Avoiding Shipwreck: Stranded Assets in Oil and Gas

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INTRODUCTION

AVOIDING SHIPWRECK: STRANDED ASSETS IN OIL AND GAS

What is the risk of non-monetisation of fossil fuel resources for major suppliers? How can this risk be mitigated?

'Stranded assets' refers to oil, gas and coal reserves that cannot be produced, because of climate change policy and/or competition by non-fossil technologies.

An increasing number of international oil companies (IOCs) are reshaping their portfolios due to 'net-zero' carbon targets. National oil companies (NOCs) and major producing countries face the risk of not fully monetising their resources amongst the goal and need to limit respective carbon risk.

THE ABDULLAH BIN HAMAD AL ATTIYAH FOUNDATION

Energy Industry Report

This research paper is part of a 12-month series published by the Al-Attiyah Foundation every year. Each in-depth research paper focuses on a prevalent energy topic that is of interest to the Foundation's members and partners. The 12 technical papers are distributed in hard copy to members, partners and universities, as well as made available online to all Foundation members.

EXECUTIVE SUMMARY

- 'Stranded assets' are oil, gas and coal reserves that cannot be produced because of climate change policies and/or competition from other energy sources.
- Such policies may include outright bans, carbon taxes or caps, or policies that improve the competitiveness of non-fossil fuelled technologies such as electric vehicles.
- The 1.5°c target of the Paris Agreement allows for no more than 464 gigatonnes of CO_2 emissions to 2100, but current oil and gas reserves would yield 1120 gigatonnes and coal another 2100 gigatonnes.
- However, because of the natural decline of oil and gas fields, significant new investment will still be required up to 2040.
- Low-cost and low-carbon assets will be advantaged; the 'stranded assets' will be those that are high-cost and/or high carbon.
- Most value in current production accrues in the first few years, and most reserves are held by governments and NOCs. Therefore, 'stranded assets' are a problem more for major resource-holding countries than for international oil companies with strategic options and relatively short reserves lives.

IMPLICATIONS FOR LEADING OIL AND GAS PRODUCERS

- Major oil and gas producers should consider policies for faster monetisation of their assets. This can include higher production (and implicitly lower prices), or sales and privatisations. This would ensure that lower-cost reserves are more fully produced and that limited 'carbon space' is not taken up by coal or higher-cost oil and gas.
- Nevertheless, major resource holders need to take the risk of 'stranded assets' seriously, for instance if they are excluded from major markets or if prices fall sharply due to competition from other technologies.

To some extent, they can follow the approach of IOCs by improving cost control, reducing operational greenhouse gas emissions, shifting from oil to gas, and expanding non-emitting uses for oil, such as petrochemicals.

- If public investors, particularly Western ones, are forced out of oil and gas by 'stranded assets' and divestment concerns, this could create opportunities for acquisitions.
- However, in the long-term, big petroleum producers will need major expansions of hydrogen, carbon capture, use and storage (CCUS), and carbon offsets to keep their resources viable.

CLIMATE POLICY AND TECHNOLOGY COULD MAKE HYDROCARBONS 'STRANDED ASSETS'

The International Energy Agency defines 'stranded assets' as "those investments which have already been made but which, at some time prior to the end of their economic life, are no longer able to earn an economic return." Specifically, in relation to fossil fuels, this relates to investments in discovering and developing reserves or fields, which then cannot be produced or cannot continue production because of future climate policy. This could be a rising carbon price that makes them uneconomic, or an absolute or practical ban on production or use.

This concept arises from comparing known oil, gas and coal reserves against the amount of carbon dioxide emissions that are compatible with the Paris Agreement's (2015) target of limiting warming. For a 50% chance of no more than 2°c of warming, 1200 gigatonnes of carbon dioxide could be emitted between 2020-2100. For a limit of 1.5°c, only 464 gigatonnes could be emitted. This compares to much larger known reserves or supplies of fossil fuels.

This means for 2°c we could theoretically burn all of the oil and gas and a little of the coal. For 1.5°c, we cannot even burn all of the oil. In actuality, of course, large amounts of coal continue to be burnt, therefore even for the 2°c target, a large amount of oil and gas cannot be utilised or is 'unburnable'.

These 'proved' reserves are likely to be substantially added to by new exploration, improved recovery from existing assets, and unconventional resources (oil sands, tight and shale oil and gas).

The potential burden of 'stranded assets' depends on which fuel is considered. Coal, as a low-value and dirty fuel with several

competitive alternatives, is likely to see most of its reserves stranded. A large quantity of coal reserves is held within countries that have caps or costs on emissions or may introduce them in the near future, including the OECD countries and China.

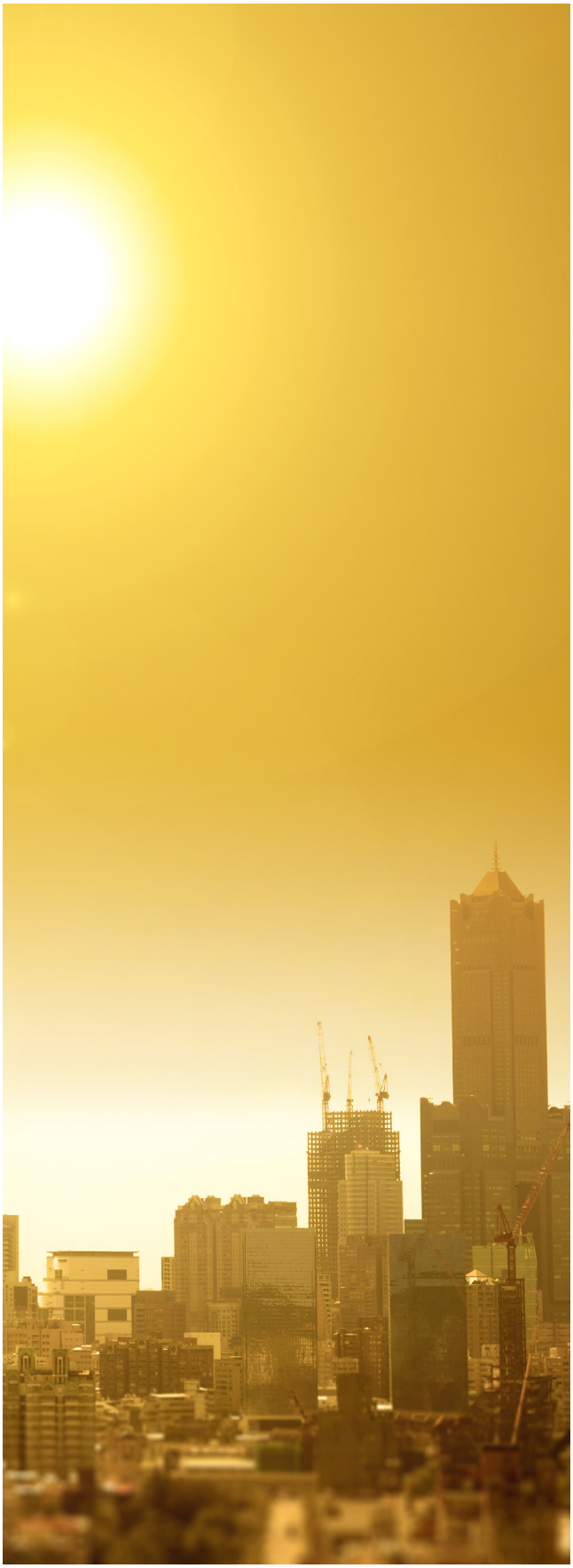
Gas is much lower-carbon and more evenly distributed. On the other hand, it also has strong competition from renewables in power generation. Oil reserves are primarily concentrated in the OPEC countries and to a lesser extent OPEC+ (mainly Russia). OECD reserves are small other than the high-carbon Canadian oil sands.

CLIMATE POLICY AND TECHNOLOGY COULD MAKE HYDROCARBONS 'STRANDED ASSETS'

The burden also depends on where emissions caps are implemented – most likely in the country of use, rather than of extraction. In 2019, 21% of coal, 33% of gas and 72% of oil was traded internationally. The future for oil is therefore very much dependent on decisions in the importing countries. For coal, producing and consuming countries are to a large extent the same thing.

The validity of the 'stranded assets' concept depends on governments actually taking strong action against climate change, in line with the Paris Agreement targets. Evaluations suggest that governments' current pledges under the Paris Agreement would lead to 2.8°c of warming by 2100, and their real-world actions are in line with 3°c of warming [ii]. These actions are likely to be strengthened, but there is a difference between the resources that 'should' be stranded to achieve the 1.5°c target, and the much smaller amount that will be stranded under current policies.

Investors have increasingly begun to consider 'stranded asset' risk in valuing companies and assessing their strategies. They have pushed for moves to shorter-cycle production and non-carbon investments such as renewables. This also partly ties in with a growing campaign of 'divestment', encouraging university endowments, pension funds, international financial institutions and other such investors to avoid fossil fuel assets, because of the financial, environmental, and reputational risk.



THE CONCEPT OF STRANDED ASSETS RELATES TO THAT OF 'PEAK OIL DEMAND'

The idea of peak oil demand is that, within the foreseeable future, world demand for oil will peak and then decline (see the Al-Attiyah Foundation Research Series, Issue 3, March 2018).

Peak oil demand can be brought about by some combination of (a) technology (eg improved energy efficiency, electric vehicles, ride-sharing, plastic recycling and substitutes), (b) economics (eg slower world economic growth and population growth; reduced travel needs because of ageing populations, teleworking and Covid-19), and (c) environmental policy, including absolute restrictions on oil production or use, or carbon prices that would reinforce factors (a) and (b). Estimates for the date of peak oil demand range from 2019 to after 2050, but many estimates cluster around the 2025-35 time period. That is well within the life of most existing oilfields and associated facilities and pipelines.

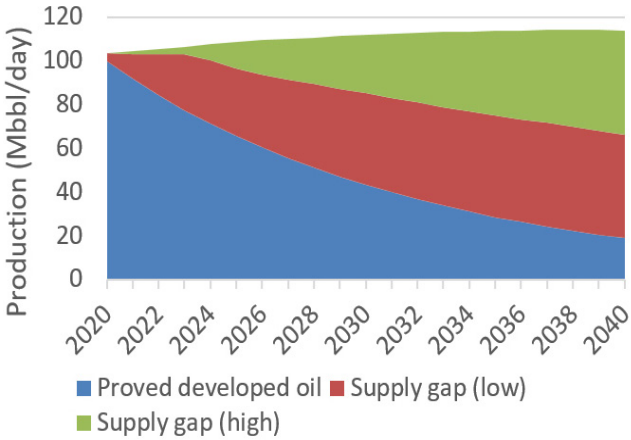
Peak oil refining demand is likely much sooner because of the increasing share of natural gas liquids (NGLs) and biofuels (see the Al-Attiyah Foundation Research Series, Issue 40, December 2019 [iii]). Refineries in declining markets, such as Europe, could become uneconomic even while overall world oil consumption is still rising. Similarly, pipelines serving specific markets might become stranded.

Peak gas demand is generally thought to be further away in time than peak oil demand (see the Al-Attiyah Foundation Research Series, Issue 29, January 2019 [iv]). Some studies show a flattening of gas demand in the 2030-40 period; others show it continuing to rise to 2050.

EVEN WITH PEAK OIL AND GAS DEMAND, NEW INVESTMENT WILL BE REQUIRED

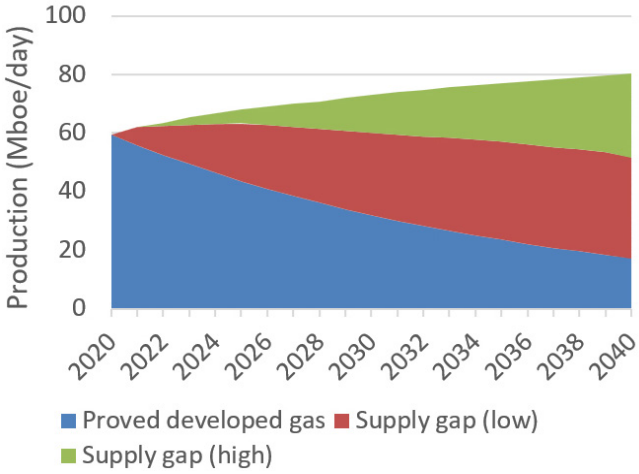
Current assumed average natural production decline rates are about 8% annually for oil and 6% for gas. These are much faster than likely decline rates of demand post-peak demand of about 2-3% per year. Therefore, without substantial investment in new production, output will fall well below demand even in a post-peak demand situation. By 2040, current oil fields may yield about 19 million barrels per day (bpd). However, 47 million bpd of new output would be required in a 'peak demand' case, or 95 million bpd in the case of continuing slow demand growth (Figure 1). Investment would have to yield 28-77 million bpd of new production, by a combination of expansion or at least reduced declines in existing fields (enhanced recovery, infill drilling), extensions and near-field exploration, development of currently discovered fields, and exploration of new plays and basins.
The challenge for gas is less because demand is

FIGURE 1 REQUIRED NEW OIL SUPPLY [v]



expected to decline more slowly, and because of assumed lower declines in production. Nevertheless, current developed fields will decline from 59.4 million barrels of oil equivalent (Mboe/day) now to 17.2 Mboe/day by 2040, requiring 34.4-63.1 Mboe/day of new production (Figure 2).

FIGURE 2 REQUIRED NEW GAS SUPPLY [vi]



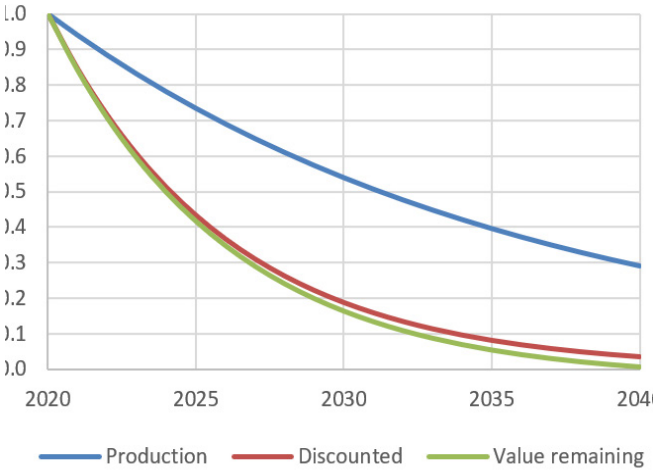
Therefore, peak oil/gas demand or 'stranded assets', do not imply a halt in investment in new production. Investment may indeed be lower than in previous years, causing overcapacity and a reduction in value of drilling rigs, seismic vessels, frac fleets, offshore construction ships, frac sand mines, and all the other associated service industry assets. These, though, tend to have much shorter useful lives than oil- and gas-fields.

The need for new investment shows that it is not true that - as some environmentalists claim - climate policy requires no exploration for new oil and gas. If new reserves are discovered that are lower-cost and/or lower-carbon than existing resources, they can still be developed while the disadvantaged assets remain undeveloped.

THE VALUE OF CURRENT PRODUCTION FALLS OFF QUICKLY

For companies with a relatively short reserves life, the value of current production falls off quickly (Figure 3). Assuming an annual decline of 6%, quite moderate for most IOCs without reinvestment, a production rate of 100 barrels per day in 2020 would fall to 29 bpd by 2040. The value of this production then has to be discounted to allow for the time value of money; assuming a typical 10% annual discount rate, the lower level of production in 2040 is worth only 4% of the 2020 production.

FIGURE 3 DECLINE IN VALUE OF CURRENT PRODUCTION



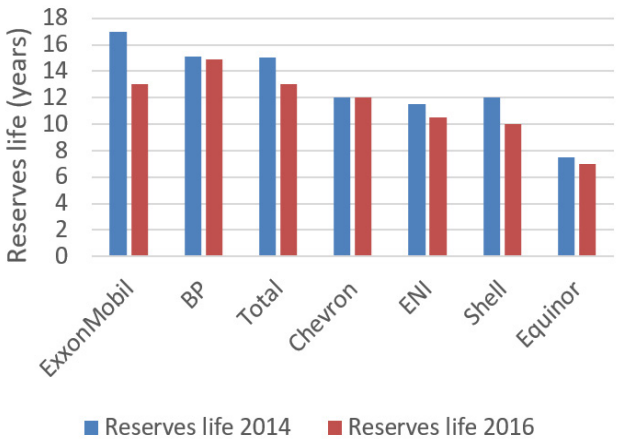
By 2030, only 16% of the asset's original value remains, and by 2040, only 0.6% remains. For shale reserves, with much higher initial declines, even more of the value is compressed into the first two or three years of production.

The major IOCs have relatively short reserves lives (7-15 years), and these have fallen in recent years, because of a turn to shorter-cycle (shale) production; a failure to replace output with new finds; divestment of older fields; and write-downs of reserves that have become uneconomic because of falling prices. The lack of investment in new fields is partly because of low prices, but also, at least in the case of the European IOCs, because of shareholder pressure

THE VALUE OF CURRENT PRODUCTION FALLS OFF QUICKLY

inspired by concerns over 'stranded assets'. By contrast, the major Middle East NOCs have an average reserves life for oil of 60-90 years, well beyond likely estimates for peak oil demand and strong climate policy.

FIGURE 4 RESERVES LIFE OF MAIN IOCS [vii]



Of course, some of the market value of an oil company reflects long-life fixed assets (pipelines, refineries and so on); undeveloped reserves and exploration potential; and future, unspecified, growth. But this does suggest that the major IOCs, and even more the big shale-focused independent firms such as EOG and Occidental, should be able to realise most of their value before strict carbon limits constrain them.

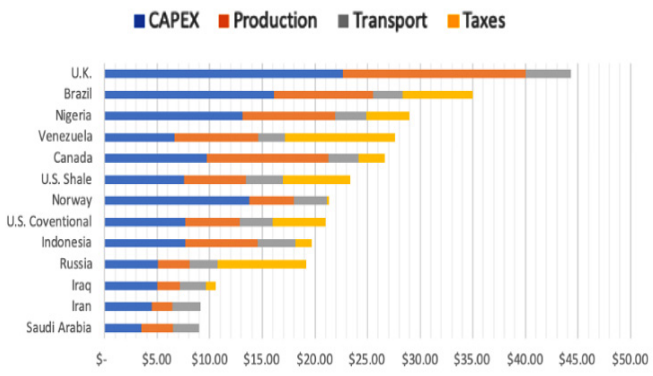
POLICY, COST, AND CARBON WILL DETERMINE 'STRANDED ASSETS'

Coal is the most carbon-intensive fuel and the easiest to replace, and therefore most coal resources should become stranded. Indeed, coal consumption has fallen sharply in the US and Europe over the past decade (mostly due to competition with cheap natural gas and renewables, and to some extent to EU and UK carbon prices) and has plateaued in China. However, coal remains very important for local employment and energy security in China, India and other developing Asian countries, and significant use will continue, reducing the 'carbon space' available for oil and gas.

Given a shrinking demand for oil, it can be expected that prices would tend to fall in the long term (though with possible temporary spikes). Only the most cost-competitive oil resources will be produced. Indeed, some cost-competitive oil may not be produced because of government bans or civil society action such as blocking pipeline construction, particularly in OECD countries.

Production costs vary widely worldwide (Figure 5). These are of course average figures, and individual fields will have a wider range of costs, including very expensive resources with costs of $100 per barrel or more. It can be seen that a significant amount of production 'cost' is actually taxes in countries such as Russia, Venezuela, and Brazil. Production could continue at lower prices, if governments are willing to give up some of their tax take.

FIGURE 5 COST OF OIL PRODUCTION BY COUNTRY [viii]



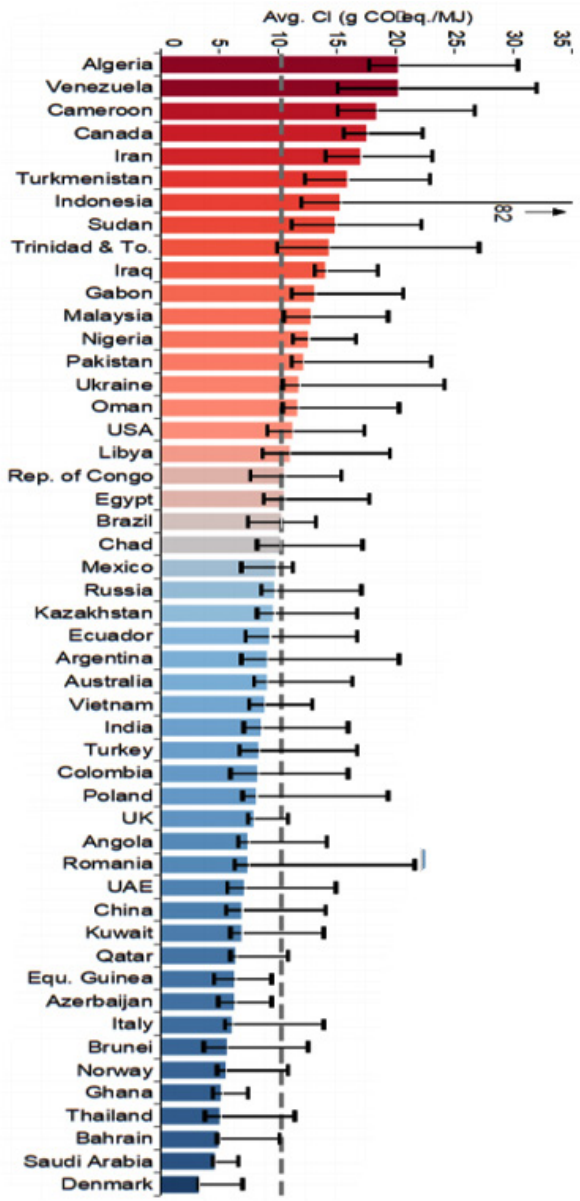
In a world of low oil prices, it would be expected that most production would be from the Middle Eastern countries with low production costs (Saudi Arabia, Iraq, Iran) and Russia. Already-developed fields in countries such as Norway, however, would be able to continue operating.

Resources with higher greenhouse gas emissions would also be disadvantaged. The carbon intensity of upstream assets varies widely (Figure 6) from Denmark (3.3 grams of carbon dioxide equivalent per megajoule (gCO_2e/MJ) to Algeria (20.3 gCO_2e/MJ). The level of intensity is determined by features such as oil and reservoir quality, the natural CO_2 content of the gas, recovery methods (energy-intensive water injection or thermal/steam injection for heavy oil), the amount of flaring, venting and fugitive methane, and the age and energy-efficiency of the facilities. Other facilities, such as LNG liquefaction plants, similarly show a wide range of intensities.

Carbon intensity could affect stranded assets in two ways. Some countries, such as countries within the EU, are moving to ban the use of oil

POLICY, COST, AND CARBON WILL DETERMINE 'STRANDED ASSETS'

FIGURE 6 UPSTREAM OIL CARBON INTENSITY [ix]



and gas with a higher carbon footprint than a certain benchmark. In that case, high-carbon assets inside the EU would presumably be unable to operate, and those outside the EU would have to find other markets. This might be difficult, for instance, for Algeria which is linked to European countries by existing gas pipelines. Similarly, a carbon price may be imposed by an increasing number of countries, raising the effective cost of production.

A carbon tax of $100/tonne would add $2/boe to production costs in Denmark but $12.42/boe to costs in Algeria, thus making high-carbon assets considerably less competitive.

The twelve members of the Oil and Gas Climate Initiative, a group of major IOCs and NOCs, agreed on 16 July 2020 to reduce their upstream oil and gas carbon intensity from 23 kg CO_2 equivalent per barrel of oil equivalent (CO_2e/boe) in 2017 to 20-21 kg CO_2e/boe by 2025 [x]. There has already been a tendency for international firms to sell their Canadian oil sands assets, which are particularly high-carbon, to local specialists, as Shell did to Canadian Natural Resources in 2017 [xi].

An increasing number of major oil companies have committed to net-zero greenhouse gas emissions by some future date. This encompasses Scope 1 (direct emissions from operations), Scope 2 (emissions from purchased electricity), and Scope 3 (emissions when the company's products are used by others). Scope 3 can be further subdivided into emissions from the company's upstream production, and emissions from the products it refines or trades. In the case of refined and traded products, there is obviously the possibility of double-counting.

Oil companies - mostly European ones - have set a range of targets for 'net-zero', mostly by 2050 but with different definitions (Table 1). Some of these are expressed in 'intensity', ie greenhouse gas emissions per unit of energy. Intensity can be reduced by shifting from oil to gas, and from hydrocarbons to renewables. A few of the announcements contain intermediate targets, but they have been criticised for being long-term aspirations well beyond the tenure of current management and boards.

TABLE 1 OIL COMPANIES' NET-ZERO TARGETS [xii]

Company	Scope 1 & 2	Scope 3 own production	Scope 3 3rd party
Repsol	0 by 2050		
ENI	Net zero upstream by 2030; net zero all activities by 2040	80% reduction by 2050	
Shell	Intensity -65% by 2050 + full offsets		
Total	0 by 2050	Europe 0 by 2050 Intensity -60% by 2050	
BP	0 by 2050		Intensity -50% by 2050
Equinor	Carbon neutral by 2030 Net zero by 2050	-50% intensity by 2050	

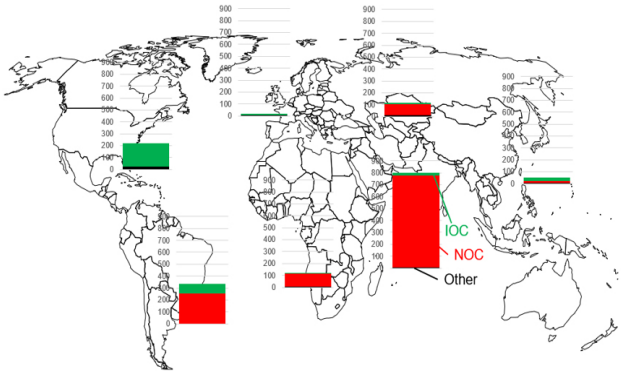
Net-zero for Scope 1 and Scope 2 should be relatively feasible to reach by improving energy efficiency, implementing CCUS, bringing onshore power to offshore installations, and using zero-carbon energy for operations. Scope 3 is not under the oil companies' direct control and cannot be net-zero as long as they continue to sell oil and gas, unless it is all consumed with non-emitting uses (see below) or is fully offset.

Offsets include the direct drawdown of carbon dioxide from the atmosphere, either via trees and other plants; by enhanced mineral weathering [xiii]; or by 'direct air capture' (DAC), ie technological means to remove atmospheric CO_2. These have likely 'costs' at large scale of \$100-200/tonne of CO_2, although cheaper for some reforestation projects. They are therefore only suitable for high value uses of oil and gas, such as aviation and some industrial processes, that cannot easily be decarbonised.

MOST RESERVES ARE HELD BY STATE-OWNED, NOT INVESTOR-OWNED, COMPANIES

The large majority of oil and gas reserves are held by NOCs such as Petróleos de Venezuela SA, Gazprom, Saudi Aramco and Qatar Petroleum, not international oil companies such as Shell, ExxonMobil and BP (Figure 7). NOCs and Sovereign Wealth Funds (SWFs) hold about 75% of world oil reserves, larger IOCs hold just 4%, and others (mostly smaller companies) 21%. This disparity is most pronounced in the Middle East, but only in North America, Asia-Pacific and Europe (which has very small remaining reserves) do NOCs have less than ¾ of the reserves.

FIGURE 7 SHARE OF OIL RESERVES, BY REGION AND COMPANY TYPE [xiv]



The same holds for coal reserves, which are mostly state-owned in China and India. Some NOCs are listed, such as Saudi Aramco, Petrobras (Brazil) or Equinor (Norway), or have publicly traded debt such as Petróleos Mexicanos (Pemex), but with the exception of Aramco (which only has 1.5% listed), these tend to be firms with smaller reserves.

Even in the case of IOC-held reserves, the bulk of the value usually accrues to the host government via taxation, production shares and direct equity stakes.

Governments will probably not voluntarily give up the value of their major assets. Therefore 'stranded assets' in leading oil and gas producers will only likely occur either because of limits on fossil fuel imports or use in big consuming countries, or because advances in other technologies make some oil and gas resources uneconomic (ie prices fall below production costs).

However, this does suggest that 'stranded assets' are more of a problem for governments and their NOCs than for IOCs. IOCs can, over time, shift into less carbon-intensive resources, and into zero-carbon energy sources. Or, they can gradually liquidate their reserves and return cash to shareholders. NOCs largely have to work with the reserves they have been given.

NOT ALL FOSSIL FUELS ARE COMBUSTED OR CREATE EMISSIONS IN USE

To the extent that fossil fuels are used to make methanol as a fuel, urea as fertiliser, or biodegradable plastics - or plastics which are then burnt as waste - they still create emissions down the value chain. Fossil fuels that make long-lived plastics or other materials do not contribute to carbon dioxide emissions, at least not for an extended period.

This partly explains the turn by many major oil companies towards petrochemicals, particularly an NOC with a long reserves life such as Saudi Aramco and Abu Dhabi National Oil Company (ADNOC). This includes the direct production of chemicals from crude oil, minimising the output of fuels.

Fossil fuels which are burnt with CCUS, similarly do not produce emissions as long as the captured CO_2 is secured. Natural gas that is used to produce hydrogen with CCUS, or that is used in power plants or industry with

CCUS, does not face the risk of stranding, as long as it remains economically competitive with alternatives such as renewable-generated hydrogen.

Finally, resources whose emissions are fully and verifiably offset should also not be stranded, as long as the cost of those offsets does not make them uneconomic.

TO SOME EXTENT, STRANDED ASSETS CAN BE REPURPOSED

Although climate policy and economics may limit the use of reserves of oil and gas, other petroleum assets can be repurposed. For instance, gas pipelines and distribution networks can carry hydrogen, with some adaptations. In July 2020, a consortium of European gas infrastructure companies released a plan showing development of a hydrogen network. By 2040, this would consist of 23,000 km of pipelines, of which 75% would be converted natural gas pipelines and only 25% would be new construction [xv].

Similarly, refineries can be adapted into biofuel or synthetic fuel plants, and LNG terminals could possibly be retrofitted to export hydrogen. Offshore oil platforms can be used as hubs for offshore wind electricity transmission or hydrogen production.

A fully developed CCUS industry would also make extensive use of existing oil and gas installations, particularly well-characterised depleted oil and gas fields and other suitable subsurface storage locations, as well as seismic, drilling rigs and other service equipment. The geothermal industry also uses drilling and other subsurface technologies.

CONCLUSIONS

Strict climate policy and the increasing competitiveness of non-oil/gas technologies will limit production and prices, likely by 2030 if not before. This could lead to high-cost/high-carbon assets becoming 'stranded', particularly if regions such as the EU impose carbon border tariffs or outright bans on high-carbon imports.

The strategic responses are different between IOCs and NOCs. IOCs can (and are) shifting to shorter-cycle production, lower carbon fields, oil to gas, and fossil fuels to renewables. NOCs need to reduce their upstream carbon intensity, but they have relatively little flexibility within their asset base. However, if traditional investors leave the petroleum sector, NOCs and SWFs may find opportunities for value-creating investments outside their home country. NOCs should also consider raising production, even at the cost of lowering prices, to squeeze out higher-cost competitors and ensure they maximise their revenues over the long term.

Governments can reduce their exposure to the petroleum sector by (part)-privatising their NOCs, as Norway, Brazil, Russia, China and Saudi Arabia have already done, to varying degrees. Or, they can monetise assets by selling minority stakes to investors.

However, in the longer term, to limit the risk of stranded assets, all companies – but especially NOCs – will have to invest in non-emitting technologies. That includes producing materials (such as long-lived petrochemicals) from oil and gas; manufacturing hydrogen or combusting natural gas for power with CCUS; and investing in offset approaches. Net zero will be required for all fossil fuel companies, by 2050 and probably earlier for many. That requires a strategy and major investments to be starting today.

APPENDIX

i. From data in BP Statistical Review of World Energy 2020, IPCC https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf
ii. https://climateactiontracker.org/publications/governments-still-not-acting-on-climate-crisis/
iii. https://www.abhafoundation.org/media-uploads/reports/Research_Series_Issue_40_12_2019-print.pdf
iv. https://www.abhafoundation.org/media-uploads/reports/Research-Series-isssu-29-01-2019-JANUARY-FOR-PRINT.pdf
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x. https://www.worldoil.com//news/2020/7/16/aramco-and-exxon-join-other-oil-companies-by-adding-carbon-targets?id=1757595
xi. https://www.reuters.com/article/us-shell-divestiture-cdn-natural-rsc/shell-sells-canadian-oil-sands-ties-bonuses-to-emissions-cuts-idUSKBN16G0PH
xii. Company statements, https://www.worldoil.com/news/2020/5/12/supermajors-all-have-ambitious-and-widely-varying-net-zero-goals#:~:text=Repsol%20will%20cut%20Scope%203,extracts%20to%20zero%20by%202050.&text=Shell%20will%20cut%20the%20carbon,the%20emissions%20for%20the%20customers.
xiii. https://www.nature.com/articles/s41586-020-2448-9.epdf?sharing_token=cDffHX4XU2pnleM5j2TsQdRgN-0jAjWel9jnR3ZoTv0OtB5LS5Y5Cwumoumb5Vs9p-GQp7NWqtO_367vUmB4Gw5Yqpe4ZJ57A4gxt5ZO6De-JIyAh9jOguTuTo3oTbzWXJqwU-XR8dov5uDAbB7I-Yudc7a9crIY-JcUKnbz11SVN-_Cs_Au95Ke29WMRdSg-B8ZiPw5hHPLLdzAflXObZHGcC_G-Scvbu25Vw7DV-3tUIrmmo-Ak8Sg3Fsl8hi3KAz3JRwzUXFqeJmSfEgP-wzF26FK4J5f_FaeAniF99gi-rjlhOEQ2KcbqFBlrdcqC1yC-m2Q5Y-7_qXpEX-1AzguUWAvQpuCGx5gKy5VOaROiB-HtrcUr81pfjeguTWTEYElPm4kH0Y_xbQverhPYenapV-viLmuYOkulFTyYizdhSFFApGwujrsO2CtBn31lawwXsX-WN4Zu0s-CZdhMzubZr8hl96538Dhc1lsKBm4zekgiSC1m-bavnUgO2_xQR2qmYes1n1t&tracking_referrer=www.newscientist.com
xiv. From data in https://www.eni.com/assets/documents/documents-en/WORLD-OIL-REVIEW-2019-Volume-1.pdf
xv. https://fuelcellsworks.com/news/snam-gas-infrastructure-companies-present-a-european-hydrogen-backbone-plan/

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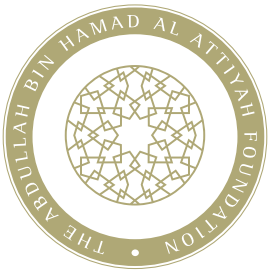

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