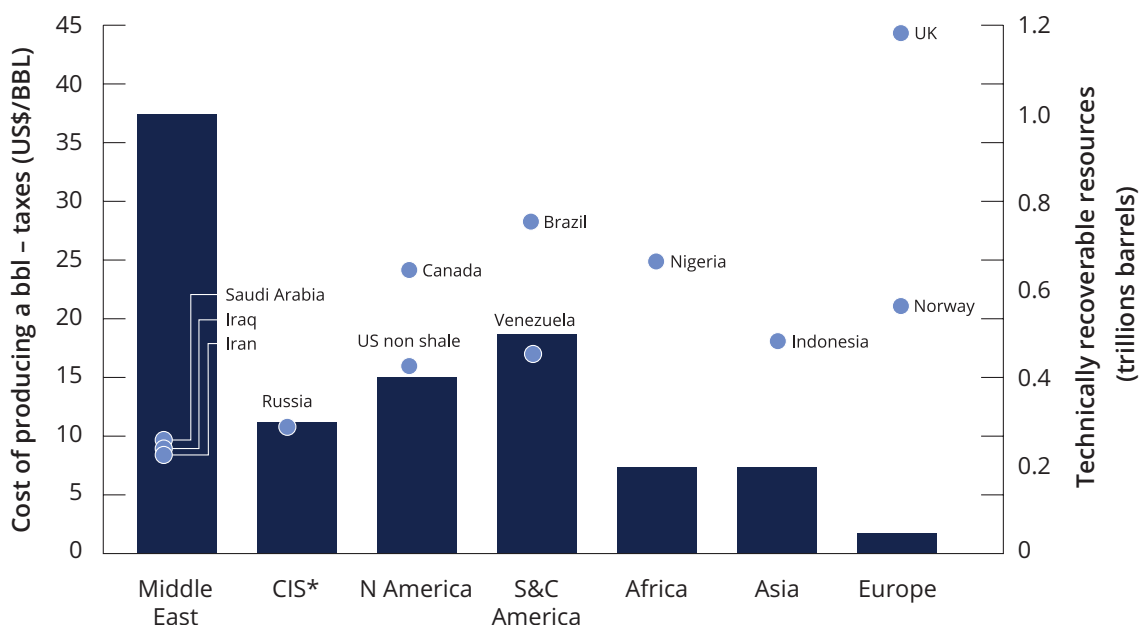
(i.e. total amount of carbon that can be released into the atmosphere before the 2°C global warming limit is breached)



Source: Oil Change International graph with data from Rystad Energy, IPCC, IEA, World Energy Council

CHART 2. GEOGRAPHIC LOCATION AND COST OF TECHNICALLY RECOVERABLE RESERVES

Each bar represents the technically recoverable resources, grouped by region. The dots represent the average cost of production minus taxes (US\$/ bbl) for a few countries

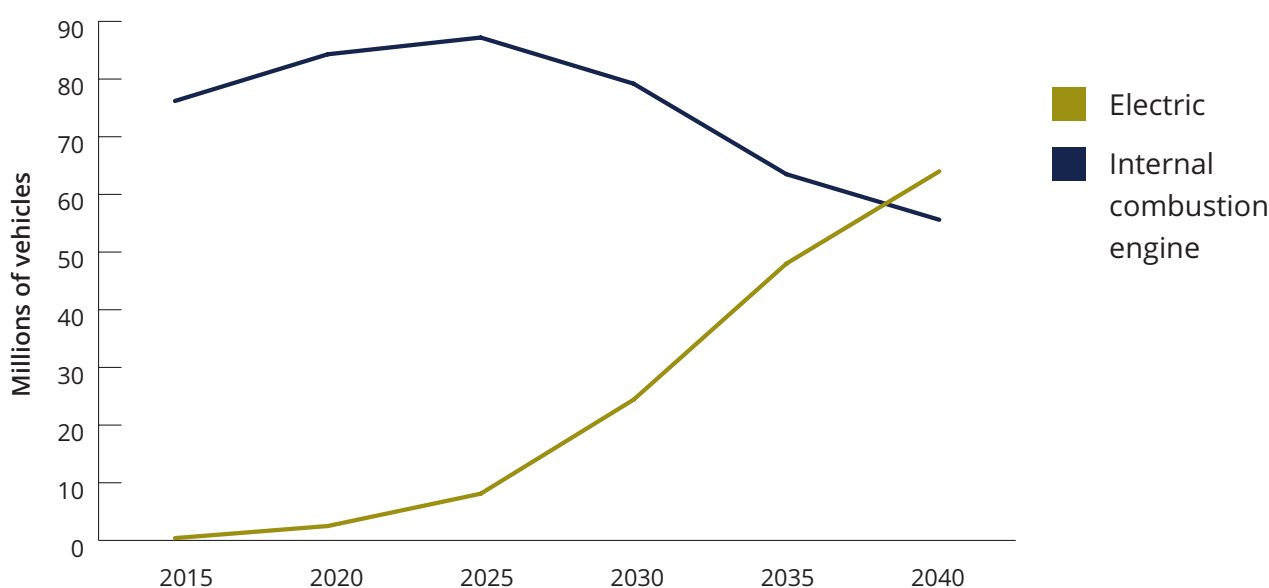


Source: Rystad Energy UCube and authors own calculations and author's own calculation with data from WS

*CIS: Commonwealth of Independent States: Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Uzbekistan.

Policies and economics combine to promote oil-avoiding technologies in the consuming sector. Electric vehicles are also poised to erode oil demand. Forecasts of sales of electric versus internal combustion engine vehicles over the coming two decades – which given ongoing global air quality concerns may well turn out to be very conservative – show a significant decline in combustion engines sales (see Chart 3).

CHART 3. ELECTRIC VERSUS INTERNAL COMBUSTION ENGINE SALES FORECASTS 2020-2040



Source: Bloomberg Energy Finance⁴

The low carbon transition is happening. It can be actively managed by societal actors including governments, regulators, investors, banks and companies, in an orderly fashion or left to unfold in a disorderly fashion. Against this backdrop, shareholder value in the publicly listed international oil and gas companies (IOCs) may be better secured by investors and civil society actors engaging with IOCs to demand they deliver a managed transition to business models compatible with a 1.5°C/2°C global warming limit. This is a major undertaking. With such a transition will come requisite changes in IOCs approach to capital expenditure, dividend policy, and business model diversification.

The objective of this research project was to demonstrate a robust and credible pathway for oil major business models to become 1.5/2°C-compatible under a range of scenarios. In doing so **the authors expected to develop insights into the political economy challenges that need to be addressed to deliver a global low carbon transformation.**

⁴ See <https://www.bloomberg.com/gadfly/articles/2017-07-13/electric-vehicle-takeover-think-different>

From a political economy perspective, declining value among national and international oil and gas majors is one of the key barriers to increasing ambition for climate action and low carbon development. **Without a credible strategy to manage the risks in transition away from oil dependency, while avoiding major economic shocks, many political leaders will remain sceptical about committing to the scale and pace of change necessary to avoid dangerous climate change.**

E3G, the Oxford Sustainable Finance Programme at the University of Oxford Smith School of Enterprise and the Environment and Chatham House worked together to set out some of the dynamics being faced by, and options available to, one set of the major oil and gas producers – the IOCs – in undertaking a transition to be 1.5/2°C-compatible. The Oxford Sustainable Finance Programme and E3G then worked together to design an online wargame that simulated the transition to a low carbon economy. The game was developed and run in two stages. The first stage looked at the interplay between private companies, the IOCs, only. In the second stage the national oil companies (NOCs) – who are the oil price-makers – were also included.

2. KEY CHALLENGES FACING THE INTERNATIONAL OIL COMPANIES

For the publicly listed IOCs in particular the key questions both they and other stakeholders (including investors, civil society and governments) need to answer about their capital allocation strategy are:

- > What is the timeframe for decision-making?
- > How should the IOCs respond to maximise value to shareholders and to society?

For the IOCs, adequately answering these questions will require a different approach to business strategy and planning compared to that used in the past. As one observer notes: “oil company managements have believed with quasi-religious fervour in perpetually rising oil demand. Therefore, finding new reserves seemed more important than maximising cash distributions to shareholders”⁵. A new approach is needed and some, but by no means all, of the oil majors are now starting to pay serious attention to how to do this. This is arguably long overdue.

Section 2 of this report reviews the key challenges facing the IOCs. Section 3 details the plausible scenarios for how IOCs might respond to these challenges. Section 4 explains how the wargame was designed and delivered. Section 5 provides a summary of the results of the gaming, first in the IOC and then IOC/NOC wargames. Section 6 provides an assessment of how the oil and gas majors are responding already. Section 7 sets out general conclusions and next steps, including an assessment of what different concerned parties (Governments, IOCs, investors in IOCs and civil society) can take away from the results of the exercise.

⁵ See <https://www.reuters.com/article/us-kaletsky-oil/heres-why-oil-companies-should-be-a-lot-more-profitable-than-they-are-idUSKCN0JK01N20141206>

In a world committed to global temperature increases of no more than 1.5/2°C, the current business models of IOCs and the largest domestic listed companies face significant profitability challenges.

IOCs are already operating at the margins of profitability and some are largely funding their dividend payments to shareholders borrowing from capital markets.

Between 2013 to 2016, dividend payments by the 18 biggest IOCs fell by an average of 28%, while their free cash flow dropped by almost 60%, mainly as a result of the fall in oil prices since 2014. Of the 17 companies in this group for which data is available, investment net of divestment in 2016 was US\$110bn (40%) below 2013 levels. The combination of an increased oil price and significant cost cutting by the companies meant net investment within this group recovered in the first 6 months of 2017 to a level approximately equal to that for the whole of 2016. **Although in 2017 the companies as a group appeared to have stabilised their financial position, there was significant variation between individual companies – and the existential challenges facing the sector remain.**

Profitability challenges for the IOCs are likely to be further intensified by several structural factors relating to NOC competition and shifts in demand for oil and gas. The exact speed and scale of these changes are uncertain and dependent on policy and regulation to promote clean energy and clean transport; advances in technology; and actions to reduce energy demand through increased energy efficiency. These changes create significant potential for stranded asset risk for the oil companies and therefore significant value loss for private (and public) investors. This in turn raises public policy concerns about financial instability and a growing pension deficit in the UK. As such active consideration of how the IOCs could transition to a 1.5/2°C-compatible business model seems advisable⁶.

For the IOCs this means making difficult decisions about how best to design their finance, capital allocation strategy and dividend policies in an uncertain market and policy environment. While the need to reduce carbon emissions from IOC products is clear, it remains to be seen over what timeframe and how this will come to pass.

Both the IOCs and their investors need greater clarity on the possible 1.5/2°C-transition pathways (i.e. scenarios under which this might unfold) to understand how best to maximise shareholder value in the short and medium term and limit asset stranding.

⁶ It is worth noting – but is not covered in this report that while, in principle, IOCs could cease oil and gas exploration and monetise all their existing assets by 2040 this is certainly not the case for NOCs due the scale of their resources and reserves and who consequently face an even greater risk of stranded assets

Some investors, analysts and NGOs have argued that the decapitalisation (managed decline) of oil majors, particularly the international oil companies⁷ might be the best way of maximising returns for their shareholders given the 'head winds' that the sector is facing from policy and regulatory changes; disrupter technologies; modal shifts in transport; and energy efficiency. Some of the arguments made are as follows:

- > IOCs were pushed into ever larger and higher breakeven point projects by a number of structural factors, such as NOC competition, changes in demand, and the role of new technology. This was brought to an end by the price collapse after 2014 and the cancelled projects and disposals of tar sands assets leaves the IOCs better able to orient their resource base towards lower cost curve, shorter cycle projects.
- > While IOCs might be able to diversify into other sectors over time (e.g. renewables or energy efficiency), it is not clear why shareholders would want companies to transition into areas where they lack expertise.
- > IOCs capital expenditure could be returned in dividends or share buy-backs and the proceeds allocated by the shareholders to other investment opportunities providing option value to investors.
- > If capex is too high, environment-related risks could result in stranded assets within IOCs portfolios due to lower than anticipated oil demand creating downward price pressure.

Falling oil prices have been driven by oversupply, the ongoing fragile global economic recovery, energy efficiency standards beginning to bite and the loosened grip of Organization of the Petroleum Exporting Countries (OPEC) on global market prices. This is prompting an energetic push back from the industry, including a charm offensive on the role of gas in the low carbon transition and calls from the oil industry for tax cuts to avoid job losses in the sector⁸.

The process of adapting the business model of a single oil major to be 1.5/2°C-compatible, let alone the sector as a whole, would be a very significant undertaking with a range of very complex moving parts. **While such calls are being made with increasing force, the implications cannot be underestimated and the practicalities of delivering such an outcome, both for the businesses and the oil sector as a whole, have not yet been worked through.** The range of issues that must be addressed include: unpicking a wide spectrum of entrenched interests; unpredictable feedback loops with other IOCs, NOCs, suppliers, governments, and investors; and interactions with resource markets and commodity pricing (including oil prices but also secondary impacts in other sectors from agriculture to coal). These issues and many others need to be better understood if such a strategy is ever to be successful.

⁷ By this we mean publicly listed companies such as Shell, BP and Exxon with extensive interests outside their home countries

⁸ For example a marked recent increase in the visibility of IOCs promoting the role of gas in the EU energy transition debate and see <http://www.theguardian.com/business/2015/jan/15/oil-chiefs-call-for-north-sea-tax-cuts>

The decapitalisation/managed decline approached favoured by many civil society organisations will certainly not an easy undertaking but is still entirely credible approach for the IOCs to take.

ConocoPhillips, for example, stands out amongst the US companies for their early acknowledgment of the challenges posed by climate change to the business. Their first climate change action plan was published in 2004. Since then they have consistently reported on greenhouse gas (GHG) emissions and sets targets for reducing them; this is not the case for all US companies. They sponsor the MIT Joint Program on the Science & Policy of Global Climate Change and disclose their progress in reducing GHGs via the Carbon Disclosure Project. In their 2013 sustainability report, ConocoPhillips they state: “we recognise that human activity, including the burning of fossil fuels is contributing to increasing concentrations of GHGs in the atmosphere that can lead to adverse changes in global climate”. Climate change is listed among the company’s risk factors and they explicitly state that climate change policies may reduce demand for ConocoPhillips products. Subsequent Sustainability reports from the company outline the way that considerations of climate change are integrated into all business decisions, with clear responsibilities and reporting lines. Overall the company’s tone on climate change is the least combative of the US companies.⁹

In another example albeit from a much smaller company, DONG Energy announced on 2 October 2017 it was changing its name to Ørsted, following what it described as a “profound strategic transformation from black to green energy and the recent divestment of the upstream oil and gas business”. The renaming of the business marks the end of a 10-year process in which the company has moved away from coal and oil to embrace renewable energy. As well as divesting from its upstream oil and gas business, the company has halted all use of coal. GHG emissions have been cut by 52% since 2006 – and the firm has said that by 2023 it expects GHG emissions will have been slashed by 96% compared to 2006 levels.¹⁰ CEO Henrik Poulsen has gone on record to say that Ørsted is now dedicated to green energy stating: “Our focus going forward will be on green growth based on our existing business platforms in offshore wind, biomass, green customer solutions and advanced waste-to-energy solutions.”

While DONG is a listed company, the Danish Government holds the majority of DONG’s shares (50.1%). It’s size – it is around one-third of the size in terms of market capitalisation of Exxon – and part-Government ownership structure are likely to have been significant drivers of the decision to get out of coal and oil, and wind down gas operations moving to just trading and selling it during the final transition to a clean economy. While it is true that these kinds of statements have also been heard from some other IOCs¹¹, there is a key difference in that Ørsted’s statements have been backed up by quite radical action that has transformed the company.

9 For details see www.conocophillips.com/environment/climate-change/climate-change-action-plan/

10 Company announcement 2nd October 2017 <http://www.dongenergy.com/en/investors/company-announcements/company-announcement-detail?omxid=1623554>

11 Shell’s announcement in November 2017 that it will double its investment into clean power and cut the net carbon footprint of its products in half by 2050, and around one-fifth by 2035 as well as its purchase of First Utility are further recent examples of this

While these examples are encouraging, the companies are outliers among the oil and gas majors. The sheer size of the IOCs and NOCs (see Table 1) as well as the high interdependencies between them, including various joint ventures, and the implication this has for asset prices means there is a strong case to be made for the companies along with governments, regulators, investors and civil society actors to work together to facilitate a process of orderly transformation across the whole sector.

TABLE 1. TOP TEN OIL AND GAS MAJORS – IOCS AND NOCS

	COMPANY	COMBINED OIL & GAS VOLUMES BBL/DAY	COUNTRY AND OWNERSHIP STRUCTURE	MARKET CAP	MARKET CAP (NOV '17)
1	Saudi Aramco	12.5m	Saudi Arabia (100% State-owned)	N/D	N/D
2	Gazprom	9.7m	Russia (51% State-owned)	US\$93.1bn	N/D
3	National Iranian Oil	6.4m	Iran (100% State-owned)	N/D	N/D
4	ExxonMobil	5.3m	USA	US\$422.1bn	US\$355.79
5	PetroChina	4.4m	China (100% controlled)	US\$220.9bn	N/D
6	BP	4.1m	UK	US\$147.8bn	US\$101.93
7	Royal Dutch Shell	3.9m	Netherlands	US\$239bn	US\$204.79
8	Pemex	3.8m	Mexico (100% State-owned)	N/D	N/D
9	Chevron	3.5m	USA	US\$227bn	US\$222.68
10	Kuwait Petroleum Corporation	3.2m	Kuwait (100% State-owned)	N/D	N/D

Source Forbes and Bloomberg

Investors and civil society organisations have been campaigning to change the business objectives of the oil and gas majors through initiatives such as Greenpeace's Arctic Campaign and the Investor-led Aiming for A Coalition¹². Shareholder resolutions focused on "strategic resilience for 2035 and beyond" have started important discussions inside the companies and among investors – but currently there is no sense of how this might be implemented. **This research project sets out to try to articulate why and how that could happen.**

¹² <http://investorsonclimatechange.org/portfolio/aiming-for-a/>

3. SCENARIOS

WHAT COULD THE INTERNATIONAL OIL COMPANIES DO?

Given the changing context and challenges facing the IOCs, E3G and Chatham House analysis set out five plausible strategies the IOCs could adopt. These are named as:

1. First one out
2. Last one standing
3. Planned transformation
 - i. Renewables
 - ii. Services tie up
4. Drift
5. Ostrich

First one out, Last one standing and Planned transformation are all credible responses to serious loss of demand due to climate policies (and carry the risk of what to do if demand is not destroyed.) Drift and Ostrich – as the names imply – are not.

All are plausible responses from the companies, which is why they were assessed in this report. Planned transformation – both to renewable energy (RES) and to services tie up with NOCs – are the only strategies that are representative of real diversification and carry with them the option of splitting the business.

All of the IOCs are adopting some elements of these business strategies and much of the internal management conversation will revolve around whether to focus on maximising dividends or optimising longer term value through low cost capex, and over what timeframe.

The strategies are summarised in Table 2 below, followed by additional details on the three credible approaches. Summaries of the other two strategies can be found in Annex I.

TABLE 2. BARRIERS TO IMPLEMENTING DIFFERENT POTENTIAL 1.5/2°C-COMPATIBLE BUSINESS STRATEGIES

	Barriers to implementation											Companies exhibiting elements of this strategy
	Culture	Internal decision-making on resource allocation	Skills base	Approach to business planning assumptions	Market access	Ability to sell off assets	Design of energy policy for power generation in target markets	Making the case to investors	Value-add for NOCs	Loss of corporate sovereignty and identity	Voices of reason in the company	
First one out	Y	N/A	N/A	Y	N/A	Y	N/A	N/A	N/A	N/A	N/A	None
Last one standing	Y	N/A	N/A	Y	N/A	Y	Y	N/A	N/A	N/A	N/A	ExxonMobil Shell (?)
Drift	Y	N/A	N/A	Y	Y	N/A	Y	N/A	N/A	N/A	N/A	All
Planned transformation & services tie up	Y	Y	Y	N/A	Y	N/A	Y	Y	Y	Y		Total
Ostrich	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Y	Chevron

FOOTNOTES: COMMENT ON PLAUSIBILITY

First one out: Given the headwinds facing the industry, appears the most credible and feasible option. However, not all IOCs can be the First one out – so the key question is who moves first to maximise the return of value to shareholders.

Last one standing: Feasible but ability to execute depends on the cost of extracting bookable reserves

Drift: Much of the Drift strategy's success will be linked with the fate of NOCs and home governments struggling to deal with falling public revenues from oil. The election of Trump as US President indicates a shift toward protectionism. That makes this strategy less feasible to lack of access to lower cost NOC reserves resulting from a shift toward resource nationalism, but could protect the US margins on domestic production.

Planned transformation: Feasible but will require very strong leadership and change management since the nature of the business and skill set within the business will need to change radically.

Services tie up: While possible in theory looks to have weak feasibility – the lack of skills and highly competitive nature of the services business, which has also just gone through massive cost-cutting, makes credible diversification look like a very hard sell.

Ostrich: Given the value at risk and strong headwinds this is not a credible strategy but may be the one adopted in practice.

3A. FIRST ONE OUT

First one out is a capital return-based strategy deployed by a company that has a strong portfolio of high producing and low-cost assets that ‘sees the writing on the wall’ regarding the 1.5/2°C global warming target. The business model would be based on sweating existing assets and cutting costs to keep dividends high while investment in the upstream part of the company declines. The focus is on running down the upstream business of the company while returning value to shareholders through dividends and share buy backs while there is still a reasonably buoyant market for its products (as the tobacco companies have done very successfully). Inevitably, this means that the company must refocus its areas of operation, functionally and geographically, to where they can maintain an acceptable return. Extensive company restructuring would occur. Exploration would be highly focused on potential low-cost projects and, where elements of the upstream or downstream portfolio are deemed to be at risk of failing to meet profit targets in the short term (5 years), these would be disposed of, potentially at a cost, so as to pass on decommissioning costs/liabilities where possible or reflect them in the pricing of the assets¹³. Where this is not possible, ‘good’ (i.e. low cost and good producing) assets may be ring-fenced from higher risk assets through a possible legal and operational separation of the business. The feasibility of doing this will depend on the mix of oil and gas; upstream and downstream; and geographic location of assets.

RISKS TO IMPLEMENTATION

Cultural: For the very large IOCs this business model challenges the current direction of European and American majors towards new high cost (e.g. deep sea offshore, Arctic) reserves. “Reserve replacement” should give way to “income replacement” as a company objective. For this, the management must adopt an entirely different mindset moving away from assumptions that the old way is the best way. A shift from an engineering-driven culture to a shareholder value profit-driven culture will be especially difficult for older employees as the focus shifts from projects to the business entity. This is not new, it has been going on for years, but to a lesser extent. IOCs also tend to be adept lobbyists with excellent government access, used to lobbying for climate and energy policy and wider fiscal decisions in their favour. There are signs this influence is starting to decline but to deliver a new strategic direction convincingly there would need to be a further attitude changes. The current charm offensive on gas from some companies is not compatible with this approach since it props up the old business model, making the First one out strategy look potentially less credible to investors as a business strategy. Also, managements tend not to want to run smaller companies.

Business planning assumptions: For the oil-focused parts of the businesses in particular there needs to be a realistic assessment of demand growth and related oil pricing to inform business planning and decisions on whether to sweat or dispose of assets. Companies have a portfolio of projects with a range of costs and therefore different oil price-related breakeven points. Tough decisions about disposal of projects at the higher end of the cost-curve (as well as downstream assets)

¹³ The issue of passing on/sharing decommissioning costs is a fast-evolving field see <https://www.bloomberg.com/news/articles/2017-01-31/shell-shows-how-to-remove-obstacles-to-north-sea-oil-deals>

will need to be made. This must be done in light of credible assessments of where markets will be strongest and identification of the triggers (policy and technology etc) that will materially impact prices and market sizes during the period over which decline will be managed (perhaps 10 years). The skill will be in making good judgments about the scale and pace of change. For example, since 2014 expected project costs have been reduced through technological advance and more selective project management, and the proportion of marginal projects in current portfolios has decreased as the portfolio is reduced overall. For a First one out company an even lower oil price might need to be assumed to determine which parts of the portfolio to sell off to minimise exposure to asset stranding and ensure a focus on maximising revenues and therefore dividends can be maintained during the run off period.

Ability to sell off assets: If company reserves are simply too expensive relative to the price of oil to realise they become worthless and non-saleable, blocking this option. Some asset swaps – as proposed between Shell and Gazprom – may be possible (encompassing some of the ‘Drift’ strategy’s characteristics, see Annex I). Downstream, the IOCs’ strategy of divestment has faced a number of problems. There are many examples of refineries being sold by the IOCs for US\$1. However, refineries purchased at knockdown prices can generally afford to maintain production and do not reduce the surplus of product on the market. This may not matter to the IOC seller if it is withdrawing from the market completely, as in some African countries and Australia. In addition, physically closing refineries in most OECD countries entails high clean-up costs, and therefore many refineries are kept notionally in service as storage facilities. Finally, in many countries refineries are still seen as an issue of security of supply and closure attracts considerable political attention and therefore sales may be blocked¹⁴.

For some companies the strategy of “income replacement (and growth) will be at odds with the culture of high risk upstream-dominated companies such as ExxonMobil and BP. Nonetheless there is a strong value case to adopt this strategy, based on maximising value to society and shareholders. Such a move would be based on an understanding that ‘the writing is on the wall’. Companies and shares can and have done well in an ex-growth sector (e.g. tobacco) given the right management strategy. Such a strategy could also reduce liability risk (e.g. class action brought against companies as a result of climate change damage¹⁵). Moving early also means the company can have more control in setting prices while there are still many buyers in the market. Timing will be critical to maximise value. Finally, this strategy may also enable decommissioning of operations to be dealt with through disposal of assets early (so others take on this cost) and otherwise being able to factor costs into the company’s wind down.

For investors this should/could be a welcome move. Even before the financial crisis there had been growing disillusion with large long-term, high-risk projects. Since these are precisely the sort of projects undertaken by IOCs, it is not surprising that their shareholders have become increasingly disenchanted. The US\$1 trillion of capex cuts made since the oil price collapse give companies a

14 P. Stevens (2016) International Oil Companies: The death of the old business model. Chatham House

15 Given the global Paris Agreement, size of the companies and cost of dealing with increasingly frequent and extreme weather events this is a clear risk – one cited by Mark Carney in his 2015 Tragedy of the Horizons Speech. In September 2017 San Francisco and Oakland filed separate lawsuits against five oil companies seeking billions of dollars to protect against rising sea levels they blamed on climate change

chance to recalibrate their forward investment decisions¹⁶. There is a strong argument to be made that this approach is preferable since it allows financial markets to reallocate capital to other sectors – which should be an investor’s role after all – instead of the IOCs. In the interim, revenues and therefore dividends over for the next ten years or so could be little affected since it is only after 2025 that oil demand is expected to peak and fall. ‘Growth’ style cash-flows could be expected for the next five years or so¹⁷. After that a decline should be expected as the company winds down – and a key remaining issue is how decommissioning costs are covered, this could vary depending on the jurisdiction – legal requirements are different.

For governments this model will quickly expose the wider economy to the effects of the transition. Governments currently dependent on taxing upstream oil revenues – notably developing country exporter countries – will need to think actively about how tax revenues from the sector will be replaced or spending cut back.

3B. LAST ONE STANDING

The Last-one standing strategy would be deployed by a financially strong company that prioritises becoming the biggest and lowest cost producer with vast low-cost reserves and downstream assets based where they can be used to maximise control over sales. The focus would be on how to maximise the value from capital expenditure in an ultimately shrinking market, gaining market dominance as a route to survival. It may well borrow to keep dividends and capex up while aggressively taking competitors out of the market to maintain size (and potentially even grow). It would be a purchaser of assets from other producers wanting to get out of/too weak to stay in the market. The company will prioritise quality, profitability and resilience of the portfolio to high impact uncertainties (e.g. electric vehicles, energy policy) and deploy robust lobbying tactics to achieve this. As a result, it bets that demand will hold up for the foreseeable future and that as the overall market for oil and gas shrinks it will be the last one standing. When the market for oil and gas used for combustion purposes finally ends (the exact date is of course unknown), it could shrink the business to be a monopoly supplier of non-fuel petroleum based products.

The closest current example of this business model appears to be that of ExxonMobil, the world’s largest internationally traded IOC. However, analysis published by the Institute for Energy Economics and Financial Analysis (IEEFA) raises doubts about how strong Exxon really is. IEEFA analysis shows deep financial weakness in the company, including a 45% drop in company revenues in the last 5 years, a growing reliance on debt to cover dividends, a decline in capital expenditure, end of year cash balances and free cash flow. In January 2017 ExxonMobil posted its ninth-straight quarter of year-over-year profit declines¹⁸. The main contributor to this was Exxon’s de-booking 4.6bn bbl (equivalent to 19% of its proven reserves). This was in recognition of persistent lower oil prices catalysed by the Securities and

¹⁶ See Upstream Intelligence Newsletter June 27 2016. See also IEA (2016) World Energy Outlook Table 2.4 most companies have cut by a third or more compared to previous projected figures. Projects in the deep North Sea, pre-salt Santos Basin, and Gulf of Mexico have been deferred

¹⁷ Carbon Tracker Initiative (2016) Engaging for a Low Carbon Transition

¹⁸ See <https://www.bloomberg.com/news/articles/2017-01-31/exxon-misses-estimates-as-recovery-from-slump-proves-elusive>

Exchange Commission's inquiry into Exxon's reporting of its reserves and asset valuations¹⁹. In January 2018 ExxonMobil posted its strongest annual earnings since 2014, although this fell far short of analyst estimates.

Shell's 2016 purchase of BG also shows aspects of this strategy. The BG portfolio included a majority of reserves deemed productive at oil prices of US\$20bbl and was in part used to justify the purchase to shareholders²⁰.

RISKS TO IMPLEMENTATION

Risks are as for First one out but with key differences with respect to management attitudes and how advantaged is the asset base.

Cultural: This business model challenges the current specialisation of European and American majors in high cost projects. The management must therefore adjust their expectations of rising demand and rising prices that have been used to justify high risk high capex investment (and in fact they are all talking about 'lower for longer' and giving much lower breakeven figures for their portfolios) – and rigorously adjust plans to reflect a reduced demand and price growth trajectory. High cost projects may not be developed in the foreseeable future unless there is government support based on security considerations – but given technology innovation around electric vehicles this seems unlikely.

Business planning assumptions: As for First one out, for the oil-focused parts of the businesses in particular there needs to be a realistic assessment of demand growth and related oil pricing to inform business planning and project investment. As for First one out, much of the existing portfolio may need to be shelved, at least for the time-being²¹ (for ExxonMobil for example this could be half the existing reserves, which would need to be aggressively replaced with acquisition of further lower cost reserves from other IOCs/NOCs). This must be done in light of realistic and sophisticated assessments of where markets will be strongest and risk assessments of the triggers (policy and technology etc) that will materially impact prices and market sizes in the next 5, 10, 15 years. This planning could also be confounded by governments wishing to intervene to prevent a change in strategy and thereby retain tax revenue and dividend streams, however unstable.

Energy policy for power generation: For gas the 'golden age' may similarly not materialise as expected, especially as the cost of RES continue to fall. To retain potential future market share the IOCs will need to try to negotiate a space for gas in the power generation systems of developed countries where it could substitute for existing assets (mostly coal) to gain a share of growth markets. This could be justified to governments on the basis of diversification of supply and/or improved air quality – which could in turn justify the investment in gas transportation infrastructure.

19 See <https://www.ft.com/content/53f66878-9d13-11e6-a6e4-8b8e77dd083a>

20 See <https://www.ft.com/content/469635d6-c4ed-11e5-b3b1-7b2481276e45>

21 In due course, with sufficient market control, higher costs reserves could be realised later.

Achieving this will require a clear focus on targeting lobbying to markets with the highest growth potential, i.e. developing countries, and selling goods at a price that both creates demand and is economic to supply.

Ability to sell off assets: As for First one out, if company reserves are simply too expensive relative to the price of oil to realise they become worthless and non-saleable, blocking this option. (More detail on challenges is as set out for First one out.)

KEY INTERESTS/INCENTIVES FOR DIFFERENT STAKEHOLDERS

For companies with strong balance sheets there is a strong incentive to buy market share and political power when the market is looking challenged. Although the ExxonMobil story does seem to indicate that political power is waning: most of (78%) of the de-booked reserves are at Exxon's Kearn oil sands project in Canada, which started in 2013 and expanded in 2015. A Last one standing strategy will need to have a strong analytical underpinning of market opportunities and how the 1.5/2°C transition might unfold and affect markets. It must be delivered with an accompanying aggressive and covert lobbying strategy to drive up demand for products as far as possible for as long as possible. In addition, where assets can't be sold but must be retired, the issue of mothballing versus decommissioning operations will need to be addressed. For a Last one standing strategy there would be a strong incentive to sell residual assets to less reputable market players (possibly at a negative cost) who will run assets down and, where not legally mandated, undertake remediation of sites so as to preserve shareholder value²². In some cases, the alternative will be to mothball in the hope that prices pick up as they control more market share and therefore product volumes. Options around such decisions will need to be carefully balanced.

For investors this strategy could meet with approval, but only if the portfolio of assets justifies it and blatant lobbying is avoided²³. For them the commercial resilience of the company (a factor of its large low cost portfolio and growing size relative to the shrinking market) could well imply lower risk and therefore a lower cost of capital²⁴.

For governments where near-end-of-life assets are sold on, the issue of decommissioning operations should be a priority issue. Governments should pay close attention to how assets are disposed of and to whom, and insist legal clauses are included in sales to ensure sufficient funds are retained for decommissioning. Where assets cannot be sold, governments should insist a separate decommissioning entity and/or fund is set up.

22 This has, in effect, happened with the sale of Vattenfall's German lignite assets – 4 mines and 7600 MW of power generation capacity. The portfolio has now been 'sold' to Czech company EPH at a de facto negative price of around €1.6bn, with EPH expected but not obligated to deploy funds to decommission the mines and power stations

23 For example, in the IIGCC's Updated Guide: Investor Expectations of Oil and Gas Companies 2016 one of the key areas of scrutiny is whether the company engages with public policy makers and other stakeholders to support development of cost-effective policy measures to mitigate climate-related risks and low carbon investments. See <http://www.iigcc.org/publications/publication/updated-guide-of-investor-expectations-of-oil-and-gas-companies-2016#sthash.rbRSi2pY.dpuf>

24 This would represent a change in sentiment since in the past investors might only have favoured such a strategy if it was clear that the asset base was sufficiently advantageous to justify it

3CI. PLANNED TRANSFORMATION – CLEAN ENERGY

Planned transformation comprises a company strategy to diversify out of oil into gas and/or clean energy. The IOCs' past diversification efforts have been notoriously poor, almost always destroying value and resulting in massive asset write-downs. Such efforts have included coal mining but also fish-farming, pet food, typewriters, software and high street retailing that are rarely discussed in the media nowadays but are remembered by many investors²⁵. Efforts to diversify into clean energy have also – on the whole – proved short lived. For example, Shell's push into solar was regarded by some as a license to continue with its core business of oil extraction. It ended with the sell-off of the solar business in 2006/2007. Similarly, there has been some 'dabbling' with carbon capture and storage (CCS), but again this has been at the margins, with a focus on research rather than large scale demonstration or deployment. The internal company discussion seems to have been focused on the role of government not companies in delivering market development opportunities to drive investment.

Given current global energy trends, diversifying 'closer to home' – to gas and RES – and with a more enduring approach may prove more fruitful. An example of this type of approach is, in the case of gas, Shell – which acquired BG in a US\$52bn mega purchase. In the case of RES, Total is increasingly pushing into the renewable and storage market. In April 2016, Total announced the creation of a gas, RES and power division, saying it wanted to become a "leader" in RES and electricity storage within 20 years. In May 2016, Total bought battery manufacturer Saft²⁶. As noted earlier DONG has now actually completed its transition to Ørsted, a clean energy company.

Diversification into gas, is – in reality – a version of the 'Drift' strategy but with a focus on just gas assets. As such it carries a specific set of controversies. The first is around the expected future market share for gas and whether this too will soon become an ex-growth sector. The second factor is that diversifying into gas means acquiring reserves and infrastructure on a scale that would have a meaningful portfolio diversification effect given the size of the IOCs involved. This potentially leads to megamergers on a scale that has caused quite some concern to investors already. For RES, there are questions about whether the IOCs can attract the right skills needed to successfully move into RES and the culture challenges this may bring to the business.

RISKS TO IMPLEMENTATION

Culture: Already the IOCs that have diversified into gas are struggling with managing the differing cultures within the business. In the case that a Planned transformation approach is focused on RES, another layer of challenge lies in trying to bring in engineers with the right expertise, who are likely to be younger and highly values driven. This will be at odds with the idea of 'propping up' the fossil fuel business models.

²⁵ LAPF & Carbon Tracker Initiative (2016) Engaging for a Low Carbon Transition

²⁶ Other diversification strategies are potentially feasible but would require an IOC convincing shareholders to tie up capital in order to fund diversification. This could be possible, especially given their privileged position in the FTSE-100 index. This would be about complete re-invention of the business

Added to this, RES is a completely different business model and there is absolutely no guarantee that an IOC management team can run it well, or indeed better than, a specialist management team.

Internal decision-making on allocating resources across oil, gas and RES: Management will have to decide and justify the allocation of resources to the different parts of the business – a non-trivial task given the different risk profiles and opportunities²⁷.

Skills: This is a particular issue for diversification to RES/storage. IOCs are increasingly seen as the latest ‘pariah’ companies on a par with tobacco companies and arms manufacturers and this hampers their efforts to attract talent. The IOCs were always very proud of the fact that they were able to attract very high-quality graduates. However, in the last 20 years or so, it appears that the ‘best and brightest’ have been switching their interest to greener forms of energy. Whether they can be attracted back at the level and in the number needed to deliver a renewable diversification strategy remains to be seen, but will be a core internal consideration in relation to evolving company culture²⁸.

Energy policy for power generation: Challenges will be as set out for the Drift strategy – see Annex I. Related to this is whether energy systems shift more toward decentralisation and the degree of digitalisation will all have impacts – and to a greater or lesser extent could be driven by policy and regulation.

Making the case to investors: A strong and credible story to investors will be needed in terms of how the pathway to diversification into clean energy will be managed. Investors are likely to be sceptical about this strategy not least because stock markets traditionally place a low value on the stocks of conglomerate businesses (the “conglomerate discount”) versus pure play companies. This is because portfolio managers can allocate exposures in their portfolio as they choose and change them immediately, rather than being tied in to a conglomerate. Robust representations will need to be made to investors on how decisions will be made to allocate capex across different sectors of the business to maximise value; clear return on capital employed (ROCE) and return on investment (ROI) targets and reporting on a comparable basis; how the skills needed will be attracted; and how the newer parts of the business will be able to deliver profits without cross subsidy from other part of the business.

²⁷ The culture of gas companies is very different from that of oil companies. In an oil company, the strategy and underlying culture is driven by the geosciences being used to discover crude oil, with a market for the resultant oil taken as a given. By contrast, gas is concerned with securing markets and customers, which is outside the expertise of much of the senior management in the IOCs. From P. Stevens (2016) International Oil Companies: The death of the old business model. Chatham House

²⁸ Financial Times (27 October 2016) Oil Industry struggles to fill hole left by baby boomers <https://www.ft.com/content/f0c72686-9761-11e6-a80e-bcd69f323a8b>

KEY INTERESTS/INCENTIVES FOR DIFFERENT STAKEHOLDERS

For companies it gives managements the opportunity to continue to manage and do deals rather than shrink the business and give money back. To make the case to diversify to gas, as in the Drift model, the IOCs will need to try to negotiate a space for gas in the generation systems of developed countries where it could substitute for existing assets (mostly coal) to gain a share of generation growth. Also, as for Drift, a key consideration for IOCs would therefore be what political influence could be achieved alongside company acquisition to ensure future market share. Gas could be an effective medium term (10-15 year) strategy depending on where assets are purchased and what price, but is perhaps not a long-term strategy for survival.

In the case of diversification to clean energy, this is a more radical shift – but one that makes the strong statement of acknowledging that the world they are operating in is changing but that the company plans to change and stay in business. It will entail a radical culture change that in turn requires a strong story and a demonstrable track record to convince investors that such businesses can be run by an IOC to deliver returns superior to those that could be achieved investors reinvesting their capital elsewhere²⁹. The location of much, although not all of, the high value renewable energy opportunity is to be found in politically challenging countries (the Middle East and autocratic African nations for example), and difficult environments (deep offshore wind, wave and tidal) and IOCs have expertise in managing large-scale projects (albeit often late and over budget) in these environments and so it is not inconceivable they could become important market players in these specific spaces.

CCS will be needed for deep decarbonisation of industry³⁰. The IOCs are perhaps the best placed companies to build a CCS network that could be used to manage carbon dioxide emissions from industrial and gas power sector players with balance sheets too small to manage this type of capex investment. By investing to demonstrate CCS at scale, the IOCs (and indeed NOCs) could build themselves a future business model. However, so far this has not proved a feasible option.

For investors questions will be raised about whether the IOCs rather than financial markets are best placed to reallocate capital across sectors. One key issue to consider, therefore, is whether there should be – in due course – a legal and operational separation of the fossil fuel parts of the business and operational RES assets on the basis of different risk profiles. Financial separation could be achieved – under strictly controlled conditions) by subsidiaries organised as Special Purpose Vehicles (SPVs) with no financial recourse to the Parent company. Doing this would, however, implicitly admit the weaknesses and risks of the IOCs investing outside their normal field of operation.

²⁹ For example, generating companies or networks companies in the power sector where the IOCs have neither experience nor structural advantage

³⁰ CCS is also potentially important in the context of growing debate on the role of hydrogen in heating in the Northern hemisphere

This is the model DONG (now Ørsted) has used, with investment coming from CIP, a subsidiary of PensionDanmark set up for this purpose. In some countries the tax regime could permit the use of a master limited partnership to achieve a somewhat similar result in oil development and infrastructure projects. An SPV structure for the fossil business looks less viable simply because of the risk those assets carry from asset stranding and decommissioning (which is well defined in some jurisdictions such as the UK but not in all). However, if the business gets to a point where more revenues are being generated by RES than by fossil fuels a case could be made for structural separation of the business, with a decapitalisation/managed decline strategy deployed for the oil and gas side of the business on one side and growth of the RES business on the other.

For Governments the issues are not straightforward. For some 'home governments', i.e. those that receive corporate tax returns, the RES option could prove a 'double-edged sword'. On the one hand, diversification to survive long-term – if successful – would potentially address the developed country government's 'headaches' around loss of oil revenue and the need to shore up of companies in the short term (notionally at least) through tax credits. For developing countries this approach could be part of a credible programme of diversification of export-dependent economies (such as in Saudi Arabia's "Vision 2030"). On the other hand, pension funds and insurers would need to develop other sources of reliable returns as dividends paid by the oil companies dwindle. However, this strategy would also mean those less progressive home governments (such as the USA) would need to move forward fast on enabling the low carbon transition through appropriate fiscal and regulatory policies to promote clean energy investment. This may actually be helpful for civil society advocates fighting for accelerated climate action because it would potentially become in the interests of a clean energy-diversified IOC to lobby for an end to fossil fuel subsidies, to shore up the clean side of the business and give them a competitive advantage in the sector³¹. In the case of diversification to gas, the issues are as set out for Drift above.

3CII. PLANNED TRANSFORMATION – SERVICES TIE-UP

Production sharing contracts and production sharing agreements are forms of cooperation widely used in the relations between IOCs and NOCs. These would be the key elements employed in an IOC "Services tie-up". In a service-based partnership, a technically strong IOC would manage projects (reducing their costs) for an NOC and be rewarded by some mixture of cost recovery and (in some cases) profit sharing. The upside is that by giving up insistence on "equity oil" and shifting more to a service-based model – extraction, project management and also possibly trading services – the IOC retains access to low cost production assets and further low cost exploration opportunities. The downside is that the IOC faces political risk (of changes in the terms of the contract). Finally, ownership of the assets (but also the risk of their being stranded) remains with the NOC.

³¹ This will depend on the geography in which they are operating and who their competitors are. Whether this would be the best outcome for shareholders and society is highly debatable

RISKS TO IMPLEMENTATION

Value added for NOCs: In the 1990s, the IOCs believed that they could bring three key benefits to any upstream project: risk capital for exploration and development, technology for upstream operations and an ability to manage the risk of large projects. In the following decade, all three factors began to look less relevant. The rise in oil prices after 2002 meant that capital became less of a constraint for existing producer governments³². The service companies to whom the IOCs outsourced much of their technical capacity in the past 20 years can now supply much of the technology required by NOCs. The IOCs' reputation for managing large projects came into question as a result of failures such as the Kashagan Field in Kazakhstan and the Deepwater Horizon spill in the Gulf of Mexico³³.

Skills: Skills are related to the value-added issues. Historically, the IOCs had played a key role in developing technology for the oil and gas industry³⁴. However, there has been a progressive move by IOCs to outsourcing technology and skills to contractors such as Halliburton. In trying to deliver the hybridised model, many of these roles played by the IOCs would either not be missed or simply be taken up by service companies, NOCs and smaller non-integrated private companies³⁵.

Access to markets: Opportunities to access to NOC market have in more recent history been limited. However, the falling oil price may open up more opportunities. For example, in Saudi Arabia's 2016 "Vision 2030" the key theme was a reduction in dependence on oil revenues (in 2015 42% of Saudi GDP came from oil revenues) through economic diversification. As part of this, there have been plans to sell shares (but far from a controlling interest) in part of Saudi Aramco as well as public companies providing services to it. The intention is for the Saudi public investment fund to hold controlling shares but for there to also be diverse private shareholders. Revenue raised this way realises the value of assets that might otherwise be stranded. Other examples of such sell offs include 2016's sale by Petrobras of its controlling share of the Carcara oilfield to Norway's Statoil for US\$2.5bn³⁶. Here the large balance sheets of IOCs appear again to be an attractive resource for cash-strapped NOCs and their owner governments.

32 It is important to note the prevailing oil price has again reversed this situation, with most producer government unable to maintain previous levels of domestic expenditure at current export prices, and are borrowing to help bridge the gap

33 P. Stevens (2016) International Oil Companies: The death of the old business model. Chatham House

34 In the integrated business model, research and technical services were often located within the company. As the industry fragmented in the 1980s, international service companies expanded to meet the needs of NOCs as well as those of private-sector companies that were outsourcing technical competence. IOCs and service companies drew on technical developments outside the industry (e.g. increasing computing power, communications, materials and sensors) to achieve incremental as well as step-change improvements in the technologies of oil and gas production, transportation and processing. The result has been a continuous reduction in the costs of exploration and development, reduction of environmental impacts, and a steady increase in the resources that can potentially be developed. Horizontal drilling and 'fracking' are the most recent and well-known examples of these technologies, but they are built on the legacies of the development of 3-D and 4-D reservoir modelling, measurement; while drilling, coiled drill tubing, dynamic positioning of rigs and platforms offshore, and liquefaction and gasification of natural gas. The IOCs were crucially important in the development of offshore oil production (though they played virtually no part in the shale technology revolution that has been so important in recent gas and oil developments). Source *ibid*

35 The prices of offshore services have fallen by 50 percent and in shale oil and other fields by as much as 35 percent. Schlumberger and Halliburton have cut thousands of jobs. Source <http://www.oilandgasinvestor.com/further-price-cuts-are-difficult-oilfield-service-companies-836646#p=full>

36 See <https://www.bloomberg.com/news/articles/2016-07-29/cost-cutting-petrobras-gets-2-5-billion-from-statoil-field-sale>

Loss of corporate sovereignty and identity: The quality of NOC partner and their ability and willingness to take advice and risk manage project delivery will be key. In addition, given geopolitical instability in some regions, there is potentially the risk of future nationalisation of assets. Given that the nature of the business will change substantively there may also be issues with attracting and keeping a sufficiently high-quality workforce.

KEY INTERESTS/INCENTIVES FOR DIFFERENT STAKEHOLDER

For companies the cost pressures on oil exploration and the need to develop gas reserves close to where they will be used mean there is an incentive for companies to pursue a Services tie-up strategy. The question will be on what terms and where – as the size and scope of opportunity will be geography and asset-specific. This is because, unlike IOCs, NOCs have much larger, longer life reserves and ties to national governments, which arguably imply a greater risk of stranding. Given this and the shift from developing and owning assets to providing services the company may consider the legal and operational separation of the NOC-related business from the rest of the company.

For investors this could be a viable approach, but companies will need to present a strong rationale and reassure investors concerned they are committing capital with fewer controls. Investors may also believe that an NOC/service company or NOC/more sophisticated NOC model would be more credible. It will be important to explain how an IOC will manage the policy-related stranded asset risk arising from country governments instituting tighter climate policies once their financial interests in the sector are diminished. The flip side of this is whether by undertaking such purchases the IOCs may seek to block the climate transition in those countries through requiring, as a condition of sale, guaranteed access to local market opportunities, for example.

For Governments that own NOCs, access to capital is growing in importance as an economic diversification strategy (away from oil and gas) and so this looks to be potentially attractive, if the terms are right.

4. WARGAMING

USING THE DECISION-SUPPORT TOOL TO UNDERSTAND THE LIKELY SUCCESS OF DIFFERENT STRATEGIES

The truly innovative element of this research project was the wargame element, which sought to simulate the future options available to IOCs and NOCs. Much has been written already about the uncertain future faced by the IOCs – and robust cases made for the companies to now wind down their fossil fuel businesses. There are five plausible approaches that IOCs could take, only three have the potential to lead to the creation of commercially viable 1.5°C/2°C-compatible business strategies and models. Taking the ‘wrong path’ will be expensive.

The Oxford Sustainable Finance Programme and E3G created a dynamic decision support tool (the ‘2 Degree Pathways decision support tool’, used for ‘Oil majors wargaming’³⁷) to explore the different pathways companies could take and model the impact on shareholder value. **This tool aims to help inform company, investor, government and civil society thinking around the pathways the oil and gas majors can take to become 1.5°C/2°C-compatible.** The tool does not aim to devise a corporate strategy, but instead highlights the risk and opportunities inherent in a managed transition. It has been designed to enable players to explore how different approaches to capital expenditure, dividend policy and business model diversification could play out not just next year, but over many years.

It is an early example of how forward-looking scenario analysis of the kind envisaged by the Taskforce on Climate-Related Financial Disclosures (TCFD) can be used to stress-test the robustness of the business models and strategies of companies highly exposed climate transition risk.

The wargaming tool was developed in two stages: first to explore the impact of the climate transition on the IOCs only; second to add the NOCs into the wargame. As noted above many of the IOCs choices will – in the end – be constrained by the NOCs, which have access to the lowest cost oil and gas.

An overview of the wargame is provided here – with additional detail set out in Annex II.

37 <http://www.2degreepathways.com>

The 2 Degree Pathways Wargame and Decision Support Tool allows players to role play oil and gas company decision-making on energy transition time horizons. The tool is an online web app that players interact with in a session facilitated by the Oxford Sustainable Finance Programme and E3G. Sessions run about 5 hours and allow players to learn the game and run through two different climate transition scenarios. The ideal number of players is between 16 to 30, although the game can be played with as few as 6 or as many as 40 players.

Working in small teams, players are given a fictional oil and gas company for whom they are the sole decision-makers. Players manage the cash flow and the assets of their company. The main dynamic of the game is that the players, in aggregate, form the supply curve for oil and gas. Prices clear according to scenario-driven demand and the players' companies produce oil and gas in exchange for cash. They then set their capital allocation policies for the next year. The players are primed with Section 172 of the UK Companies Act 2006, which is shown in Box 1.

Box 1: UK Companies Act 2006 S.172

A director of a company must act in the way he considers, in good faith, would be most likely to promote the success of the company for the benefit of its members as a whole, and in doing so have regard (amongst other matters) to—

- a) the likely consequences of any decision in the long term,
- b) the interests of the company's employees,
- c) the need to foster the company's business relationships with suppliers, customers and others,
- d) the impact of the company's operations on the community and the environment,
- e) the desirability of the company maintaining a reputation for high standards of business conduct, and
- f) the need to act fairly as between members of the company.

Players are given login credentials to the web app, which gives them access to their company's dashboard. The dashboard includes two information pages providing information about the fictional state of the world and the performance of their company; an allocations page where they set their capital allocation policy for the next year; and a transactions page where they can buy and sell assets via auctions with other gamers.

The facilitator uses an administrator dashboard to advance the game through 1-year time steps 'turns'. Players are told they will play through to 2040, however the facilitator may end the game 1 or 2 years early to avoid reverse-induction effects of finitely repeated games. At the end of the game the facilitators debrief the participants, discuss the game results, and their relevance to the strategies of real companies.

5. RESULTS OF THE WARGAME

The Oxford Sustainable Finance Programme and E3G ran ten sessions of the wargame between November 2016 and October 2017 with more than 150 individuals with a range of organisations including financial institutions, extractive companies, consultancies, government, civil society groups, non-profit foundations, thinktanks and academia. Informal sessions were also hosted with students and colleagues as part of the development process. The results of these sessions are intended to shed light on the opportunities and challenges IOCs and NOCs face in transitioning to become 1.5/2°C-compatible and provide insights into how they might be overcome.

It should be noted that the wargame and tool is evolving, with additional capabilities, scenarios, and dynamics being continually introduced. The Oxford Sustainable Finance Programme and E3G are planning a next phase of systematic testing to generate more results. Future plans for development include agent-based simulation to discover both optimal and scenario-robust strategies; a high-quality single-player web-based game to make the wargame accessible on a mass basis; and then using the web-based game as a testing environment for certain uncertainty, 'nudge' and behavioural-economic research topics.

5A. IOC-ONLY GAMING

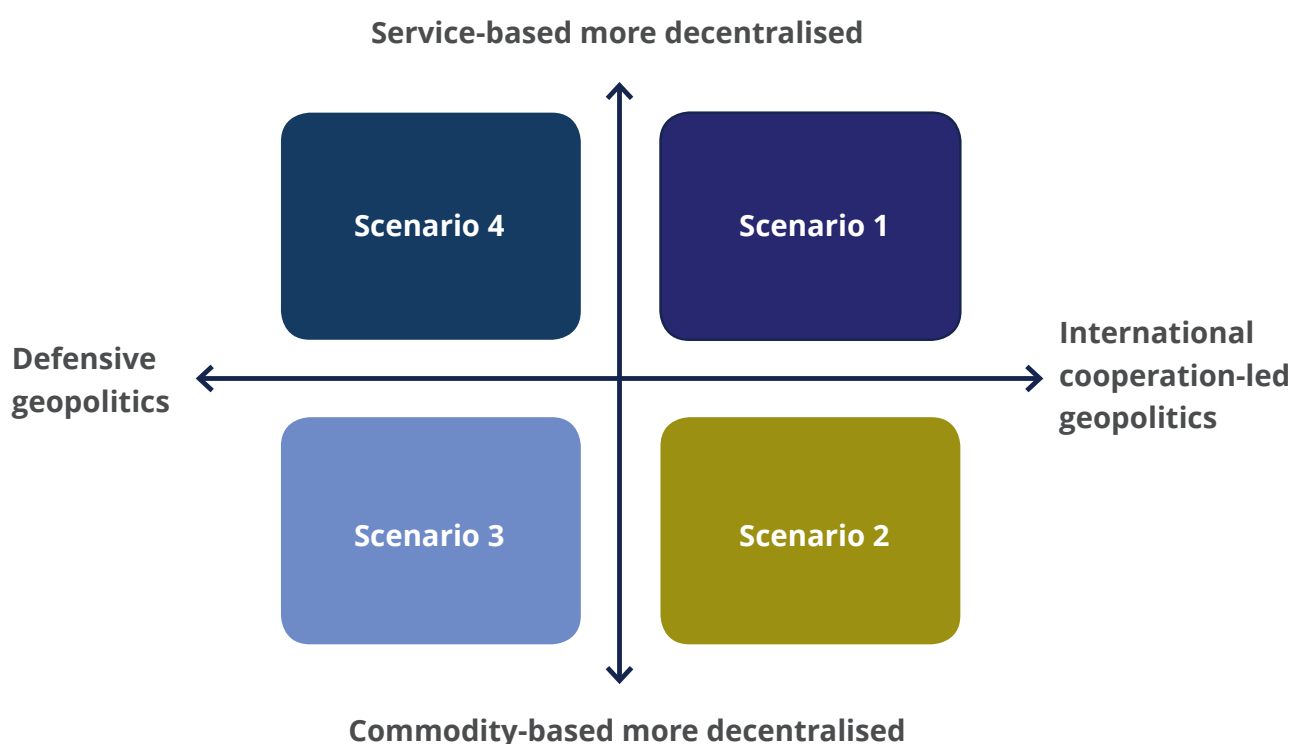
Here we focus in on the specific results of one gaming session run with investment industry professionals along with former and current extractive industry professionals, with occasional references to broader trends observed in the wider group of sessions run during the project. The session run with investment industry professionals along with former and current extractive industry professionals gave results that were generally indicative of the many others sessions run during the course of the project.

In the game, there were six fictitious IOCs named: Roxxon, Ewing, Globex, Virtucon, Danconia and VBCA. Each of IOCs had different portfolios of gas and oil assets at the start of the game that bore resemblance to real IOCs. The player's task was to role play company board level decision making. The capital planning time horizon was from 2017 to 2040; decisions were made on a rolling year-by-year basis.

At the start of the game players were presented with key elements of the UK Company Act 2006 (Box 1), which stipulates that directors' duties include an obligation to promote the success of the company, to consider the community and the environment, the interests of employees and to be fair to shareholders³⁸. Although the UK Company Act 2006 is applicable to the UK only, other jurisdictions such as the USA have similar requirements. Thus, it was used as a reminder to the players as 'virtual directors' of their 'virtual responsibilities' and as a guide to what success could look like in the game.

During the wargaming, two out of four possible transition scenarios developed by E3G were run: scenarios 1 and 3.

CHART 4. SCENARIOS AND DRIVERS



Scenario 1 set out a rapid and relatively orderly transition to a low carbon global economy. By contrast, Scenario 3 set out a late-stage transition that was more disorderly as a result of 'crash policies' being introduced haphazardly to force a last-minute reduction in carbon emissions to stay on track with a global temperature increase limited to 1.5/2°C. To formulate the scenarios, data was drawn from a variety of sources including International Energy Agency, Greenpeace and Statoil. A detailed description of the four scenarios can be found in Annex III.

Significant asset stranding was observed under both scenarios played. In the interests of brevity we focus here on the results from orderly transition scenario (Scenario 1); those from the disorderly Scenario 3 showed even more extreme assets stranding. (See Box 2 for a definition of stranded assets.)

³⁸ See <http://www.legislation.gov.uk/ukpga/2006/46/section/172>

Box 2. Definition of stranded assets in the context of the game.

For the wargame we use a slightly idiosyncratic definition of stranded assets for the sake of simplicity. We define assets as stranded when by 2040 in a carbon constrained world oil demand has fallen to a low enough level that there will never be sustained high prices for companies to utilise the high cost reserves remaining on their balance sheets. Below is a further detail on the concept of stranded assets and the different definitions employed by others.

There are a number of definitions of stranded assets that have been proposed or are used in different contexts. Accountants have measures to deal with the impairment of assets (e.g. IAS16) which seek to ensure that an entity's assets are not carried at more than their recoverable amount³⁹. In this context, stranded assets are assets that have become obsolete or non-performing but must be recorded on the balance sheet as a loss of profit⁴⁰. The term 'stranded costs' or 'stranded investment' is used by regulators to refer to 'the decline in the value of electricity-generating assets due to restructuring of the industry'⁴¹. The potential losses to electric power utilities as their industry is deregulated play an important role in the debate about restructuring the industry. Various electricity restructuring Bills have been introduced into the US House and Senate, but the questions of whether and how to compensate utilities for stranded costs remain a contentious and uncertain factor in the debate about restructuring. This was a major topic for utilities regulators as power markets were liberalised in the United States and United Kingdom in the 1990s.

In the context of upstream energy production and from an energy economist's perspective the IEA defines stranded assets as 'those investments which have already been made but which, at some time prior to the end of their economic life (as assumed at the investment decision point), are no longer able to earn an economic return'⁴². The Carbon Tracker Initiative also use this definition of economic loss, but says they are a 'result of changes in the market and regulatory environment associated with the transition to a low-carbon economy'⁴³. The Generation Foundation defines a stranded asset 'as an asset which loses economic value well ahead of its anticipated useful life, whether that is a result of changes in legislation, regulation, market forces, disruptive innovation, societal norms, or environmental shocks'⁴⁴.

39 Deloitte, 2016. IAS 16 — Property, Plant and Equipment. Available at: <http://www.iasplus.com/en/standards/ias/ias16>.

40 Ibid

41 Congressional Budget Office, 1998. Electric Utilities: Deregulation and Stranded Costs. CBO Paper.

42 IEA, 2013. Redrawing The Energy Climate Map. World Energy Outlook Special Report, p.98. Available at: <http://www.worldenergyoutlook.org/media/weowebiste/2013/energyclimatemap/RedrawingEnergyClimateMap.pdf>.

43 Carbon Tracker Initiative, Carbon Tracker Initiative's Definition of Stranded Assets. Available at: <http://www.carbontracker.org/resources/> [Accessed August 23, 2016].

44 Generation Foundation, 2013. Stranded Carbon Assets. p.21. Available at: <http://genfound.org/media/pdf-generation-foundation-stranded-carbon-assets-v1.pdf>

Different definitions for economists ('economic loss'), accountants ('impairment'), regulators ('stranded costs'), and investors ('financial loss') make it difficult for different disciplines and professions to communicate between each other about very similar and overlapping concepts.

Caldecott et al. proposed a 'meta' definition to encompass all of these different definitions, 'stranded assets are assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities'⁴⁵. This is a widely used definition.

Asset stranding occurs regularly as part and parcel of economic development. Schumpeter coined the term 'creative destruction' and implicit in his 'essential fact about capitalism'⁴⁶ is the idea that value is created, as well as destroyed, and that this dynamic process drives forward innovation and economic growth. Schumpeter built on the work of Kondratiev⁴⁷ and the idea of 'long waves' in the economic cycle⁴⁸.

5A1. MAIN OBSERVATIONS FROM IOC-ONLY WARGAMING

Under Scenario 1, a rapid and orderly transition developed. The majority of IOC players, (Roxxon, Ewing, Virtucon and Danconia) used market dynamics more than policy signals to decide their capex and dividend policy. **In other words, a player's strategies were largely informed by the actions of their peers.**

As noted earlier, the success criteria for the players were left intentionally open to interpretation. As part of the debriefing session at the end of the players were asked to identify what metrics and objectives they set themselves to measure success. **The results showed that the majority of players focused on relative company market valuation metrics**, although maximising dividend payments, minimising oil and gas assets on their balance sheet and maximising green investment (or combinations thereof) were also used in some cases. During the game players had been given appropriate information to track their success according to each of these criteria. To assess market valuation in particular, an income-approach method was used, whereby the market valuation is equal to the cash flow of future dividends payments, discounted at the firm's cost of capital.⁴⁹

Looking at the session played generally over the course of the project, because players were given advance notice of finishing date for the game (typically 2040), there was a tendency among players to attempt to

45 Caldecott, B., Howarth, N. & McSharry, P., 2013. Stranded Assets in Agriculture: Protecting Value from Environment-Related Risks. Smith School of Enterprise and the Environment, University of Oxford. Available at: <http://www.smithschool.ox.ac.uk/research-programmes/stranded-assets/Stranded Assets Agriculture Report Final.pdf>.

46 Schumpeter, J.A., 1942. Capitalism, Socialism and Democracy, Routledge, p. 83. Available at: http://aulavirtual.tecnologicocomfenalcovirtual.edu.co/aulavirtual/pluginfile.php/520365/mod_resource/content/1/TEORIAS DEL EMPRENDIMIENTO.pdf [Accessed August 14, 2016].

47 Kondratiev, N., 1926. The long waves in economic life, Martino Publishing.

48 Perez, C., 2010. Technological revolutions and techno-economic paradigms. Cambridge Journal of Economics, 34(1), pp.185–202. Available at: <http://cje.oxfordjournals.org/content/34/1/185.abstract>

49 This is one of many methods to value an extractive company (other methods include market-value asset valuations, and market comparisons See, e.g. RD Bryan (2012) Company Valuation: Oil and Gas. Society of Petroleum Engineers: The Way Ahead, 8(3), pp.10–13. Available at: <https://www.spe.org/en/twa/twa-article-detail?art=575>

strategically ‘game’ the final turn, for example by paying a massively larger dividend than would otherwise be sustainable. Thus, the authors generally used metrics from 1-2 turns earlier to evaluate success among players.

For the gaming session run with investment industry professionals along with former and current extractive industry professionals, **the winning IOC player (Globex) (as defined by market valuation) acted differently to most of the other IOCs – responding to policy signals and so acting at odds to peers in the short-term.**

The Globex players acknowledged in the debriefing session that they had been **influenced by their duties under the UK Company Act 2006**. Globex achieved success by first aggressively divesting its oil assets, before opportunistically buying already developed medium cost oil assets when the price crashed. Globex initially kept the level of gas in its portfolio steady, while restricting dividends and borrowing significant amounts from the capital markets to invest in green assets. As the timeline of the game unfolded, Globex liquidated almost all their fossil fuel assets and invested the capital green investments, while gradually increasing dividend as the game ended. Limiting its dividend to allow it to buy green assets meant that Globex’s market valuation fell sharply during the early years of the game but bouncing back significantly as dividends grew towards the end of the game.

According to the analysis undertaken by E3G and Chatham House on options open to the IOCs to align with a 1.5/2°C world, **this strategy was closest to a Planned transformation strategy⁵⁰**. One tentative conclusion from the game is that **a Planned transformation strategy such as this will need to be developed early and retained, despite short-term valuation pressures**. While Globex’s valuation was initially reduced, in the longer run this strategy was vindicated by shareholders receiving significant dividends and a valuation bounce-back. Despite this approach, Globex couldn’t fully wind down of all its fossil fuel assets. It was left with approximately 24% of its initial fossil fuel assets, concentrated as undeveloped high cost oil and developed high cost oil and gas (see Chart 4).

In the real world, this type of strategy would probably need shareholders to support a Planned transformation strategy run over much longer than usual time-periods (up to 15 years). This is long past the usual market-based ‘long-term’ view of between 1-3 years.

In this context, to deliver an orderly transition it will be as important to shift investors’ attitudes and expectations about IOC capex and dividend policies as to shift IOC’s business strategies. Without this a management team trying to execute such a strategy would likely be ousted before they even really got started.

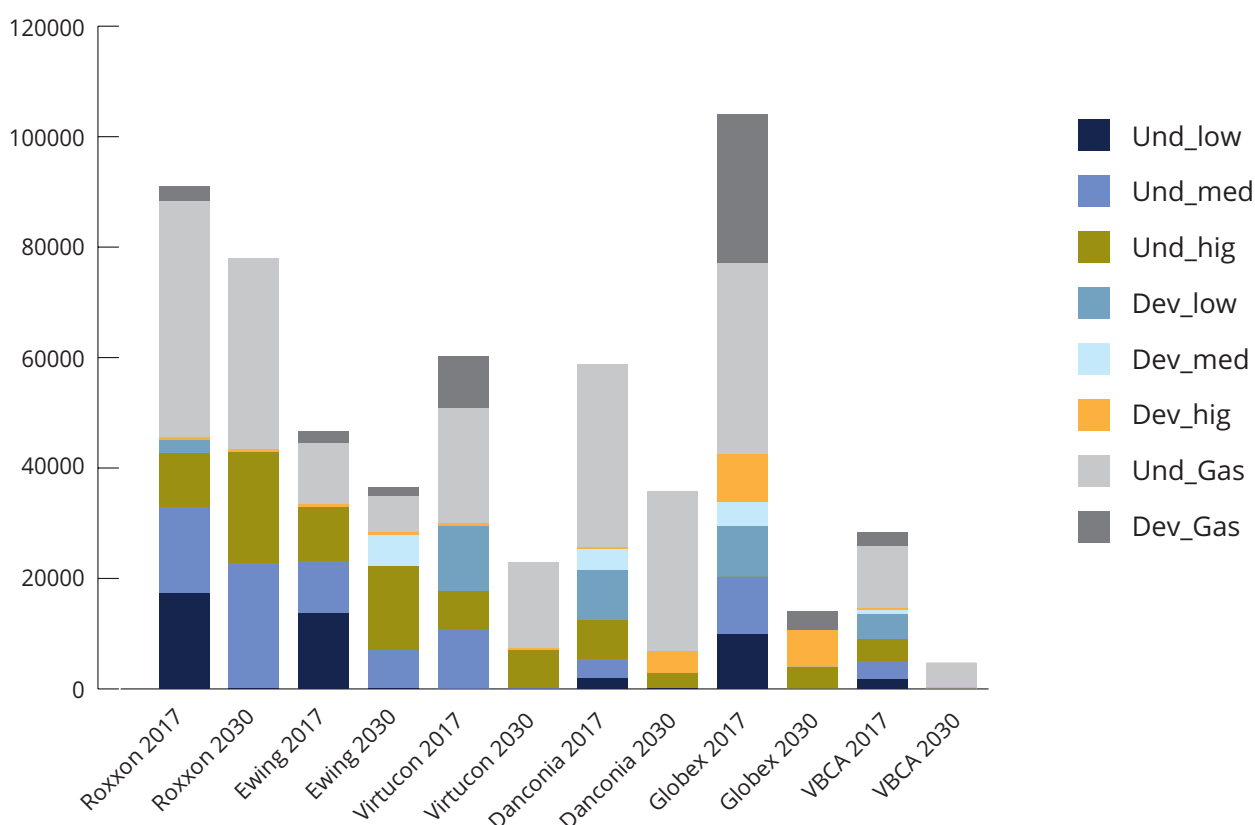
VBCA, which was a much smaller company than Globex, also aimed to ‘play out’ a managed decline/divestment strategy. **This strategy looked a lot like a First one out strategy⁵¹**. VBCA aggressively divested from fossil fuels but without reducing the dividends returned to shareholders. **VBCA’s saw its market valuation decline but – unlike for Globex – the valuation did not bounce back at the end of the game. This was despite the fact that the company had the fewest stranded assets**

⁵⁰ See https://www.e3g.org/docs/E3G_Briefing_Future_pathways_2degC_oil_FEB2017.pdf

⁵¹ Ibid.

(based on nominal value) of all the players (see Chart 5). This is explained partly by the amount of debt accrued and invested into green assets by Globex but also by the market valuation techniques used in the real world (and in the decision support tool), which continue to assign nominal value to assets that may well be – as in the game – stranded.

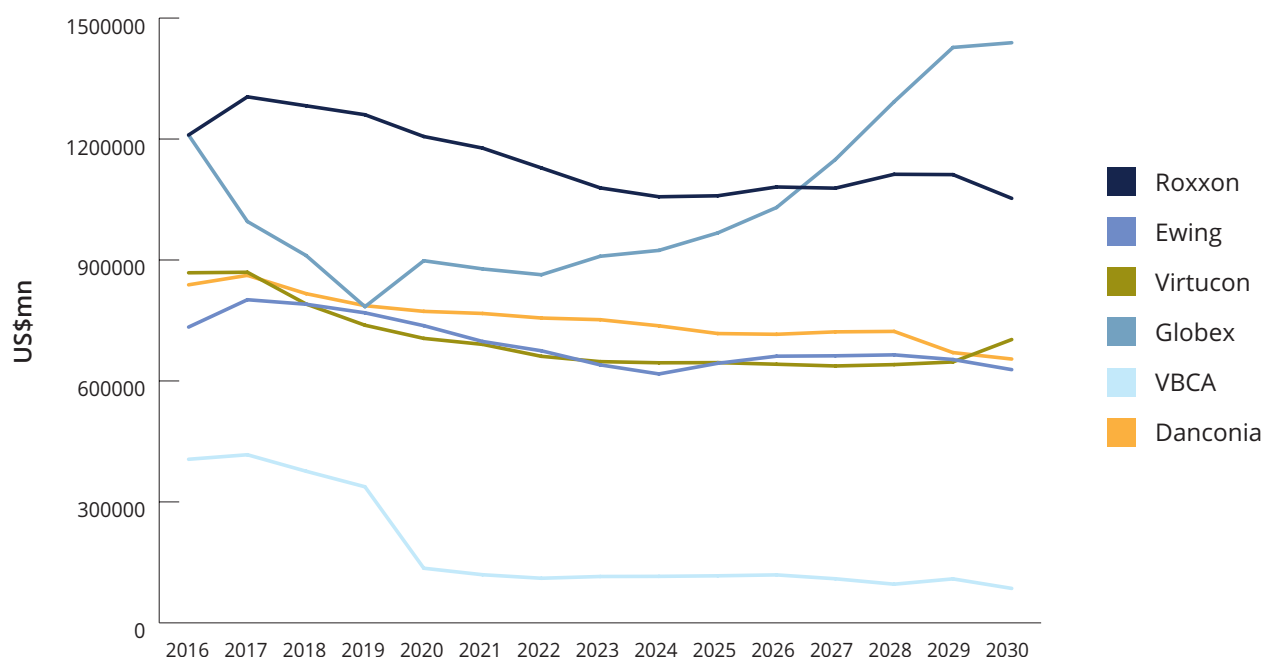
CHART 5. IOCS ASSETS – BARREL OF OIL EQUIVALENT



It could be argued therefore that the VBCA strategy was better for shareholders since it limited asset stranding. This can be seen as a limitation of the game. The companies were not explicitly penalised for having stranded assets, nor were they limited in the absolute amount of debt they could raise, providing they were able to service this debt.

Ewing and Danconia appeared to be deploying Drift strategies; Roxxon Last one standing. By the end of the game, **all three IOCs had substantial stranded assets.**

Despite this, their market valuation remained relatively stable out to 2030 (see Chart 5). As noted above this reflects the market valuation techniques used in the game.

CHART 6. MARKET VALUATION OVER TIME

One of the key overall observations from all the sessions played during the project duration was that not all the assets held by the IOCs could be monetised. Therefore, at some point during the game asset stranding became inevitable as fossil fuel assets became unsellable. **Success by players in the game – much as in real life – relied on good timing in terms of developing and/or selling and assets. IOC players could have made a good return up to 2025 from developing their existing reserves base; but after 2025 this strategy becomes exhausted.**

A further observation is that most players seemed to be betting on an increased role for gas as a major climate transition fuel, as is seen among the real IOCs. Based on this belief they aggressively bought up gas assets, held them and waited for demand to recover. As the years passed (within the game) the expected gas boom did not come to pass – and **much of the asset stranding observed was unsurprisingly concentrated in gas and also high cost oil.**

Finally, the **size and shape of company portfolios seemed to limit the 1.5/2°C strategies open to the IOCs.** This unsurprisingly significantly impacted on market valuation at the end of the game. It indicates that for **real IOCs an early and realistic consideration of their options going forward is necessary – including whether a First one out or Planned transformation strategy is the most appropriate for the Directors to advocate** given their obligations under the UK Company Act 2006.

The decline in market valuation that came from the Planned transformation strategy deployed by Globex and First one out deployed by VBCA observed in the game has some significant implications

for a 'real world' IOC First one out strategy. This is that the **CEO and management team would need to engage with shareholders at an early stage of strategy development and set out a credible long term plan to align with the reality of a 1.5/2°C world. Shareholders would need to resist the temptation to pressure the management to deviate from this approach but 'stay with them' as the company's oil business is run down.** There will be a particular need to resist exploring for new high cost oil reserves that will take decades to develop (e.g. in the Arctic) that later become stranded due to policy/regulation and/or lack of demand.

This in turn will rely of the IOCs having a clear view of how the transition might unfold (their own scenarios) – and adjusting their capital allocation strategy accordingly.

The gaming raises **significant questions over whether, even if IOCs put transition strategies in place where growth is achieved by switching their investments towards renewables, shareholders will be willing to accept this** and believe this will deliver more overall value to them. Inherent short-termism in markets means **many investors quite simply prefer to 'buy' the continued growth story** sold by the IOCs and will arguably prefer the IOCs to sell their assets/ borrow to keep dividends up rather than develop and deliver a Planned transformation or First one out strategy focused on longer term value creation. **As such the Directors of the IOCs In trying to meet their fiduciary obligations under the UK Companies Act and similar legislation in other jurisdictions will have their work cut out for them.**

To avoid preventable surprises, savvy investors should ensure that high-cost assets are appropriately discounted to accommodate ex-growth scenarios in their market valuations.

For the IOCs **better disclosure and communication regarding how they plan to respond to the threat climate change transition risk poses will provide the 'breathing space' needed to open meaningful dialogue with investors** over how to address the disruption to their industry and become an active part of delivering an orderly transition to 1.5/2°C.

5B. NOC-IOC WARGAMING

The NOC-IOC war-gaming was a prototype game that nonetheless yielded useful information. NOCs must consider not only how best to manage the business's interests, but also how the company will contribute to the diversification of home country economies that depend on continued exports of valuable oil and gas. NOCs control between 80% and 90% of proven global oil reserves – and most NOCs engage with IOCs in a variety of contractual arrangements that affect the opportunities open to IOCs.

Eight fictitious companies – two IOCs (Globex and Roxxon) and six NOCs – played. The NOCs were modelled on some of the largest oil and gas giants owned by national governments globally.

As in the IOC-only game, each player's task was to role play company board-level decision making. The capital planning time horizon was 2017 to 2040. Decisions were made on a rolling year-by-year basis.

The IOC players were presented with key elements of the UK Company Act 2006 as before.

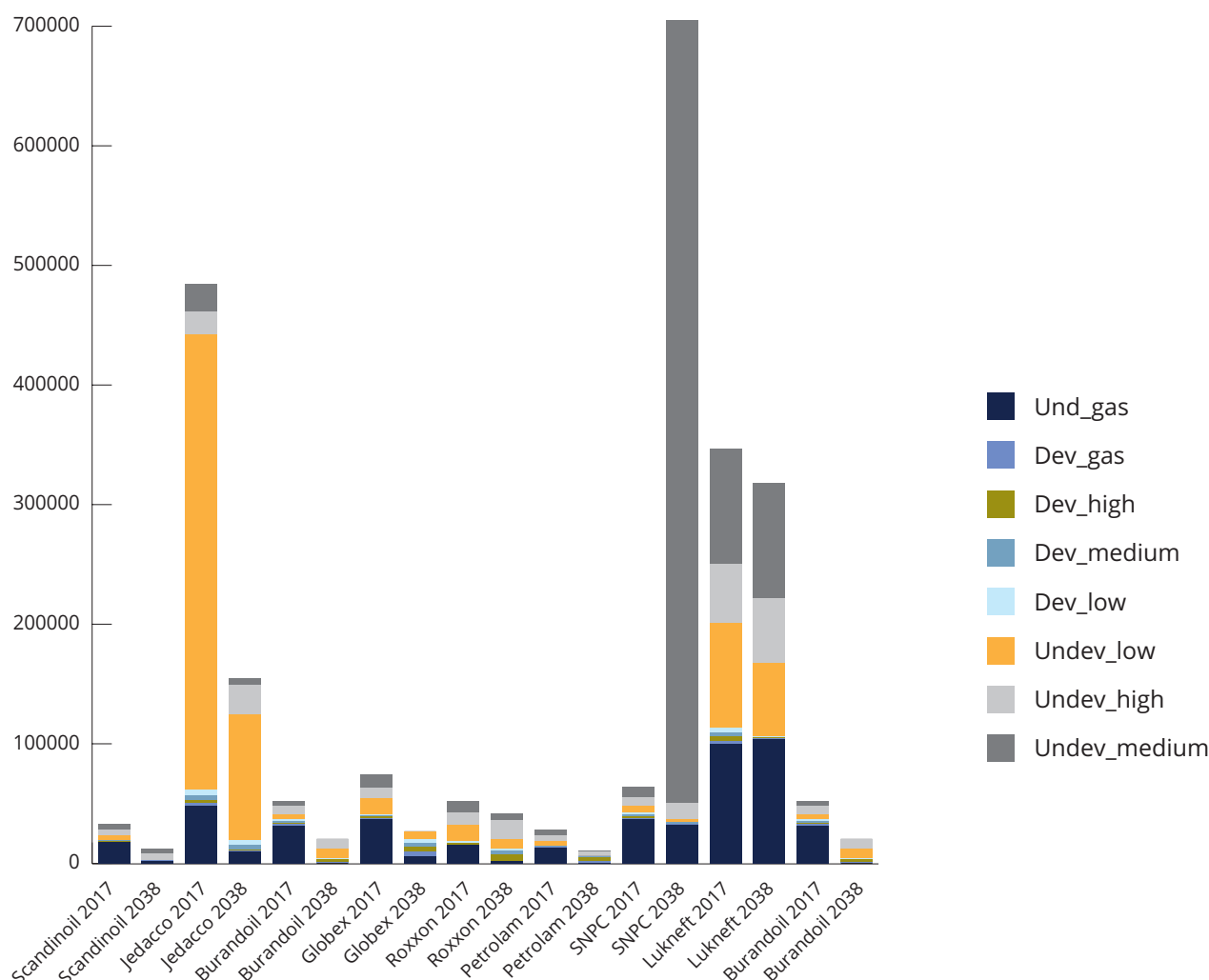
The NOC players were instructed differently. As significant contributors to national budgets, NOC management teams have significantly less independence than those based in IOCs. This is because they face the additional question of what the companies will contribute to the diversification of their home economies, which currently depend on continuing exports of valuable oil and gas. Reflecting this dynamic, each of the players were given game instructions in the form of mission statements (shown in the Annex IV). These instructions represented the research team's view on how the respective home country governments might leverage their part or full ownership of the NOCs to direct how they respond to changing market and policy conditions. For example:

- > **For Jeddaco** it was noted that company revenues are key to the budget of this Arab-gulf oil-rich country; players were directed that on average they should provide in the future approximately US\$280bn per year in dividends.
- > **For Lukneft** it was noted that the player's focus should be on maximising revenues as a key commitment is to fulfil the budgetary requirements of the government of this former Soviet Union country, which in 2016 was to return US\$120bn from oil and gas revenues.
- > **For Petrolam** it was noted that this Latin American company's indigenous resources are on the medium-to-high part of the cost curve. The mission therefore was to increase market share and try to utilise resources to the maximum, including developing medium/high cost resources where possible.
- > **For Scandinoil** the direction was to maximise dividends paid in to this northern country's sovereign wealth fund over the lifetime of company operations and to ensure it is a viable company long-term.
- > **For Burnadoil** it was noted that this African-owned company operates on the medium-to-high part of the cost curve. The mission was to increase market share and try to utilise medium/high cost resources while ensuring the survival and profitability of the company.
- > **For SNPC** the mission was to ensure the company is sustainable and secures the necessary resources for its Asian owner, regardless of international climate policy. It was noted that the player should consider buying resources from other companies as the country needs to maintain high levels of Strategic Reserves.

The following analysis sets out what happened in this game. Scenario 3 was used: a late-stage disorderly transition, resulting from 'crash policies' being introduced haphazardly to force a last-minute reduction in carbon emissions to stay on track with a global temperature increase limited to 1.5/2°C. (See Chart 4 earlier, which sets out the four possible scenarios.)

As before, significant asset stranding was observed, with substantial high-cost reserves were unused over the duration of the game (see Chart 7).

CHART 7. NOC ASSETS – BARREL OF OIL EQUIVALENT



5BI. MAIN OBSERVATIONS FROM NOC-IOC WARGAMING

The game went through three major oil price cycles, with oil reaching highs of US\$75bbl in 2016; US\$61bbl in 2028; US\$57bbl in 2033; and US\$45bbl in 2040 and lows of US\$38bbl in 2020; US\$18bbl in 2030; US\$16bbl in 2024; and US\$8bbl in 2036 (see Chart 8).

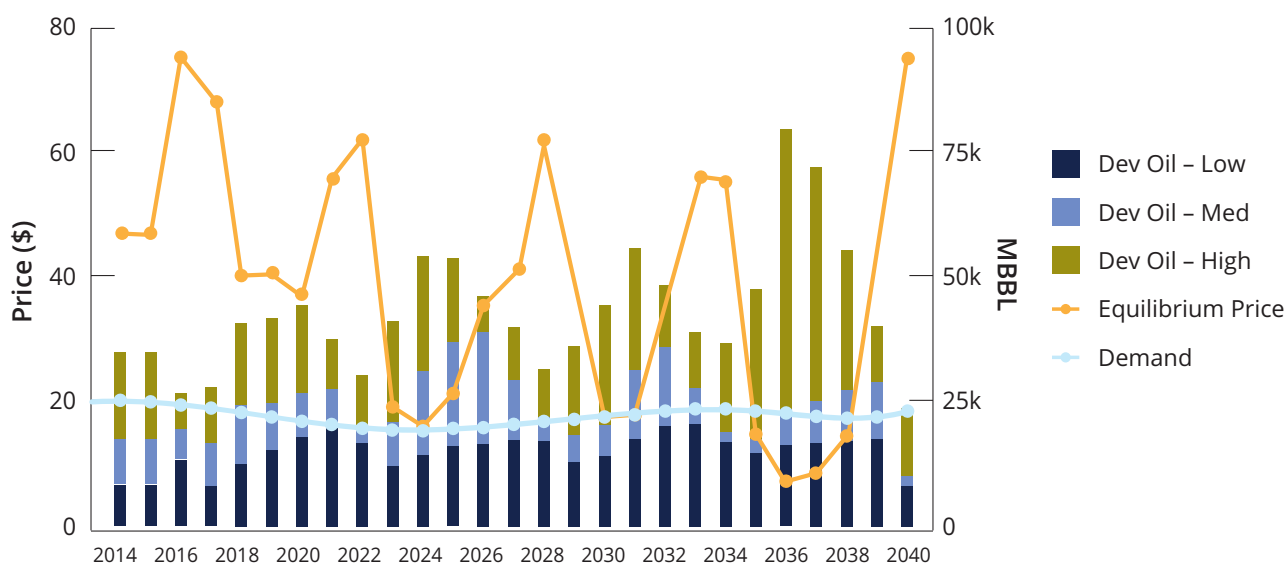
These cycles each followed the same pattern: over production followed by oil price collapse; reductions in production; oil price climbs; increased production; and then a further price collapse. The oil price fell to US\$8bbl in 2036 when the player controlling market dynamics – **the Jeddaco player, who acted as the swing producer – changed tack and focused on selling off undeveloped low and medium cost oil while maximising medium and low cost oil production through to 2040.**

This was a clear case of theory mimicking reality – given 2017’s announcements of a Saudi Aramco IPO. In parallel the Jeddaco player sold substantial volumes of undeveloped gas in the 2020s and 2030s.

In response to this – in the mid-2030s – the Globex player bought very cheap (less than US\$1) undeveloped gas reserves and undeveloped low cost oil reserves (~US\$12bbl). **These were all stranded – indicating potential any future purchasers of listed Saudi Aramco shares may need to be cautious about their forward value.** Roxxon was a major purchaser of gas and oil throughout the 2020s and 2030s and saw major asset stranding across all reserves as a result.

In the case of the first oil price collapse in 2020 both the Jeddaco and Lukneft players scaled up low cost oil production to monetise those reserves. At the same time the IOC and other NOC players with medium cost oil focused on trying to sell off those assets. This led to the second oil price collapse to US\$16bbl in 2024. Jeddaco and the other NOCs then responded by again by cutting back low-cost oil production, with the IOCs cutting back medium cost oil production, which brought the oil price back up to US\$61bbl (see Chart 8).

CHART 8. OIL PRODUCTION, PRICE AND DEMAND⁵²



52 Dev oil = developed oil

TABLE 3. RESULTS BY MARKET VALUATION AND DIVIDENDS IN 2040

RANKING	COMPANY	MARKET VALUATION US\$MN	DIVIDENDS US\$MN	GREEN RETURNS US\$MN	CASH US\$MN
1	Jeddaco	1643732.7	4288254.45	0	219762.18
2	Lukneft	1118131.35	1529145.43	0	28244.31
3	Globex	1700671.93	600028.37	434500	252429.08
4	Burandoil	1060975.38	566450.94	1144400	204420.45
5	SNPC	836616.8	406398.47	251556	63426.31
6	Roxxon	723555.38	407450.41	29680	151657.13
7	Petrolam	763949.01	92271.41	0	71206.52
8	Scandinoil	5514.92	144609.75	166744	19183.36

IOC PLAYERS

The team playing Globex focused on the policy signals and as a result sold off developed and undeveloped oil reserves, paid down debt and invested aggressively in green assets. As a result Globex significantly outperformed the other IOC Roxxon (even accounting for differences in the starting size of the companies), coming third overall based on market valuation and dividends (see Table 3). As noted above, in the mid-2030s the Globex team bought very cheap (less than US\$1) undeveloped gas reserves and undeveloped low cost oil reserves (~US\$12bbl) which were all stranded. This team acknowledged in the debriefing session that they had been influenced by their duties under the UK Company Act 2006.

In comparison, the team making decisions for Roxxon managed to sell most of the developed low, medium and high oil reserves. Additionally, in 2028/2029 and in late 2030s, when the oil price fell to single figures, the developed gas reserves had mostly been monetised. However, there was significant stranding of undeveloped oil and gas reserves. The Roxxon team's decision to change course and increase investment into green assets came relatively late – in 2027 (compared to 2018 for Globex) – and was a less successful transformation strategy compared to Globex's efforts. This was principally because it had less capital available and therefore less flexibility to diversify. Roxxon came 6th of 8 in the game based on market valuation and dividends.

NOCs

Among the NOCs, the players controlling Jeddaco had, unsurprisingly, a major influence over market dynamics and began by limiting oil production to keep oil prices relatively high out to 2022. The Jeddaco team did not invest in green assets and did not take on debt – instead focusing on maximising

dividends (i.e. revenue to the government) in the 2030s. Throughout the early years there was a focus on selling off high cost oil reserves at a low cost (less than US\$1bbl at times). Despite this, significant amounts of developed high and low cost oil reserves were stranded along with undeveloped low cost reserves and significant volumes of undeveloped gas. This dwarfed the volumes stranded by other teams – and reflects the very large asset base of the company along with the inability of a market with declining demand to absorb these volumes of product.

The Lukneft team did not follow instructions, taking a passive approach to the game, which led to a halving of Lukneft's market value between 2017 and 2018 and a further halving of market value between 2018 and 2019. Afterward the market valuation was unsurprisingly volatile through the remainder of the game, with dividends (revenue streams to governments) dwindling to just 2% of their 2017 levels in the late 2030s. Lukneft came second overall in terms of market valuation and dividends, with relatively limited stranding of both developed and undeveloped reserves across the cost curve, however it did not meet the objectives set in the game card (discussed further later).

Looking at the other end of the spectrum, the collapsing oil price limited the Petrolam team's options so there was massive stranding of undeveloped gas reserves, and some significant stranding of undeveloped low, medium and high cost oil reserves. With high volumes of medium and high cost developed and undeveloped reserves the team had limited options available to monetise existing low cost reserves and seemed intent on better times being around the corner – that of course never arrived.

Finally, Scandinoil finished last in the group. In a confused strategy, green investments were made in an attempt to transform the business. However, a failure to manage debt levels combined with a failure to sell low cost oil reserves at the right time led to almost no dividends (i.e. revenues to the government) being paid in the last 10 years of the game and the company bankrupting itself with a valuation near zero in 2033. This also resulted in significant write offs – with high, medium and substantive low cost developed and undeveloped gas and oil reserves stranded.

5BIII. CONCLUSIONS

In terms of the how the NOC teams performed against their missions, the results were mixed. Of course, this was based on playing only one scenario – and different outcomes will occur with different teams in charge – but nonetheless there were some interesting results, summarised below.

- > **For Jeddaco** it was noted that company revenues are key to the budget of this Arab-gulf oil-rich country; players were directed that on average they should provide approximately US\$280bn per year in dividends. **The team performed well against objectives, coming first based on market valuation + dividends and ended up with a cash position of US\$219.8bn (placing it second after Globex).**

- > **For Lukneft**, it was noted that the focus should be on maximising revenues as a key commitment is to fulfil the budgetary requirements of the government of this Former Soviet Union country, which in 2016 was to return US\$120bn from oil and gas revenues. **Poor decisions made early on – which by implication were predicated on the oil price remaining in the US\$50-US\$80bbl range – saw revenues to government dwindling to just 7% of their 2017 levels (~US\$5bn/yr) in the late 2030s and a final cash position of US\$28.2bn, far short of the objective. Lukneft came second overall based on market valuation + dividends but second to last based on its cash position.**
- > **For Petrolam** it was noted that this Latin American company's indigenous resources are on the medium-to-high part of the cost curve. The mission therefore was to increase market share and try to utilise resources to the maximum, including developing medium/high cost resources where possible. **The Petrolam team had limited options to do this with the oil price collapse and volume of lower cost reserves in the market. The final cash position was US\$71.2bn, which placed Petrolam 5th of 8 players. Based on market valuation + dividends it came 7th of 8.**
- > **For Scandinoil** the direction was to maximise dividends paid to in to this northern country's sovereign wealth fund over the lifetime of company operations and to ensure it is a viable company long-term. **The Scandinoil team largely failed in their mission – revenues dwindled to 2% of their high in 2017, and the company was placed last based on both cash position (US\$19.2bn) and market valuation + dividends. On the other hand, it did have green assets worth US\$166.7bn, placing 4th of 8 based on this criterion, indicating there could be options to spin off this part of the business.**
- > **For Burnadoil** it was noted that this African company operates on the medium-to-high part of the cost curve. The mission was to increase market share and try to utilise medium/high cost resources while ensuring the survival and profitability of the company. **An enthusiastic purchaser of green investments, undeveloped gas and undeveloped low cost oil, the Burandoil team did increase the company's market share while increasing production of high, medium and low cost oil and gas reserves through to the 2030s. Burnadoil came 4th of 8 in terms of market valuation + dividends and 3rd of 8 in terms of cash with a final position of US\$204.4bn and with a very significant lead in green market share – US\$1.14tr compared to the next largest (Globex at US\$434.5bn).**
- > **For SNPC** the mission was to ensure this Asian company is sustainable and secures the necessary resources for the country, regardless of international climate policy. It was noted the team should consider buying resources from other companies as the country needs to maintain high levels of strategic reserves. **The SNPC team bought low cost oil right through to early 2030s and undeveloped oil and gas through to the end of the game with the result that they had significant stranded gas reserves and some stranded high and medium oil reserves. Sinopec came 5th of 8 in terms of market valuation + dividends and 6th of 8 in terms of cash at US\$63.4bn with green assets worth US\$252bn.**

More generally, what the IOC-NOC game underscores is that governments face a choice of either monetising wealth now or losing it later. In a disappearing goods market, as the oil and gas market looks set to be, the goods may well sell at much lower prices in the later stages. Investors wanting exposure to oil need to decide on their strategy sooner rather than later: invest in IOCs and get out in time or, if and when listed, invest in Saudi Aramco – not both. Investors will need to have a view on why they are buying in a disappearing good market and have an investment strategy to match. The UK Government should think carefully about the provision of subsidies for Saudi Aramco, such as the US\$2bn in credit guarantees,⁵³ when its value, even as the last NOC standing, could be significantly reduced by climate policy and technology change⁵⁴.

NOCs control between 80% and 90% of proven global oil reserves – and most NOCs engage with IOCs in variety of contractual arrangements that affect the opportunities open to IOCs. As the results of the game indicate, there is a high probability among the IOCs of undeveloped high and medium cost reserves being stranded. Given the significant levels of debt held by these companies this is quite rightly a major concern. The IOCs have reserves with 12-15 years life compared with the NOCs up to 80 years (Saudi Aramco) so their time horizons and potential flexibility differ wildly. It is also more difficult to diversify a country away from a very dominant oil and gas sector, than to return capital into a smaller, or non-existent company.

The focus now of the NOCs and IOCs should be on unwinding the fossil fuel businesses to maximise returns to shareholders including governments and limit liabilities to shareholders and to governments. Differences in the rates at which companies and governments discount the future offer potential for arbitrage and asset trading.

53 <https://www.reuters.com/article/us-saudi-aramco-britain/uk-to-provide-saudi-aramco-with-2-billion-credit-guarantees-idUSKBN1D91NV>

54 <https://www.ft.com/content/2115e218-802e-11e7-94e2-c5b903247afd>

6. WHAT ARE THE OIL AND GAS MAJORS ACTUALLY DOING?

In parallel to the war-gaming, desk-based analysis was undertaken to assess how those oil and gas majors for whom information is readily available are currently responding to the pressures on their businesses. What follows is a sector-wider analysis, including IOCs and NOCs. The companies analysed include BHP Billiton, BP, ENI, Lukoil, Repsol, Rosneft, Shell, Statoil and Total in Europe; Anadarko, Apache, Chevron, ConocoPhillips, ExxonMobil and Occidental in the US; Petrobras in Brazil; and CNOOC and Sinopec in China.

We have focused on a discussion of general trends and, where relevant, specifically focused on the activities of the five largest IOCs (BP, Shell, Total, Chevron and ExxonMobil). The information comes from company websites, annual reports, sustainability reports and investor presentations, as these are the ways that the companies have presented their positions and responses to these issues to the public as well as to investors. This analysis is new and covers activities between 2013 and 2016, notably starting before the price collapse and the Paris Agreement.

The analysis is presented in four sections:

- > General trends;
- > Discussion of climate change;
- > How, if at all, this translates into strategy or portfolio change;
- > Investment into renewables or other low carbon technology/businesses.

It is worth noting upfront that the overwhelming influence on the companies during this period was the collapse of the oil price from its high of US\$116 in July 2014. This, more than anything else, spurred the companies into action and changed the tone of their strategy and outlook statements. Capex, which had been rising in the years running up to 2013, was cut very sharply by all the companies from its peak in 2014 by between 30% and 65% by 2016. The companies also had to take large impairments, peaking in 2015, with some companies highlighting that continued lower oil prices would require more in the future. Companies do not generally detail specific impairments

in their Annual Reviews, though some do split them by geography. Some can be the result of poor timing: for example, shale assets bought before the price collapse would be liable to write downs, although at current valuations some such projects are now profitable.

This is not unrelated to the companies positioning after the Paris Agreement was signed. Many of the projects cancelled or delayed (indefinitely) were high on the cost curve (Arctic, ultra-deep water or tar sands). They were also exactly the kind of projects that could have been at risk under lower prices caused by weaker demand (rather than the current oversupply) in the event that climate policies were to have a larger, earlier impact than expected.

The response to the sharp, extreme price fall was almost certainly more rapid than that emerging from a growing realisation that climate change policies might also change expectations of the price trajectory resulting from demand (weaker) and supply (more abundant). Thus, the estimated US\$1trillion of project cancellations⁵⁵ across the whole industry has created an opportunity for companies to re-orient capex lower on the cost curve, to shorter cycle projects resilient at lower prices that provide more flexibility in an era with so much uncertainty about the timing and extent of change. If they cannot get access to such projects they may be forced into decapitalising or consolidating earlier than the demand trajectory alone would indicate. This may also save shareholders from suffering huge write-downs of the now cancelled projects in the future when the demand trajectory becomes clearer.

6A. GENERAL TRENDS IN THE STRATEGIC RESPONSES OF THE OIL MAJORS

There are a few clear general trends visible within the oil and gas sector⁵⁶. They are:

- > All companies have focused on building a low-cost portfolio⁵⁷.
- > All companies focus on gas and specifically cite this as their major strategic response to the challenges of a 1.5/2°C-aligned world.
- > All companies have focused on reducing GHG emissions, notably through increasing energy efficiency measures, reducing methane leakages and routine flaring within their own businesses. They have also focused on improving design of lubricants to improve efficiency in transport.
- > All companies are focused on improving transparency, e.g. of energy use in production/shipping/ company in total, methane emissions, flaring etc and, to a lesser extent, of the risk of climate change to company value both through exposure via assets affected by climate change itself and by the effect on oil and gas demand of the responses by other market actors

⁵⁵ Source Wood MacKenzie 2015 prices

⁵⁶ The following analysis is drawn from new hitherto unpublished research by John Mitchell and Elizabeth Mitchell of Chatham House

⁵⁷ Chevron specifically states that this positions them well for future climate change related restrictions

- > All have invested to some degree in renewables and other low carbon technologies and are calling for a global fuel-neutral carbon price.
- > All call for regulations to be predictable, market driven and global, while recognising that the Paris Agreement was not enough to achieve “lower than 2°C” and that more must be done.

6B. DISCUSSION OF CLIMATE CHANGE

There was relatively little discussion of climate change as a driver of value in annual reports in 2013, although it is worth noting that there is a significant split between European and American companies on the issue. Climate change is mentioned in some sustainability reports from that year, including from Royal Dutch Shell, which noted that the pace of change was too slow and called for greater action.

EUROPEAN COMPANIES

By 2014 some European companies, specifically Statoil and ENI (but not BP, Shell and Total), had a more extensive discussion of climate change than just the disclosure of direct emissions or costs of increased regulation. ENI for example cited “the effects of worldwide energy conservation and environmental protection efforts” as a risk. Several companies were looking forward to the Paris conference and outlining their positions.

Statoil, for example, called for: climate policy to be predictable, transparent and internationally applied to avoid carbon leakage, ensure cost effectiveness and create a level playing field in global markets; a price on GHG emissions based on emitter pays should be the preferred policy framework; stated multiple regulations on GHGs should be avoided; and that costs should be technology and fuel neutral to maximise innovation through market competition.

These are in line with the stated beliefs of the other European companies. In general, there is more commonality to be found among the European companies over the past several years than among the US companies.

- > They all present the science in some detail, without any uncertainty attached to the connection between human activity and the use of carbon based fuels and climate change, or that climate change is a real and significant risk.
- > They all agree that oil and gas companies must be part of the solution.
- > They all have targets for reducing their GHG emissions – this is not the case for US companies; increasing their own energy efficiency (some give figures for carbon dioxide avoided); reducing routine flaring and methane emissions.

- > They all emphasise that demand for energy will continue to grow and that, notwithstanding the lower share that oil will have, more investment will be needed given depletion rates, thus providing opportunities.
- > They all emphasise the value of gas as a lower carbon fuel, especially compared with coal.
- > They all claim that better products and lubricants can increase energy efficiency for their clients.
- > They all use a carbon price in their internal investment decisions (between US\$40 to US\$80, used by BP as a stress test) and all call for a carbon price (global, fuel neutral) to be introduced (clearly to disadvantage coal versus gas).
- > They are members of climate initiatives (unlike the US companies)⁵⁸. This is a cultural phenomenon that is evident in other industry bodies. A recent exception to this is ExxonMobil's participation in the Climate Leadership Council.

In addition, ENI, Shell and Statoil have direct GHG emissions weighted into their CEO's remuneration, although the weight is not publicly available. All the European companies claim to be responding to requests for greater transparency about climate change risk and companies' responses from their shareholders/stakeholders. All have a great deal of information on their websites. Statoil has the most detailed scenarios in their sustainability reports outlining the impact of their own strict climate change scenario and the International Energy Agency's 450ppm scenario, showing a relatively small impact on the net present value of the company (-5% to +6%), thus seeking to address some of the more extreme suggestions. They also address the issue of stranded assets.

US COMPANIES

The differences between the US companies' treatment of climate change is much greater. They all outline the various US laws and regulations, including the Clean Air Act, but, with the exception of ConocoPhillips and very recently ExxonMobil, they hardly mention climate change by name. If it does appear, it is as a risk factor embodied in the risk of tighter GHG emission regulations. Apache and Anadarko illustrate this point well. As recently as 2016, neither company engaged in a general discussion of climate change. It is worth highlighting this comment from Anadarko:

"The US Clean Air Act, which restricts the emission of air pollutants from many sources, imposes various preconstruction, monitoring and reporting requirements which the EPA has used as an authority for adopting climate change regulatory initiative relating to GHG emissions."⁵⁹ In its 2015 sustainability report, Anadarko also summarised the agreement in Paris by stating that it "calls for

58 The Oil & Gas Climate Initiative members are BP, GNPC, ENI, Pemex, Reliance, Repsol, Saudi Aramco, Shell, Statoil and Total. BP, ENI, Repsol, Total and Statoil are members of the Clean Air Coalition Oil & gas Methane Partnership, BHP Billiton, BP, ENI, Shell, Statoil and Total are members of the World Bank Carbon Pricing Coalition and BHP Billiton, BP, Chevron, ENI, Repsol, Shell, Statoil and Total are members of the International Emission Trading Association

59 Anadarko 2015, 2016 Annual Reports

countries to set their own GHG targets and be transparent about the measures that each country will use to achieve its GHG targets” – without mentioning that those targets should be lower than current levels.

Occidental and ConocoPhillips both state that climate change measures could decrease demand for oil and natural gas, but make no further comment on demand⁶⁰. Both ExxonMobil and Chevron have increased their discussion of climate change in the years leading up to 2016, both in their sustainability reports and on their websites. Chevron states in its 2016 Sustainability Report that it: “shares the concerns of governments and the public and about climate change and recognises that the use of fossil fuels... contributes to the concentration of GHGs in the earth’s atmosphere. GHGs contribute to increases in global temperatures”.

ExxonMobil appears to be attempting to address in various reports criticism of their apparent resistance to acknowledging manmade climate change by referring to: its decades of sponsoring scientific work (leading to 45 papers published in peer reviewed journals); its advocacy for “sensible policy”; and its responsiveness to stakeholder concerns. In their 2014 Corporate Citizenship Report, ExxonMobil’s opening letter states that “managing the risks of climate change is an important responsibility for our business”.

ExxonMobil also has an external citizenship advisory panel which regularly brings up issues of transparency and the global divestment campaign – and suggests ExxonMobil should do more to encourage a carbon tax or other measures to reduce demand and discuss more fully its continued focus on oil and gas exploration and production. In all of ExxonMobil’s discussion of climate change there is a very clear pushback on the criticism it has faced through referring to the world’s need for energy and “the humanitarian imperative” to provide this, which underpins their statements about the continuing need for oil and gas for the foreseeable future, even if demand does peak. This is not controversial (though the timing is unclear), but ExxonMobil are particularly aggressive in their language – which would seem to signal a ‘Last one standing’ approach.

OTHER INTERNATIONALLY ACTIVE COMPANIES

The Chinese companies, CNOOC and Sinopec, barely mention climate change by name, although in its annual report for 2015 CNOOC does include it among other risk factors noting: “rising climate change concerns could lead to additional regulatory measures that may result in project delays, higher costs, reduced production and reduced demand for hydrocarbons”. Both companies state that they are aligned with the Chinese 13th Five Year Plan.

Petrobras did not discuss climate change until 2015, when they stated that they: “note that the results obtained at COP21 and their possible consequences ... should be a point to watch for the oil and gas industry”.

60 Occidental and Conoco Phillips 2015 and 2016 Annual Reports

Interestingly no climate change-related issues are mentioned in Petrobras 2030 Strategic Plan or 2017-2021 Business Management Plan. They do disclose GHG direct emissions as required by the emissions trading scheme, which they have been party to since 2003.

6C. HOW THIS TRANSLATES INTO STRATEGY OR PORTFOLIO CHANGE

All the companies assessed focus on the importance of gas as a transition fuel. Shell (which took over BG Group), BP, Total, ENI, Statoil, CNOOC and Repsol have all stated that they are skewing their capex towards gas specifically to position themselves to be profitable in a low carbon economy. They don't generally split future capex decision in their public reporting, although Statoil does state that 75% of capex will be on gas.

Of the projects cancelled in the last few years by the industry, very few have been gas. Shell and ConocoPhillips have both disposed of tar sands assets and Total disposed of a small coal business. ExxonMobil has de-booked some tar sands reserves.

In addition, as highlighted in the Sustainability Reports of Statoil, BP and ConocoPhillips measures have been taken to reduce methane flaring and improve energy efficiency, water efficiency and recycling. Statoil and Royal Dutch Shell also give a detailed description of the work they do both with their shipping division and their supply chain to improve energy efficiency and reduce GHG emissions. **Although none of the other companies provide such information, these are clearly things that they can and should do and are areas where further shareholder/stakeholder pressure can reasonably be applied.**

Going beyond these measures, and given our estimate that private sector companies have 12-15 years of reserves and oil and gas are likely to remain a part of the energy mix for the next 2 decades, **flexibility and resilience will be the most important factors in company business planning. It is this that will best position the IOCs to respond to the challenges posed by tightening climate change regulation, improved energy efficiency, growth in renewables, technological change in the car industry and the response of NOCs to these challenges.**

6D. INVESTMENTS IN RENEWABLES OR OTHER LOW CARBON TECHNOLOGY/ BUSINESSES

Many of the companies included in this analysis are investing in some form of renewable energy or low carbon technology/businesses. In some cases this has been happening for many years. Total has been investing for decades⁶¹; BP since the Lord Browne era of "BP Beyond Petroleum" in the early 2000s⁶²; and Exxon since 2009⁶³. Some invest directly, some through joint ventures with specialist management in place and some through dedicated venture capital vehicle ExxonMobil

61 See <https://www.total.com/en/commitment/environmental-issues-challenges/climate-change/renewable-energies>

62 See <http://news.bbc.co.uk/1/hi/business/849475.stm>

63 See <https://www.ft.com/content/c69618a0-4050-11e4-a343-00144feabdc0>

states it has invested US\$8bn since 2000 in deploying technologies such as cogeneration and CCS while researching next-generation energy sources such as algae biofuels. Continued research in technological breakthroughs will be critical to managing future environmental and climate change risks.⁶⁴

Of the most proactive, Total and Statoil have been most vocal about their intention to scale up investment in renewables and other clean tech. Total have stated their general ambition: “to become the Responsible Energy Major means providing energy that is affordable, reliable and clean. Energy is a vital, constantly changing resource that has accompanied major shifts in society throughout time. And energy must continue to adapt if it is to play a key role in addressing the complex challenges facing the world today. We want to contribute to these changes because energy is Total’s history: its past, its present and its future. Providing energy that is affordable, reliable and clean”⁶⁵.

Total’s report Integrating Climate into our Strategy also states that their ambition to have renewable energies along with energy storage and energy efficiency representing 20% of their portfolio in 20 years time⁶⁶. Total do not specify 20% of what (assets, revenues, profits capex) however.

Statoil has stated it is building a profitable new energy solutions business with the potential to account for 15-20% of capex by 2030, provided they can access and mature attractive opportunities⁶⁷. It has also stated that their offshore experience is relevant to offshore wind noting: “Statoil has been actively involved in offshore wind projects for more than ten years and aims to develop profitable projects in selected markets. To date we have invested around US\$2.3bn, using our offshore experience to develop large-scale wind farms and innovative floating platform technology that facilitates wind power in deep-water areas”⁶⁸.

In comparison, BHP Billiton, Apache, Occidental and Anadarko make no claims to be investing in renewables or low carbon technologies. Sinopec and CNOOC both talk about being “clean, green energy providers” but Sinopec provides no details and it is clear that CNOOC is actually referring to the provision of natural gas. Petrobras owns hydropower assets, to which remains committed, and biofuels/biodiesel assets, which it intends to exit, according to its 2016 Annual report and accounts. Petrobras is the only company to provide revenue and profit data for these businesses (although notably they also include nitrogen-based fertilisers). The losses from these lines of business have been consistent and large.

Of the remainder of the companies assessed here, the common thread is that none provide separate financial information for their “new energies” businesses, so shareholders have no way of analysing how successful they are. In general, these businesses are grouped in with shipping/corporate/

64 Chairman’s letter, Corporate Citizenship Report 2016

65 See <https://www.total.com/en/group/ambition>

66 Total 2017. Integrating Climate into our Strategy https://www.total.com/sites/default/files/atoms/files/integrating_climate_into_our_strategy_eng.pdf

67 Statoil’s New Energy Solutions. See <http://www.naeringsforeningen.no/ShowFile.ashx?FileInstanceId=58922e15-5bea-44c6-8505-afc943fabfe2>

68 Statoil Annual and Sustainability Reports 2016. See <https://www.statoil.com/en/news/annual-and-sustainability-reports-2016.html>; <https://www.statoil.com/en/news/22dec2017-statoil-participates-offshore-wind-tender.html>

treasury/other. The exception is Statoil, which in 2016 set up its New Energy Solutions division. The CEO's letter included in the 2016 Annual Report stated that: "In New Energy Solutions we are building a profitable business with the potential to account for 15-20% of capex by 2020, provided that we can access and mature attractive opportunities". While ambitious, the caveat is notable, and it is always easier to target spending than results.

None of the companies provide any financial targets, such as ROCE, ROI, or risk premia versus core businesses, so it is not possible to understand the investment process in detail. **This would be an interesting subject for further discussion with management teams.**

Additional details on low carbon investments are provided in Annex V.

7. GENERAL CONCLUSIONS AND NEXT STEPS

The wargaming approach described in this report has provided a number of unique insights and tools with which to assess the impact of climate change on oil and gas company business models. Simulating decision making under uncertainty reveals, in a way not captured in perfect information, the behavioural and strategic considerations that oil and gas majors face when assessing different future pathways models. Wargaming can also be a valuable tool for educating different stakeholder groups, enabling them to role play decision making from a different perspective to their traditional day-to-day roles.

We have found that wargame players regularly pursue four of the five strategic responses we identified as being possible. These were: First one out; Last one standing; Planned transformation; and Drift. The fifth response, Ostrich, whereby a company continues on a business-as-usual basis, was not regularly adopted. This may be due to an inherent behavioural bias whereby gamers want to actively participate and take decisions for their company rather than leaving things as they were. To address this bias, the authors inserted a 'dummy' company specifically set up to play out an Ostrich strategy in later iterations of the game. This enabled an active comparison of performance relative to the other strategies player chose to adopt.

7A. CONCLUSIONS FROM WARGAMING SIMULATIONS

INSIGHTS INTO OBJECTIVES AND "WINNING CONDITIONS"

As discussed above, for the IOC wargames the "winning conditions" were left deliberately ambiguous for the players. Players were shown the UK Companies Act before the game commenced and were simply asked to respond appropriately. Despite multiple possible interpretations of what might constitute success for a company, player feedback overwhelmingly focused on the relative market value of their company to the exclusion of all other metrics. This comparison with peers is normal business benchmarking. **Thus, if a player started with a company that initially had the fourth highest market valuation but had moved up to third or higher by the end of the game, they considered themselves to be successful. Conversely, if they slipped down the ranking, they viewed this as failure.** This was reported irrespective of absolute company valuation, so even if all companies lost value, provided a player's company lost less value than others this was still viewed

by the player as a success (even if objectively returning capital to shareholders may have been more optimal an outcome).

This peer comparison as a measure of success has a number of implications in the context of the game. **Adopting a First one out strategy, where players must commit to reducing the market valuation of their company to zero, is preferred in much on the commentary around the future of the IOCs due to its focus on minimising asset stranding, but was not necessarily self-reported by players as a success. This contrasts with player feedback when a Planned transformation strategy was adopted.** The general consensus among players was that the fact the company remained a viable going concern meant this result was a success. This, of course, is a stark contrast to a significant real-world debate as to whether IOCs should even attempt a planned transformation, given that they do not necessarily have a competitive advantage in non-fossil energy. **It gives some insights into why a Planned transformation strategy may be considered more attractive to IOC management teams than a First one out strategy.**

For the NOC wargames, as described above, players were given more specific objectives to fulfil, reflecting the real-world environment NOCs operate in. **A core insight from the wargames for large gulf state NOCs was in how players managed the tension between maintaining high prices versus avoiding stranded assets. If NOC players come to view oil as a ‘disappearing good’ as new technology and climate regulation limit demand, this can lead to aggressive strategies to try and maximise market share at the expense of price maintenance.**

PATH DEPENDENCY AND HERD BEHAVIOUR

The gaming revealed that there is significant path dependency to strategies and potential trigger points for herd behaviour. Decisions in the early turns of the game had a significant impact on later outcomes. **Initial trading of assets is a critical factor to enable Last one standing, First one out and Planned transformation strategies to be delivered.** For example, for players to successfully achieve First one out and Planned transformation strategies it is important to monetise high cost oil reserves in the initial turns of the game, even if these are technically sold at a ‘loss’, as this becomes extremely challenging in later years. For players attempting a Last one standing strategy maintaining investment in exploration, especially for gas, and purchasing low and medium cost oil assets when they are available is beneficial.

There is significant path dependency to managing debt levels. In some rounds of the game debt can quickly spiral out of control and players effectively bankrupted their companies by failing to pay attention to this. Conversely those players that focused on paying down debt in the early years gained a clear advantage in later years.

The game also revealed aspects of herd behaviour, especially with regard to accumulation of green assets. In the most aggressive decarbonisation scenarios, once it became clear how fast oil demand was falling, there was often a ‘run for green’ in the mid to late 2020’s. However, competition for green

resources at this point can also prevent companies from making a successful transition. **Players who performed best at the Planned transformation strategy started investing early (pre-2020) and in a sustained manner in green assets, thus achieving a significant level of transition before the herd behaviour kicked in.**

Herd behaviour generally had a negative impact on companies attempting a Drift strategy. Waiting until the transition scenario becomes clear in the later years generally led these companies to be at a significant disadvantage compared to those that had positioned themselves more aggressively earlier on.

HIGH OIL PRICES IN A LOW DEMAND WORLD

Most traditional energy models are based on an assumption that rapid decarbonisation leads to low oil prices. These assumptions on price are then strongly factored into much of the literature on energy transitions. The wargaming results showed that considerable price volatility may be present in a decarbonising world, which can result in very high prices even at much lower levels of demand. The stress placed on companies and events in NOC countries can still lead to the market being undersupplied and the oil price reaching over US\$100bbl. Even if average prices do fall this short-run volatility can dominate player behaviour.

If players are able to anticipate these price spikes they can become a profitable opportunity to utilise high cost reserves. However, they can also be misinterpreted as a return to oil demand growth and lock players into over investment in exploration and upgrading high cost assets that they then struggle to utilise. Thus, in assessing real world strategies for oil companies it would be valuable to more explicitly consider the impact of price volatility on behaviour. The gaming exercises suggest there is significant potential for value destruction if price signals are misinterpreted.

CRITICAL ROLE OF NOC STRATEGY AND COUNTRY STABILITY FOR IOCS

The wargaming suggests that both NOC strategy and country stability will be critical in assessing IOC strategic responses. The best results for players utilising a Last one standing or Ostrich strategy (the latter being captured by a dummy company, as noted above) was in the less aggressive decarbonisation scenarios combined with periods of significant disruption in OPEC countries. If OPEC share of production drops dramatically – for example in one scenario a war in the Middle East was simulated which reduces OPEC share by 10 percentage points over a 4-year period – this can create significant market space for IOCs to operate in, even if overall oil demand is declining. This can lead to periods of very high profitability for Last one standing and Ostrich companies. Conversely if OPEC increases market share, as happened in the NOC version of the game, this can be extremely punishing for IOC companies pursuing a Last one standing or Ostrich strategy, as they become rapidly squeezed out of the market.

The mainstream literature has a very wide spread of different assumptions about future OPEC market share within the oil and gas market. The wargaming results suggest it is critical to evaluate business strategies against a range of assumptions as this may have a large bearing on the eventual viability of different options.

EDUCATION TOOL FOR STAKEHOLDERS

Beyond the insights into company strategies the wargaming tool also proved valuable for educating different stakeholders about the challenges oil companies face. Civil society and academic stakeholders gave very positive feedback on the game in terms of helping them to role play from the perspective of an IOC Chief Executive. This can provide valuable insights into the decarbonisation challenges that are outside of their day-to-day roles. There may be considerable potential to utilise gaming techniques as part of NGO campaign development and student education in the future.

The overwhelming majority of stakeholders also reported that they found the games fun and enjoyable to participate in. This was especially true when players were able to form small teams to jointly discuss strategy.

7B. CONCLUSIONS FOR REAL WORLD INTERNATIONAL OIL COMPANY STRATEGIES

The gaming confirms the findings of ongoing analysis at Chatham House⁶⁹ and by the Carbon Tracker Initiative (CTI) that the IOCs business models face an existential threat from the transition to a low carbon economy. Significant levels of asset stranding were observed regardless of the transition scenario played, but were more extreme under the most rapid decarbonisation scenario.

The wargames showed different outcomes for both IOCs and NOCs in 2040, depending on who was playing (as in life). They provided useful insights into the dynamics facing the oil and gas sector by creating a means to move away from the generalisations of the sector's 'commentariat' and got into very specific details of the different pathways and how lucrative they may be over different timescales for each company. This is, we believe, a helpful innovation – adding new levels of granularity – to the debate around the future of the sector.

Decision making under uncertainty can lead to misinterpretation of short-run price signals and herd behaviour. There may also be significant behavioural biases against management teams pursuing a First one out (i.e. managed decline) strategy. Given the large size of the IOCs, this argues for urgent increased clarity from Governments to set out their long-term transition pathways.

In 2018 it is expected that Governments signed up to the Paris Agreement will publish their 2050 roadmaps. Both in the game and in reality, IOCs are betting on an increased role for gas in the climate transition. However, the size of the future market for gas is less certain than for oil due to

⁶⁹ P. Stevens (2016) International Oil Companies the Death of the Old Business Model. Chatham House

the aggressive growth in renewables, government policy on gas imports and support for alternative technologies (i.e. nuclear or legacy coal production). Government can help provide clarity on the likely future size of gas markets to minimised wasted capital expenditure both by IOCs and indeed NOCs.

Although oil price volatility was a key feature of the games, it did not suggest that prices would reach sustained high levels necessary to justify development of extremely high cost assets such as in the Arctic. IOC have aggressively cut costs and breakeven prices have reduced significantly, all the majors have proven they can be profitable at US\$50bbl, down from an estimated US\$80bbl in 2014⁷⁰, in part due to lower cost of suppliers. A key question for investors is how sustainable this is in the long term. Further investment in exploration by the IOCs looks high risk under this scenario. **Diversification to new business opportunities or simply decapitalisation/managed decline of the IOCs therefore look like least regrets option. Given there is a track record of poorly managed diversification, on balance decapitalisation/managed decline looks most credible.**

Both Planned transition and First one out strategies can be successfully implemented. However, pursuing these strategies in real life requires significant investor support, which may be challenging. In part this is due to the time horizon problem, where investors are being required to forgo dividends in the near term to ensure the longer-term survival of the company. **The ongoing debate about the need for long-termism in finance, including changes to fiduciary duties both in the UK and EU⁷¹ and even suggestions of moving away from quarterly reports, could help facilitate this sort of shift.**

There are some challenges to effective dialogue between investors and IOCs because of the gap between the technical market valuation and the potential “true value” of oil and gas assets in the future: currently set they do not reflect the downside risks of stranded assets and ex-growth scenarios. This is an issue long-raised by NGOs such as Carbon Tracker Initiative. Without this companies and investors and indeed to commentariat will continue – to make misguided assumptions about the future value of reserves. This will unpin poor decision-making processes.

The challenges facing the IOCs versus the NOCs are in very different. The IOCs have average reserves of 12-15 years, whereas the NOCs have greater reserves, of up to 80 years. This implies that the NOCs are unlikely to be flexible in altering their strategy, and as a consequence the pressure on IOCs to come up with an alternative strategy is higher. Nevertheless, the response of NOCs will have long lasting consequences on their domestic societies; forward looking government are going to be key in the transition, as noted above.

NOCs face different drivers – because they are country revenue providers. To help develop resilient forward business plans, IOC scenario analysis should, perhaps, focus more on what these NOC home

70 See <https://oilprice.com/Energy/Oil-Prices/Why-Breakeven-Prices-Are-Plunging-Across-The-Oil-Industry.html>; https://www.ft.com/content/d260e414-bfbc-11e7-9836-b25f8adaa111?accessToken=zwAAAWB-7_QYkdPSYQQUv7wR59OYNrjfitqhEQ.
MEQClFvJl1wMwzOH7Q3dorYDtuMN3HFbRDeUiXNA7jAM9OoSAiBWoa-j_H9bdpWon1TvmpSMNROJCpZZI_0FZRipiOVz1A&sharetype=gif

71 See https://ec.europa.eu/info/consultations/finance-2017-investors-duties-sustainability_en <https://www.ft.com/content/be8bcf40-5bf2-11e7-b553-e2df1b0c3220>

countries are doing than on market demand per se. Saudi Arabia's Vision 2030 agenda⁷² should be held up as the kind of proposal and discourse needed to start to facilitate a global orderly transition strategy to a low carbon world.

7C. IMMEDIATE PRIORITIES FOR SOCIETAL ACTORS AND NEXT STEPS

Oil and gas modeling needs to be better understood and improved upon. All mainstream modeling relies on an average oil price, with a lower price assumed for green scenarios. However, this doesn't adequately reflect uncertainty in the real world. Market volatility is what really matters – and is why higher oil prices are possible even with falling demand. Volatility risks capital misallocation and will require IOCs to hold their nerve as transition scenarios unfold – as it perpetuates the myth demand and the sector will recover. There is a role for civil society to play in aligning key stakeholders to play a role in facilitating an orderly transition process by helping them to understand the limits of current oil and gas sector analysis and modeling – including investment consultants, asset manager and asset owners.

IOCs should work quickly to implement the recommendations of the Taskforce of climate-related financial disclosures (TCFD). Disclosure of climate related risks is essential in delivering an orderly transition. Companies should be stress testing their planning against a variety of climate scenarios. Governments beyond those of the UK, France and Sweden as well as the EU, should consider the case for making climate risk disclosure mandatory given the disincentives to public disclosure that currently drive corporate behaviour. Better disclosure and communication of a longer-term strategy will also be integral to giving the IOCs 'breathing space' to open meaningful dialogue with investors over how to address the disruption to their industry and be part of delivering an orderly transition to 1.5/2°C. **The wargaming tool we have developed offers an example of what TCFD implementation looks like – and we encourage interested stakeholders to use and build upon the findings of this decision support tool.**

IOCs and investors must come to grips with a future that will not look like the past. If 2017 tells us anything it is that climate impacts will be increasingly influential in decision-making of governments, businesses and investors. More specifically, climate events are likely to accelerate the demise of the IOCs as governments face growing pressure to respond to them and protect the broader public. There is uncertainty around the timing and severity of such impacts, but the risks are increasing not decreasing and future disasters are inevitable. **Uncertainty should not be an excuse for business as usual.**

72 See <https://www.ft.com/content/80cedc7c-0b05-11e6-9456-444ab5211a2f>

Avoid short-termism. Timing will be critical in decision-making and IOCs have limited options, which are also dependent on the actions of their peers. In the IOC game, much more value was lost in the late transition scenario than the orderly one. Early signalling by government matters because the path dependency of IOC strategy is significant. Crash policies waste too much in capex. A Last one standing strategy is viable but requires other companies to choose an early exit. In other words, it is a “game of chicken” that results in lost value. **A successful long-term transformation strategy requires shifting investors attitudes and expectations to allow for planning beyond typical 1 to 3 year period; the best long term strategy will often be the most difficult choice to make.**

Civil society has a key role to play in protecting the public interest; but investors must step up. In addition to conducting research and running public campaigns civil society organisations have an opportunity to focus their engagement at the IOC Board level as well as with investors to maximise their influence. In parallel, investors must also address the contradictions that currently exist in their own strategies, between the business as usual approach of continued exposure to fossil fuels and the planned transformation of growth in low carbon energy.

ANNEX I

Non-credible international oil companies strategies

1. DRIFT

Drift is a mix-and-match strategy that would be used by a company aiming to optimise its portfolios within shrinking markets. There is a deliberate wait-and-see approach, with the company reacting to rather than anticipating changes in market dynamics. The focus is on consolidation and asset swapping with very tight controls on capex. The IOCs are, to a greater or lesser extent, all exhibiting some elements of this model already.

Consolidation is a natural feature of markets and it is arguable that IOCs should take this approach as a defensive tactic given the strong headwinds the industry is facing. Under this scenario the business model is focused on keeping dividends steady by optimising its portfolio of revenue-generating assets and sweating those assets. If the company can grow, it will be slowly, investing less and very cautiously on the basis of incremental decision-making to avoid embarking on potentially value-destroying acquisitions. What is more likely is the company remains the same size or shrinks as markets are squeezed, and especially if one of the other companies in the market is deploying a Last one standing strategy. The ability of the Drift approach to be sustained is also dependent on NOC behaviour, since private oil and gas companies are generally excluded from the lowest cost opportunities open to state companies in the Middle East, for example. The proposed Saudi Aramco IPO however, gives private investors (not necessarily or even probably IOCs) access to low cost profits, as do mixed companies such as Rosneft.

There are significant risks with this strategy. Paying the wrong price and buying the wrong assets could increase exposure to the climate change risk rather than reducing it. Management may shift slowly toward a portfolio of only good existing assets with very limited and shorter time-at-risk projects (success in US Shale may become crucial given its much shorter-term nature) and perhaps a very few large colossal low total cost projects, depending on the oil price, to reduce this risk.

For gas there are particular challenges, as its fortunes are linked to choices about power generation, which are highly political. During the IOC-only wargaming most players looked to gas as a remedy, but were then left with stranded gas assets. Due to the high cost of transporting gas over long distances

there has more recently been a focus on developing gas regionally⁷³. In developing countries where access to power is not universal, there could potentially be space for gas in the generation mix but cheaper coal will be a strong competitor⁷⁴. This is why the oil and gas majors are all lobbying for a carbon price sufficient to disadvantage coal versus gas. However, this is likely to be driven by demand for replacing coal capacity rather than energy access. This is because most of those without access to energy are the rural poor whose needs will be best suited to distributed and clean energy sources. Furthermore, it is far from a given whether, given the falling costs of RES and the high sunk cost of centralised gas distribution infrastructure, gas can compete.

RISKS TO IMPLEMENTATION

Culturally and in terms of business planning assumptions risks are likely to be limited since an incremental approach to decision-making is being applied. There will be risks in relation to market access and energy policy for power generation.

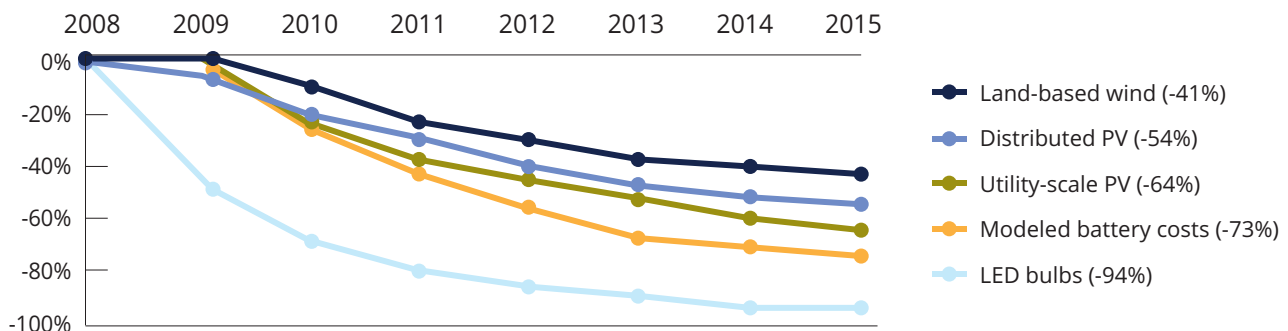
Market access: Many low-cost opportunities exist in the Middle East and are held by NOCs, which are state owned companies. Much the Drift strategy's success will be linked with the fate of NOCs and home governments struggling to deal with falling public revenues from oil. In Saudi Arabia the response has been to focus on privatisation, opening up opportunities to access low cost assets. The impending sale of parts of Saudi Aramco presents possible opportunities. Further fragmentation of NOCs could also deliver acquisition opportunities – and will be dependent on broader geopolitical factors and choices covered in the real-world scenarios. In the US a retreat to resource nationalism and attitudes to climate change, which has already happened under Trump's Presidency, may preclude opportunities to acquire low cost shale assets through company acquisitions.

Energy policy for power generation: As set out for the Last one standing model, the gas 'golden age' may not similarly materialise as expected, especially as the cost of RES continues to fall. For gas there could be opportunities to develop local markets, but this is contingent on the politics of electricity system restructuring, which is far from certain. For example, in Germany where the power company Eon 'bet' on future growth in gas demand, the company is now under considerable stress (cutting dividends, falling share price) to the point it has now spun off its 'bad assets' into Uniper, but still continues to underperform⁷⁵. A key consideration for IOCs would therefore be whether political influence could be achieved alongside company acquisition to ensure a future market share. RES investment is also dependent on policy clarity, but with falling costs and more disaggregated investments for onshore investments at least, the risks are lower (see Figure 1a).

⁷³ J. Mitchell & B. Mitchell (2016) Paris Mismatches: the impact of COP21 climate change negotiations on the oil and gas industries. In addition, it is not certain LNG import/export infrastructure will be built – LNG was oversupplied through 2024: <https://www.mckinseyenergyinsights.com/insights/lng-market-oversupply.aspx> Due to drop in oil price, LNG price also dropped, so incentive to build infrastructure removed

⁷⁴ Ibid

⁷⁵ Ibid; I. Holmes (2015) Future-proofing the Capital Markets Union

FIGURE IA. COST REDUCTIONS, SINCE 2008

Source: US Department of Energy

KEY INTERESTS/INCENTIVES FOR DIFFERENT STAKEHOLDERS

For companies The Drift business strategy, a soft variation of Last one standing, ekes out the current business model. IOC company managements may be attracted to it simply because it would enable them to continue much as they were rather than having to take tough decisions. That said it carries significant risk factors from policy and technology disruption that must be properly managed. The uncertain timeframes of technology innovation⁷⁶ (as well as policy) could be highly disruptive to the revenues needed to cover the cost of long-term investments. This may lead to assets being stranded and shareholder value lost. For this reason, the company will need to have robust internal scenarios that they use to predict the timelines of such change – and be able to explain these to investors. To ensure continued access to markets there will be a strong incentive to lobby against policies supportive of new technology deployment. There will need to be a rigorous focus on cost cutting across the business. Given that climate change is increasingly a concern for investors, any visible counter-lobbying by companies may well be deemed unacceptable and so the company may need to become passively engaged in the transition, creating value where it can be based on oil prices but not actively blocking progress. For gas, again the focus should be on cost cutting but also working with developing country governments in particular to embed gas as a transition fuel in the power sector, promoting coal to gas not coal to RES switching.

For investors one of the key controversies around the stranded assets debate is the issue of timing. Under the First one out strategy, the company would take a proactive approach to managing timing, by running down the business while maximising the value of assets. Under this Drift strategy a more passive ‘horizon-scanning-and-response’ approach is taken by the company, which still risks a relatively sudden correction with significant share value loss. Investors may well assume – as some currently do – that while the company continues to generate revenues they are a good bet and that when they cannot, they will be the last one out before the crash. Greater scrutiny of this philosophy is advisable. Investors may be better off engaging with the company to seek a shift in strategy from this pathway to either a Last one standing or First one out strategy. If neither happens the share price may

⁷⁶ The most profound challenge to business as usual for the oil companies and their dependent stakeholders comes from the motor industry. All the major motor manufacturers now have a mass market electric car offer. They are being positioned for the moment the huge reduction in the cost of driving a car with electrons rather than molecules outweighs the additional cost of the vehicle. T. Burke (2015) The road not taken

fall to a level where the company becomes a takeover target. Finally, any visible counter-lobbying on climate policy by companies should be 'called out' by investors as unacceptable.

For Governments, in the absence of a clear policy to reduce oil and gas demand in countries buying these commodities (recipient countries) either through electrification or with the aim of reducing price volatility/boosting energy security, the ongoing tax receipts to home governments may make this option attractive. This will be the case for recipient countries with a laissez-faire approach to markets that are not actively thinking through how their economies will need to restructure in response to the climate transition. Those recipient countries actively thinking through these issues will need a clear view of options available to them and their consequences (for example the opportunity cost of building gas infrastructure as a transition fuel instead of moving direct to RES). Without clear policies, recipient countries and companies leave themselves hostage to fortune with respect to the timing of innovation shocks – market not policy driven – which will be hard to predict and leave governments to manage the financial and economic fallout of asset stranding and decommissioning costs.

2. OSTRICH

Under the Ostrich strategy, the IOC starts with weak (i.e. few/high cost/short time horizon) reserves, believes the Paris Agreement will not be delivered and is confused about where residual market value can be found. Instead of taking a proactive approach to managing its fortunes, it falls back into the comfort of the old beliefs that demand for oil and gas will ultimately keep rising, oil prices will recover, and that if they just ride out the current market stresses there will be a return to business as usual. The business closest aligned with this approach is Chevron, which has a poor record on engaging with the climate debate and is the most exposed in terms of having exploitable reserves based on the current oil price. In January 2017 Chevron disclosed in first annual loss in 37 years⁷⁷. In 2018, Chevron has returned to profit but significantly underperformed compared to analyst expectations.

RISKS TO IMPLEMENTATION

Voices of reason inside and outside the company: This model looks unviable because of all the drivers listed earlier – tightening climate policy, low oil price, technological innovation, changing behaviour and so on. The change model for the industry will ultimately be driven by regulation. This in turn will be informed by voters, who in turn will be influenced by events and consumer influences, which will be determined by choices available to them. As such it will be necessary for the company to have a view on the impact of these drivers on their business model. Without this clear focus such a company is likely to see its share price fall, perhaps to a level at which it looks likely to be taken over or management change is forced.

⁷⁷ See <https://www.pipelineme.com/news/international-news/2017/01/chevron-posts-first-annual-loss-in-many-years-misses-estimates/>

KEY INTERESTS/INCENTIVES FOR DIFFERENT STAKEHOLDER

For companies in a world where high risk and high uncertainty factors threaten the business it can simply be more comfortable to ignore the megatrends and take a passive approach in the face of threats to the business.

For investors this strategy will look increasingly unviable. Once it gets really cheap, the company is likely to become vulnerable to takeover.

For governments there should be significant concern – specifically around who pays for decommissioning costs and how potential financial shocks impact the wider economy from a disorderly transition.

ANNEX II: WARGAMING

USING THE DECISION-SUPPORT TOOL TO UNDERSTAND THE LIKELY SUCCESS OF DIFFERENT INTERNATIONAL OIL COMPANY STRATEGIES

1. WARGAMING DESIGN CONSIDERATIONS

Wargaming exercises are a common method for board-level decision makers to understand the range of possible futures, the consequences of their actions and possible counter-strategies developed by other human players. A range of wargaming literature was consulted during the design of the 2 Degree Pathways decision support tool^{78,79,80} as were a number of experts, most of whom were ex-oil and gas executives. A set of interrogatable futures were developed by experts at E3G in consultation with a wide range of literature on the energy transition and third party experts, see Box IIa. The design criteria for the development of the wargame was that it be as **simple as possible while still providing the range of behaviours required to interrogate all potential futures and play all macro-strategies** (as articulated in Section 3).

Box IIa: Interrogatable Futures

Winners and Losers

Which companies and strategies might be successful under different scenarios? Which companies and strategies will be unsuccessful?

“First Out”/“Last Out” Benefits/Penalties

Are there benefits or penalties for being an early adopter or laggard in transitioning business models?

Asset Stranding

What type of assets might strand under what scenarios? To what extent can asset trading and revaluation minimise asset stranding?

78 M Herman & M Frost & R Kurz (2008) Wargaming for Leaders: Strategic Decision Making from the Battlefield to the Board Room, McGraw-Hill Education, London, UK

79 MH Hugos (2012) Enterprise Games, O'Reilly Media

80 C Elgood (1997) Handbook of Management Games and Simulations, Gower Publishing.

“Run on Carbon”

What happens if multiple companies decide to exit the carbon business at once?

“Run for Cash”

What happens if multiple companies decide to run business down, returning cash to shareholders?

“Lower for Longer” Debt Accumulation

How much debt can companies sustainably accumulate under low oil-price futures? What opportunities are missed?

Risk/Leverage Renormalisation

Are there new norms which might develop around oil and gas sources of financing and the average leverage of the industry?

The design of the wargame needed to strike the correct balance between complexity and simplicity. Enabling the full range of macro-strategies to be playable and the interrogatable futures to be possible dictated a minimum complexity, but sufficient complexity also provided expert players with the believability to take the game seriously and the prescience to make the results interesting. Being a game, simplicity was required to constrain a wargame session to a single day, and to make it teachable to a non-expert in a short amount of time. As such, game development focused on the sophistication of strategy spaces, rather than sophistication in the technoeconomic model of oil and gas extraction.

One further choice was made between discrete and continuous strategy spaces. Discrete strategy spaces, whereby a player chooses from a predefined menu (e.g. ‘green’, ‘gas’ or ‘oil’), have the advantage of reducing the learning required by the player, but change the mathematics of the underlying game from a repeated normal-form game to a graph-form game, adding path dependence to the game’s state space (e.g. to choose ‘green’ in turn 5 is meaningfully different than choosing ‘green’ in turn 1). A menu of three choices, three players and ten turns, for example, yields $\sim 10^{14}$ potential game states – necessitating an underlying continuous model anyway to give feedback to player choices. Finally, as many of the interrogatable futures are differentiated not by ‘if’ but by ‘how much’ industry members take certain actions, a continuous strategy space was ultimately more appropriate.

2. CAPTURING THE DECISION MAKING

The macro strategies described in Section 3 needed to be redefined according to the axes of choice familiar to executive-level decision makers. Oil and gas executives are charged with setting the capital policy of their companies – how they allocate free cash flow. The canonical choice faced by company managers is the extent to which they return capital to shareholders (via dividends or share buy-backs etc) relative to the portion they reinvest in their business (capex). Company executives also manage the capital structure of their company – issuing or returning debt or equity strategically to seize growth opportunities. In a given year, the free cash flow of a company is allocated among these three categories: transfers to shareholders, retained and reinvested earnings, and capital structure payments. In the wargame these three categories are called dividends, capex and debt – see Figure IIb.

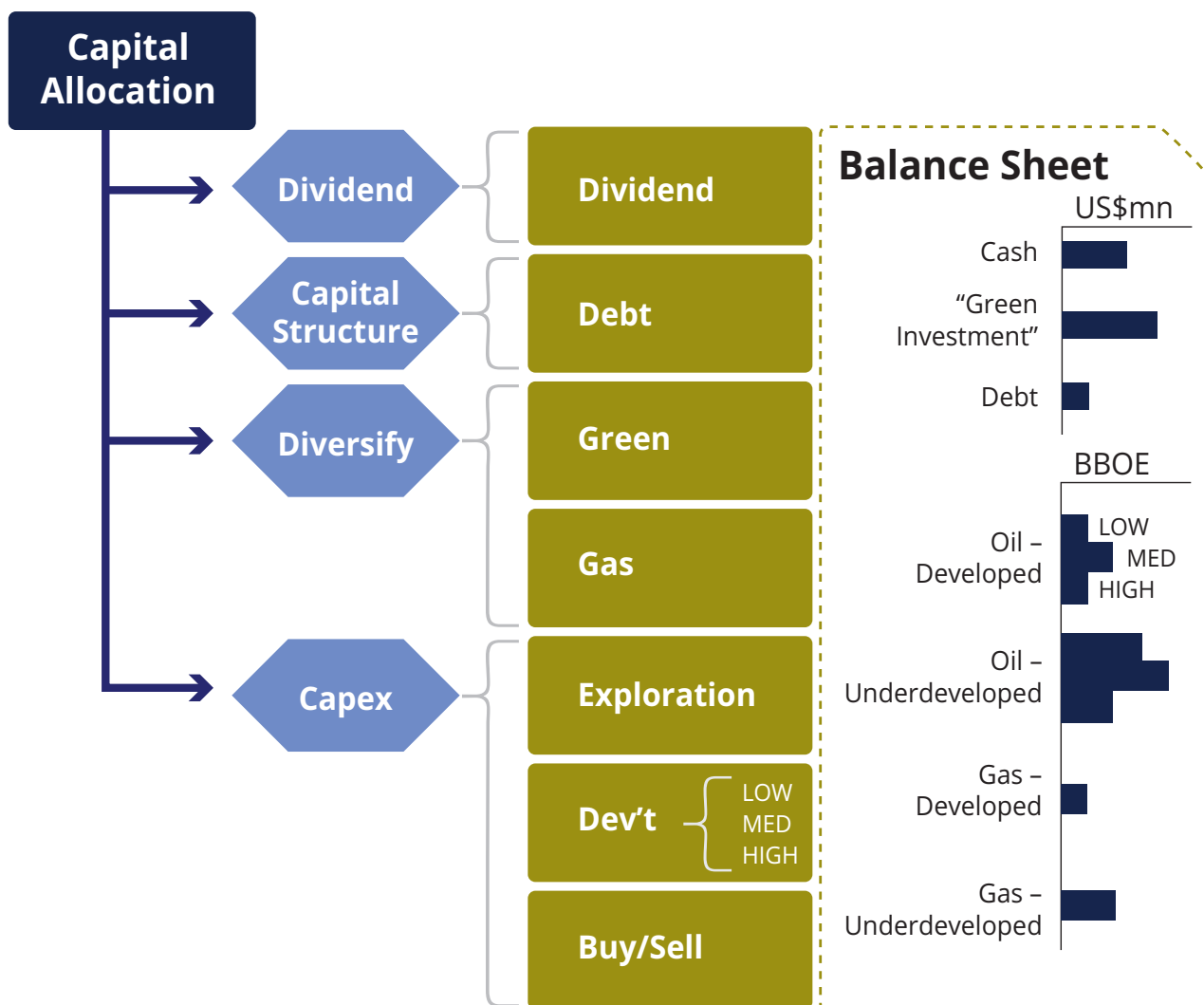
Much of the early literature on stranded assets and the energy transition focused on wasted capital – capex deployed by oil and gas companies into assets whose likelihood of being extracted and sold was uncertain, particularly in future scenarios with aggressive carbon constraints.^{81,82} Economic fundamentals suggested that assets at the higher end of the cost curve were more exposed to this risk. Risk is also unevenly distributed along the economic lifespan of an asset – assets closer to production being at lower risk of stranding. In order to capture the full range of strategies, players needed to be able to direct their capex to different assets varied both by development stage and production cost. Reflecting the uncertain nature of oil and gas exploration, capex cannot be directed according to production cost, however development capex can be. The wargame calls these options: exploration, development – low cost; development – medium cost; and development – high cost (see Figure IIb).

Oil and gas companies have the potential to transition to business models providing energy using other energy carriers or conversion technologies. The wargame distinguishes between gas as an energy carrier and a collective category of ‘green’ energy carriers and conversion technologies, which might be, for example, battery manufacturing companies, wind turbine manufacturers or renewable energy developers. Finally, oil and gas companies often grow or replenish their reserves via the acquisition of small exploration and production companies, rather than conduct the exploration activities themselves. The ability to buy and sell assets with other players is critical to some futures and macro-strategies, called ‘transactions’ for the purposes of the wargame (see Figure IIb).

For players to allocate capital to these different categories requires a fully articulated balance sheet. Players’ balance sheets are ultimately how they execute their strategy – choosing which assets to develop and when, modifying their capital structure for strategic cash injections, and trading assets with each other based on their beliefs and implicit valuations of those assets. Figure IIb shows the capital allocation options and balance sheet of an example company in the wargame.

81 Carbon Tracker Initiative (2011) Unburnable Carbon

82 Carbon Tracker Initiative (2013) Wasted Capital and Stranded Assets

FIGURE IIB. CAPITAL ALLOCATION OPTIONS FOR OIL AND GAS COMPANIES

3. DRAWING THE BOUNDARIES

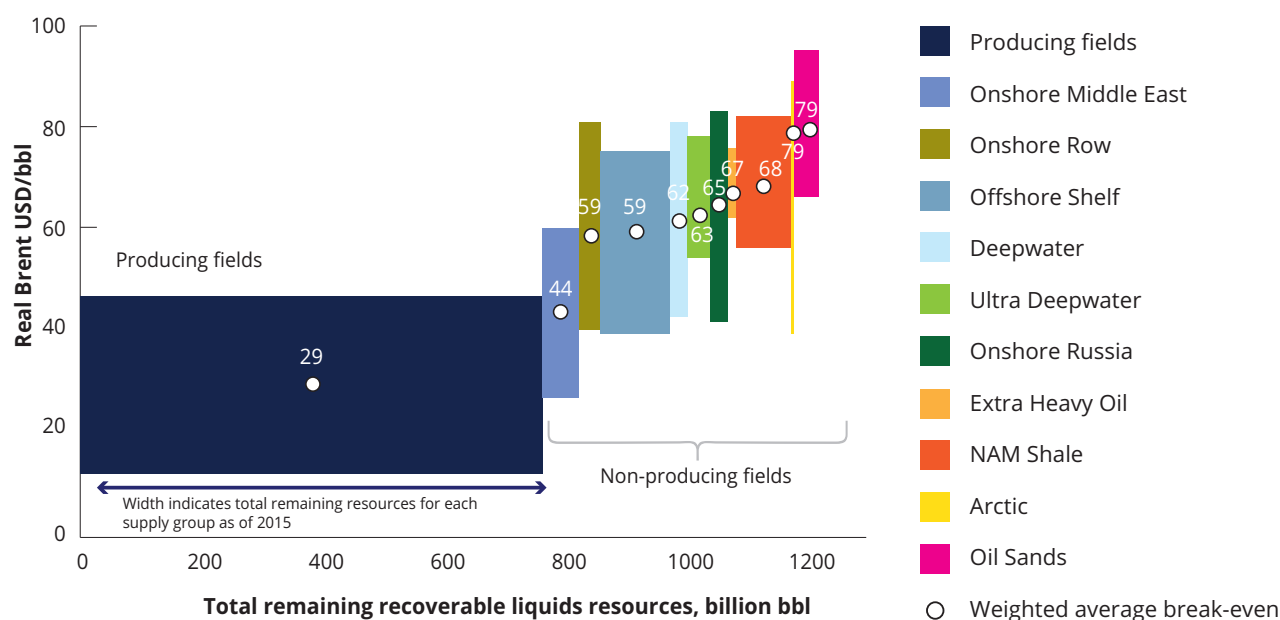
To limit model complexity, the only scenario parameters that impact the modelled performance of the companies are oil and gas demand and the supply of oil and gas by non-players, typically the OPEC. All other scenario details are provided as information to the players to help them form opinions about the future of the energy system and have been used to develop the scenario's oil and gas projections, but do not affect the prices in the wargame. All environment-related risks are interpreted as proxies for fossil fuel demand destruction. The main impact of many environment-related risks is demand impairment, for example by displacing petrol vehicles with electric vehicles or by putting a carbon tax on gas-fired power. This ignores the physical impacts of climate change, and risks less-related to fossil fuel demand like legal and reputational risks or fossil fuel supply policies like fuel standards. This broad category, however, captures many of the risks that concern executives, not just related to climate change but also changing technologies and markets.

The initial conditions of the wargame players and of their companies have a large impact on the strategies available to the players and their efficacy. Companies begin endowed with an asset base of oil and gas of varying production cost and life cycle. Assets are not allocated equally among companies. Reflective of today's oil and gas companies, be they IOC or NOC. Some have larger, lower cost or better developed reserves bases, giving the companies larger market share or more flexibility in their choices of strategies.

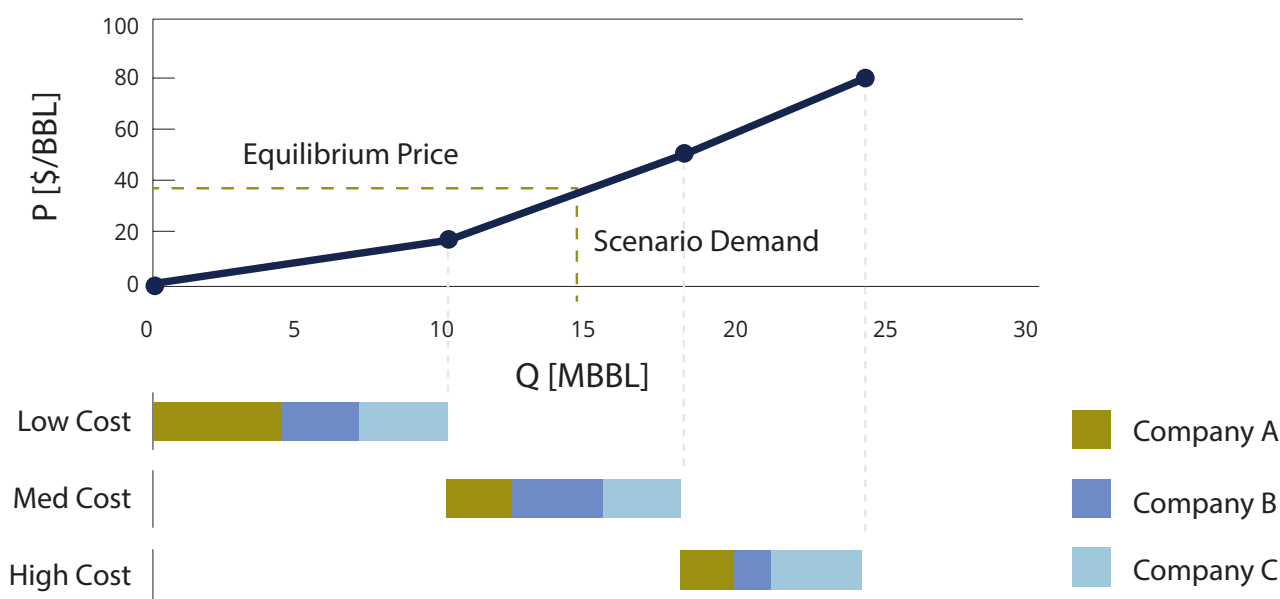
4. FEEDBACK AND INTERACTIONS

Players participate in 11 markets in 2 Degree Pathways wargame: two exogenous markets for oil and gas, with demand driven by the scenario and 9 endogenous markets comprised only of game players, one each for each of the balance sheet assets. These are undeveloped and developed oil in low, medium and high cost categories; undeveloped and developed gas; and 'green' assets. Each year in the exogenous oil market, the total volume of developed low cost, developed medium cost and developed high cost oil is aggregated together to form an aggregate supply curve. Low cost oil has a nominal cost of US\$20/bbl, medium cost of US\$50/bbl and high cost of US\$80/bbl. This roughly corresponds to the costs of the major sources of oil supply around the world (see Figure IIc). Exogenous, scenario-driven oil demand intersects with this supply curve to determine the oil price (as in Figure IId).

FIGURE IIC: OIL SUPPLY CURVE



Source: Rystad Energy

FIGURE IID: OIL PRICE FORMATION⁸³

In the game the companies produce oil in proportion to their contribution to the aggregate supply curve up to the equilibrium point and are rewarded with cash equal to the price multiplied by their produced oil. The exogenous gas market is more basic – gas is produced with a 10% ROI when aggregate supply matches aggregate demand, and has a floor (ceiling) ROI of 0% (20%) in the proportion to which gas is oversupplied (undersupplied).

In the endogenous markets, buy and sell offers for balance sheet assets can be made by any player holding the appropriate asset type or sufficient cash to match their buy volume and price. Players may determine their bid or ask prices and volumes – and their offer is immediately made visible to other players. Other players may then match the offer with a corresponding sell or buy offer to complete the transaction. Prices must match for a transaction to occur. Players may choose a reduced volume, however. Players may not overcommit their cash position. ‘Green’ assets are also released via this mechanism to the players. A scenario-determined volume of green asset becomes available each year as a sell offer with a price of unity. The return on green assets is also determined by the scenario being played.

A number of metrics are shown for all players so they can benchmark their performance at a glance and use the metrics for decision making. These metrics are calculated according to simplified versions of equations used by financial and energy analysts and are shown in Box IIb.

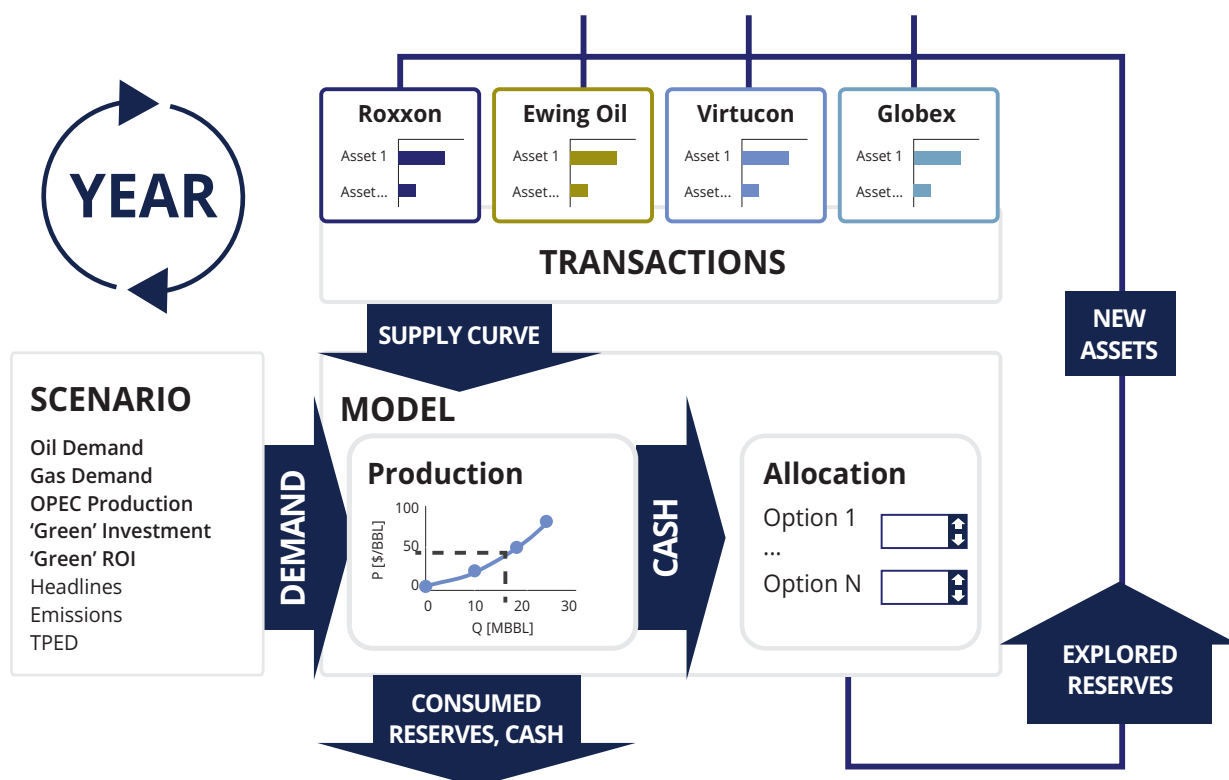
⁸³ <https://www.rystadenergy.com/NewsEvents/PressReleases/global-liquids-supply-cost-curve>

Box IIb, Decision-Making Metrics

(1) Reserves-to-Production Ratio	$R_{R/P}$	$\frac{\text{Reserves}}{\text{Production}}$
(2) Gas-to-Oil Reserves Ratio	$R_{G/O}$	$\frac{\text{Reserves}_{\text{Oil}}}{\text{Reserves}_{\text{Gas}}}$
(3) Total Enterprise Value	TeV	$\text{Cash} + \frac{\text{Future Cash Flow} * \text{Dividend \%}}{\text{CC}}$
(4) Return on Investment	ROI	$\frac{\text{Net Income}}{\text{Capex}}$
(5) Return on Equity	ROE	$\frac{\text{Net Income}}{\text{TeV}}$
(6) Debt-to-Equity Ratio	$R_{D/E}$	$\frac{\text{Debt}}{\text{TeV}}$
(7) Cost of Capital	CC	$\left\{ \begin{array}{l} 20\% \text{ } R_{D/E} = 2.0x \\ \text{lin} \\ 4\% \text{ } R_{D/E} = 0.0x \end{array} \right.$

5. SCHEMATIC REPRESENTATION

A schematic representation of the 2 Degree Pathways wargame is shown in Figure IIe.

FIGURE IIe. SCHEMATIC REPRESENTATION OF 2 DEGREE PATHWAYS WARGAME

ANNEX III

SCENARIOS

SCENARIO 1. STRONG INTERNATIONAL COOPERATION WITHIN A SERVICE-BASED DECENTRALISED ENERGY SYSTEM

- > There is continued strong growth in renewable energy deployment and investment in battery storage technologies. This leads to growing international markets and rapidly declining prices for these technologies moving into the 2020s.
- > OPEC struggles to reassert meaningful control on the oil market. Attempts to impose quotas fail amid widespread cheating from smaller members. This leads to the emergence of a more traditional 'boom and bust' price cycle as low prices restrict investment; leading to eventual under-capacity and a spike in prices; followed by a rapid expansion of capacity and eventually a price crash. This puts considerable pressure on the national budgets of many OPEC members leading to political disruption in countries such as Venezuela and Nigeria leading to temporary supply interruptions.
- > In the US there is a strong political backlash to President Trump's term in office leading to the election of an internationalist President in 2020. This leads to renewed political engagement on climate issues through the G7, G20 and other international fora. In the UNFCCC China shows continued leadership alongside the EU and others enabling an increase in NDC ambition in 2020 following the facilitative dialogue. There is also progress in developing and linking national carbon pricing systems including meaningful reform of the EU ETS to remove excess credits. Strong progress is made on removing fossil fuel subsidies which cuts production in many G20 countries.
- > Momentum on climate change combined with rising concerns over pollution levels in many emerging economies leads to a strong focus on reducing emissions in and around cities. This leads to an accelerated focus on zero carbon vehicles and associated infrastructure as one way to manage these tensions. The combination of action in developed and emerging economies means that global emissions peak before 2025.

- > In developed countries the debate over 'gas versus wires' leads to a greater focus on electrification and energy efficiency. Combined with the trends in emerging economies this means that global energy demand grows more slowly than is currently forecast in many mainstream models. Renewables penetration increases rapidly out to 2025 but accelerates sharply thereafter as a combination of greater transmission interconnection between regions and countries, demand response measures and flexible technologies drives a rapid change in business models around the power sector.
- > In developing countries and emerging economies technology 'leapfrogging' leads to rural areas moving straight to decentralised systems bypassing centralised models.
- > The move towards more decentralised systems creates clear winners and losers with high profile bankruptcies and restructuring among many traditional utilities in G20 countries in the period from 2025-2030, and significant tensions with traditional utility models in emerging economies. The switch in energy systems also creates significant unemployment in regions associated with fossil fuel production in many countries.
- > Alongside the Paris agreement there is strong international cooperation on managing climate risk. This includes the development of early warning mechanisms and action around financial regulation and insurance with a strong move to mandatory disclosure standards from 2020 onwards with broad coverage by 2025-2030. This brings an increasing threat of legal liability for investors and companies not seen to be accounting for climate impacts within their business models impacting perceptions of risk.
- > The falling cost of electric vehicles combined with new business models centred on driverless cars leads to a rapid change in the global light vehicle fleet, beyond many current predictions. This change is apparent by 2030 but accelerates even faster out to 2040.
- > Global carbon markets continue to expand post 2030 which, alongside continuing falling prices for renewables, puts major pressure on remaining fossil fuel assets.
- > Among OPEC countries and other fossil fuel exporters some make progress in diversifying their economies and moving to new growth strategies (although this still entails considerable disruption and social unrest). However, others spiral out of control and become failed states.
- > The move to a decentralised energy system with high penetration of electric vehicles puts real pressure on oil and gas demand in the period 2030-2040. Other sectors such as aviation, chemicals and plastics continue to support some demand but prospects for global growth across the sector are relatively constrained.

SCENARIO 2. STRONG INTERNATIONAL COOPERATION BUT RETENTION OF COMMODITY BASED CENTRALISED ENERGY SYSTEMS

- > Governments prioritise investment in gas infrastructure and support for nuclear power. Although renewable policies are not abandoned there is a significant erosion of policy support and the development of capacity markets favours non-intermittent generation sources in many countries.
- > OPEC and other major suppliers are able to foster a level of cooperation between themselves and other major producers such as Russia. However, the presence of unconventional oil (the 'fracklog') in the US effectively puts a ceiling on prices in the 2015-2020 period and means that OPECs control is much looser than in the period before 2014.
- > There is strong international cooperation around low carbon technology development, especially for nuclear and CCS, which leads to a significant number of global demonstration projects by 2020.
- > The EU and China continue to demonstrate strong international leadership on climate change. President Trump does not turn out to be as climate sceptic in office as his initial campaign pledges indicated and is replaced by a more internationalist President in 2020. International cooperation also leads to some upward revision of nationally determined contributions (NDCs) for the Paris Agreement by 2020 (although this is less pronounced than in scenario 1). The politics around implementation has a strong focus on exiting coal as quickly as possible while utilising gas as a transition fuel.
- > Air pollution is a growing concern in many emerging economy cities, which leads to increasing tension between the emerging middle class and political elites from 2020-2025. This leads to a growing political demand for more radical solutions to pollution related issues and does drive some demand for electric vehicles. This also substantially limits new coal build especially in emerging Asian economies such as India from 2020-2025.
- > Renewables penetration continues to grow globally but in many countries where this threatens existing utilities governments intervene to support old centralised systems, and effectively cap the market share of renewables. There is significant progress on the development and linking of national carbon markets, which drives further coal to gas switching but is not sufficient to support a structural change to low carbon generation.
- > There is strong international cooperation on managing climate risk impacts. Increasing incidence of drought and other events start to shape public opinion in a range of countries such that by 2030 there is an overwhelming call for faster and rapid decarbonisation.
- > From 2030-2040 the response to political calls for action leads to states aggressively implementing 'crash programmes' to limit demand and rapidly move away remaining fossil fuel generation that does not have CCS. This includes rapid construction of nuclear power and targeted programmes

to accelerate electrification of transport in cities. These responses create significant potential for the creation of stranded assets across gas pipelines and liquid natural gas (LNG) infrastructure and remaining coal assets in countries such as India and China.

- > Rapid decarbonisation puts major pressure on OPEC and other major fossil fuel producing economies such as Russia. This leads to significant political instability in a number of regions.
- > The crash programmes significantly raise the cost of decarbonisation (relative to scenario 1) leading to an impact on GDP growth and energy demand in the period 2035-2040.

SCENARIO 3. DEFENSIVE GEOPOLITICS WITH RETENTION OF COMMODITY BASED CENTRALISED ENERGY SYSTEMS

- > From 2015-2020, following Trump's victory and Brexit, a wave of populist politicians are elected in democracies around the world. In the EU this leads to membership referenda in a number of countries including France, Netherlands and Italy alongside the UK Brexit negotiations. By 2020 this means that the EU as a major international force is severely weakened. President Trump pursues an agenda of international isolationism with the implementation of strong protectionist trade measures. However, this does not lead to an immediate withdrawal from the Paris Agreement. These combined forces significantly weaken the West's global role from 2020-2025.
- > Although the Paris Agreement still enters into force in 2020 there is no meaningful increase in NDC ambition. Political focus switches away from the UN and other multilateral for a such as the World Trade Organisation (WTO) to focus on regional groupings and bilateral relationships.
- > The focus of carbon market development shifts to the national/local level with a patchwork of different initiatives emerging in different geographies.
- > OPEC capitalises on the defensive geopolitics, increasingly focusing on direct government to government contracts for energy commodity supply rather than trading on global markets. On the demand side China uses its "One Belt, One Road" policies to cement direct links with key resource supply centres. There is significant tension over control of the South China Sea, leading to a fractious relationship between the US and China.
- > Defensive geopolitics undermines global trade and growth. This limits the growth in global energy demand. Countries focus on the creation of 'national champions', which supports the expansion of gas and nuclear generation and the use of CCS technology.
- > Health and pollution concerns in India and other emerging economies limits coal expansion in the period 2020-2025 and some moves towards electrification of transport systems.

- > A significant wave of cyber security attacks focuses national attention on building robust defensive energy systems. This includes some renewable alongside centralised generation and the security benefits of some decentralised capacity, which is more robust to direct attacks, is increasingly valued.
- > Growing concerns over climate impacts lead to defensive investments in adaptation measures. However, by 2025-2030 it is clear that this will not be sufficient to protect citizens leading to a renewed focus on mitigation. Countries begin to implement 'carbon tariffs' on imports from high polluting countries.
- > Developing countries struggle to adapt leading to large flows of climate migrants and significant border tensions in a range of regions. Efforts to build 'walls' are costly failures generating growing public demands for more sustainable solutions. Significant tensions emerge around failures to manage access to water with conflict impacting several regions including the Middle East.
- > From 2030-2040 many countries instigate rapid crash programmes to limit emissions and rapidly move away from unabated fossil fuels through use of nuclear power, CCS and electrification of transport networks. This leads to significant losers amongst countries that had become dependent on bilateral trading in fossil fuels, especially OPEC, and major instability in a number of countries potentially leading to some becoming failed states.
- > By 2040 global super-powers such as China and the US accelerate the development of geo-engineering technologies and bio-energy with carbon capture and storage in an attempt to achieve negative emissions as carbon budgets risk being breached.

SCENARIO 4. DEFENSIVE GEOPOLITICS WITH A SERVICE BASED DECENTRALISED ENERGY SYSTEM

- > From 2015-2020 a wave of populist politicians are elected in democracies around the world. The political energy from these victories is channelled into developing a new social settlement with disadvantaged parts of the population that have traditionally lost out from globalisation. This sees a strengthening of workers' rights and a move away from open global markets.
- > Attempts at OPEC coordination fail and the oil market shifts back to a more traditional 'boom and bust' commodity cycle. This puts considerable pressure on the national budgets of many OPEC members leading to political disruption in countries such as Venezuela and Nigeria leading to temporary supply interruptions. Other OPEC members such as Saudi Arabia focus on bilateral deals with emerging economies in an attempt to defend revenues.
- > Investment continues to flow into renewable energy and storage systems leading to falling prices and increased parity for solar and other technologies in many regions.

- > Although Paris still enters into force in 2020 there is no or limited increase in NDC ambition. Momentum switches to local level with networks of cities becoming a strong vehicle for lesson learning and knowledge transfer.
- > The development of carbon markets focuses on national and local trading rather than linking internationally. This leads to significant disparities in price levels and approaches in different regions.
- > In many countries politicians focus on legal liability for private company actions, including in relation to climate risks. This leads to the implementation of strong mandatory standards for disclosure and high-profile court cases in some jurisdictions.
- > The focus on localism promotes a shift towards circular economy business models and the deployment of renewable and efficiency in both developed and developing economies. This significantly limits investment in coal (especially in Asia) and to a lesser extent gas with a global emissions peak happening by 2025.
- > The development of storage technologies and active demand management supports the rapid deployment of electric vehicles from 2025-2030 (although slightly lower than scenario 1).
- > The move towards more decentralised systems creates clear winners and losers with high profile bankruptcies and restructuring among many traditional utilities in the period from 2025-2030.
- > The shift away from international markets leads to reduced GDP growth and lower energy demand. In some countries there are successful efforts to reduce inequality within this context. In others there is significant political unrest as countries struggle to generate tax revenues in order to fund public services.
- > However, in a core set of geographies a strong focus on just transition and support to shift workers into new industries means that incumbents are not able to block the overall shift towards decentralised systems.
- > Climate impacts drive increasing concern, but this is focused into adaptation responses. Hostility towards migration leads to significant tensions over climate related migration, and over access to water resources. These factors lead to major political instability across the Middle East impacting OPEC production in the period 2025-2030.
- > A continued transition to decentralised energy systems within a more closed, lower growth world continues during 2030-2040. Electrification of transport systems continues apace and there is less international air travel than in the more globalised scenarios. This leads to wide disparities in costs and opportunities across different geographies. Those countries who successfully manage the transition prosper but there are tensions with those who lose out.

ANNEX IV

NOC GAMECARDS

JEDDACO

Mission

- > Your revenues are key to government's budget; on average you should provide in the future approx. US\$ 280 bn per year.
- > As the swing oil producer, you should also aim to maintain the stability of the oil price market.

Background info

- > Exclusive oil producer in the country, access to low cost oil—around US\$ 15/bbl.
- > Oil revenue is 62% (US\$ 88bn) of the total government budget. Also, it provides companies (utilities, manufacturers) with below-market-priced oil and natural gas.
- > Therefore, the benefits of low cost oil are passed through to the government and local industry. Keep in mind that the country's debt servicing costs is going up by 40%, this could affect your decision on capex.

LUKNEFT

Mission

- > You should maximise revenues as one of your commitment is to fulfil the budgetary requirements of your government- last year the government received US\$ 120bn on oil and gas revenue.
- > You also would endeavour to support to maintain high stable oil price.

Background info

- > Oil production resides on the lower part of the cost curve, around the US\$20/ bbl.
- > The bulk of the economic value of oil production goes to the government via taxes. 75.16% of the company is owned by the state, therefore, the government has some influence on your business model.
- > Oil Revenue on average, between 2010-2014, represented 53%.

PETROLAM

Mission

- > You operate on the medium to high part of the cost curve. Your mission is to increase your market share and try to utilise your resources to the maximum.
- > Develop your medium/ high cost resources where possible.

Background info

- > Oil production holds a strong position in the middle of the cost curve, with a weighted average breakeven of US\$ 50/bbl.
- > The government holds more than 3.7 billion common shares, roughly 50.26% of the total common shares outstanding which means that the government has the power to elect the company board of directors.
- > The company hasn't paid dividends in the last three years.

SCANDINOIL

Mission

- > As the CEO of the company you should maximise dividends paid to the country's Wealth Fund over the lifetime of your operations. You should also ensure that you are a viable company long-term.

Background info

- > Your flagship projects breaking even are at below US\$25/bbl. Given its operation, the company behaves similarly to an IOC.
- > The dividends account for 1% of the overall government budget in 2016, US\$ 1.4bn. The majority of the country's petroleum revenue does not come from your company but instead from exploration and production licenses and as such you have considerable operational flexibility.
- > Fiscal dependency directly on your company is limited although oil revenues account for 13% of the State's revenues in 2016.

BURANDOIL

Mission

- > You operate on the medium high cost curve. Your mission is to increase your market share and try to utilise your medium/high cost resources.
- > You should also ensure survival and profitability of the company. The government has been flexible in accepting no dividends in 2016 but this can't hold in the medium term.

Background info

- > Oil production's position on the cost curve is around US\$ 60/bbl.
- > The sole shareholder is the government, however, your company's near term priority is reducing its own debt; it fell from US\$ 13.6bn in 2015 to US\$ 9.8bn in 2016.
- > But, the economy depends heavily on oil production. From 2011— 2013 oil represented 80% of total government revenue and more than 60% in 2016.

SNPC

Mission

- > Your mission as the CEO of the State National Petroleum Company is to ensure the company is sustainable and secures the necessary resources for the country, regardless of international climate policy. You have to consider buying resources from other companies as the country needs to maintain high levels of Strategic Reserves.
- > Energy infrastructure is a big part of your government's foreign investment initiative.

Background info

- > Your company is the largest oil producer in the country, but does not have a legal monopoly on oil production.
- > Although it is listed in Shanghai, Hong Kong and New York, your company often acts to secure new technology and energy supplies for the country, rather than strictly commercially.
- > However revenues from SNPC are not significant in terms of government revenues, although it is economically significant in some regions.

ANNEX V

RENEWABLES INVESTMENT BY INTERNATIONAL OIL COMPANY

The table below shows a tabular summary of renewables investment by oil and gas majors between 2013-2017 with information drawn from company websites, annual and sustainability reports.

COMPANY	MISSION STATEMENT RELATING/ LOW CARBON BUSINESS	LOW CARBON ASSET/LOCATION										
		WIND	SOLAR	BIOFUELS	TIDAL/ HYDRO	OTHER	TECHNOLOGY INTEREST	PEER POSITIONING	ACQUISITIONS/EQUITY STAKES	VENTURE INVESTMENTS	RESEARCH/FUTURE ASPIRATION	ADDITIONAL COMMENTS
BP	We will broaden our renewable energy and low carbon businesses through reinvestment in the current portfolio, build a dynamic venturing arm and further our work in tackling climate change"	Yes / USA	Yes / USA	Yes / Brazil				Peer positioning: BP "has the largest operated renewables business among our oil and gas"	Biofuels (largely bioethanol in Brazil) Moved to majority stake 2011, with a project to develop biobutanol)	The website has stated that BP has spent US\$300m over 10 years into 40 start-ups attracting over US\$2bn of further funding from other sources. See additional comments*		About half the ventures are low carbon technologies. In 2016 Bp deployed seven technologies developed by these companies within BP assets. No detail about the success rates of the 40 start ups, or detail about future investment amounts
ENI		Yes / Italy, Algeria, Tunisia and Ghana		Yes / Maghera (Italy)							2013 tests on biodiesel from algae, no mention in subsequent years 2014 mentions energy efficiency technologies, no details - Focusing research on the energy mix and diversification (no detail)	
Repsol	Statement to promote & generate returns from initiatives envisaging a future where energies are more diversified" (2010)	Yes/UK			Yes, see acquisitions)		- Recharging stations for electric vehicles (IBIL, IBILEK)-TECH - Offshore floating wind turbine prototype		2011- bought 100% of Sea Energy (UK) offshore wind, sold in 2016 2013-20.34% stake in Tocardo (Dutch) generation from river and ocean currents 2013- 33% stake in principal power Inc: offshore floating turbine prototype		Posibilities in biotech, value added product from CO ₂ and storage and of electricity energy for transport (batteries for motorbikes)	Selling wood pellets using the Repsol network
Statoil	"In NES we are building a profitable business with the potential to account for 15-20% of capex by 2020 provided that we can access and mature attractive opportunities".	Yes / UK, Germany, US						CCS, Statoil is the most enthusiastic European Company		Statoil Energy Ventures: an incubator of low carbon technology companies made its first investments in 2016 9United Wind Inc., Chargeoint Inc., Conveyant Energy and Oxford Photovoltaics)		Offshore wind; The most recent comments are on the increasing competition for projects (the implication being the lower returns)
Royal Dutch Shell		Yes / USA, EU	Yes / see comments	Yes / Brazil see comments**		Hydrogen filling station. 1 in Germany, 2 in the US	CCS hedged around with the need for government support				They have invested US\$1.1bn in low carbon R&D over six years	*Solar- Joint venture with Petroleum Development Oman - Created a New Energies Group in 2016 **Biofuels using parts of crops "not used for food"
Total	"Ambition to become the responsible energy major" low carbon businesses in 20 years' time" "Renewable energies along with energy storage and energy efficiency should represent 20% of our portfolio in 20 years' time"	Yes		Yes (since 1990's)				Solar 30+ years through SunPower affiliate claim technological leadership	- Bought Saft Group for US\$1.064bn (sales US\$738m, net book value US\$538m); batteries for industry - Exited a small coal business in 2014"	Total Energy Ventures Fund		
Chevron		Yes / New Mexico & California	Yes/ USA	Yes See comment*		Geothermal/ Indonesia, Philippines				Chevron Technology Ventures (incubator, some of the ventures have a low carbon or energy efficiency aspect)		* Biofuels (non-food inputs, no details of scales, profitability)
Conoco Phillips										Carried out via a venture with G.Eand NRG. Conoco Phillips invests both via (8 ventures) and directly alongside (13 ventures) this vehicle		
Exxon	For CCS "to take off it needs to be far simpler, about half as costly and even then, is only suitable for some applications"						Fuel cells: a more recent area of focus	CCs. The annual report states that Exxon has global leadership			Biofuels. Exxon has been working on biofuels from algae since 2009, and although they don't disclose the spending so far, it is rumoured to be more than US\$1bn. They remain committed to the algae but do state that "it could take decades" to be viable at scale	
Petrobras	"Our strategic guideline to exit biofuel production activities, preserving technological skills with potential for development" (2016)				Yes				Biofuels and biodiesels via both a wholly owned subsidiary and various stakes including a 50/50 joint venture with Galp energia			These businesses include palm tree plantations, processing castor oil, cotton oil & sunflower oil and their trading, sugarcane crushing for ethanol