

center for
ENERGY STUDIES

Rice University's Baker Institute for Public Policy

Climate change, the energy sector, and financial risk

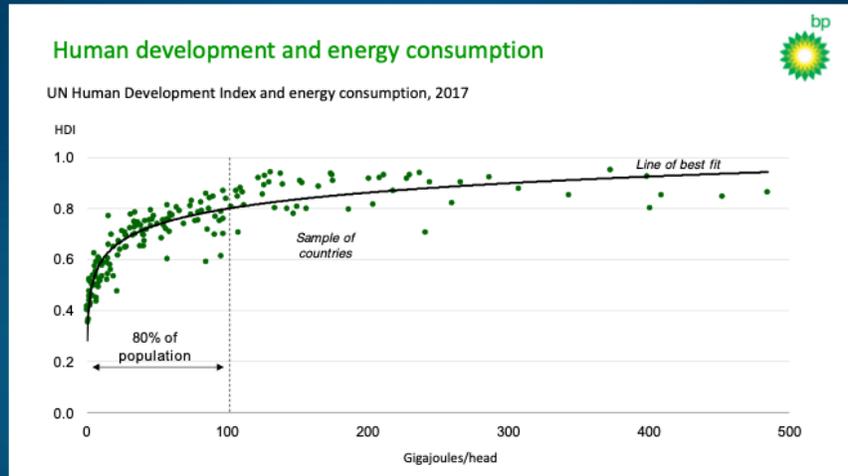
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Amid growing pressure from governments, investors, and consumers around the world, IOCs (international oil companies) – and increasingly large US independents – believe in the science of climate change and the need to address it. Moreover, there has been a significant acceleration over the past year in both public discussion of this issue and oil & gas industry engagement.

This presentation assesses oil & gas industry views on the challenge facing the industry as well as broader macro/financial risks stemming from both a changing climate and from efforts to address climate change. I'll demonstrate those views by citing outlooks from the International Energy Agency as well as two IOCs, ExxonMobil and BP.

Quality of life and access to energy



Source: BP (2019)

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First some context. Access to energy is fundamental to human well-being. This chart shows the strong relationship between per-capita energy consumption and quality of life (as measured by the UN's Human Development Index).

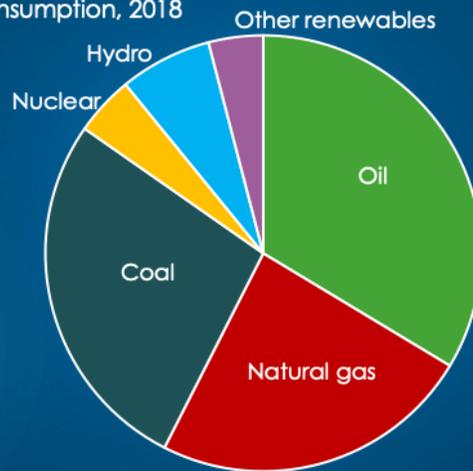
While countries at the far right of the chart (including the US) are at a point of their development where increased energy use no longer correlates with increased quality of life, 80% of the world's population is to the left of the curve—in the zone where access to energy and quality of life as highly correlated.

While access to energy is taken for granted in wealthier countries (including the US), we need to always keep in mind that the vast majority of the world's population is not in that position. This is the "dual challenge" referred to by many in the industry: the pressing need to expand access to energy to improve the quality of life, while also changing the energy system to reduce CO2 emissions.

Today, fossil fuels dominate



World energy consumption, 2018



Source: BP (2019)

And of course the reality of the energy system today is that fossil fuels dominate—accounting for nearly 85% of global commercial energy consumption. Even though they have been growing rapidly this millennium, non-hydro renewables—including wind and solar energy, the energy forms most in focus for the transition to a lower-carbon energy future—account for about 4% of global energy consumption today.

Risks to companies



- ▶ Lower demand (and lower prices) for current products
 - ▶ Timing of transition
 - ▶ Role of oil & gas
- ▶ License to operate
- ▶ Stranded assets?
- ▶ Investor pressures
 - ▶ Equity markets, lenders and insurers increasingly discounting more aggressive climate scenarios
- ▶ For financial sector: Exposure to fossil energy firms
 - ▶ BoE proposed climate stress tests

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So as we embark on a major push to re-make the global energy system, what risks does the oil & gas industry see?

Most importantly, the risk of lower demand (and lower prices) for the oil & gas that are the industry's focus today. As we will see, there are massive uncertainties about the timing of the energy transition, and of the future role of oil & gas in the global energy system (even under a transition to a lower-carbon future).

Moreover, with public opposition to fossil fuels growing in many countries, companies increasingly must engage in discussion of, and planning for, the energy transition as part of their public license to operate.

Much public discussion recently has focused on the risk to the industry of stranded assets in the face of a potentially-rapid transition. More on this later.

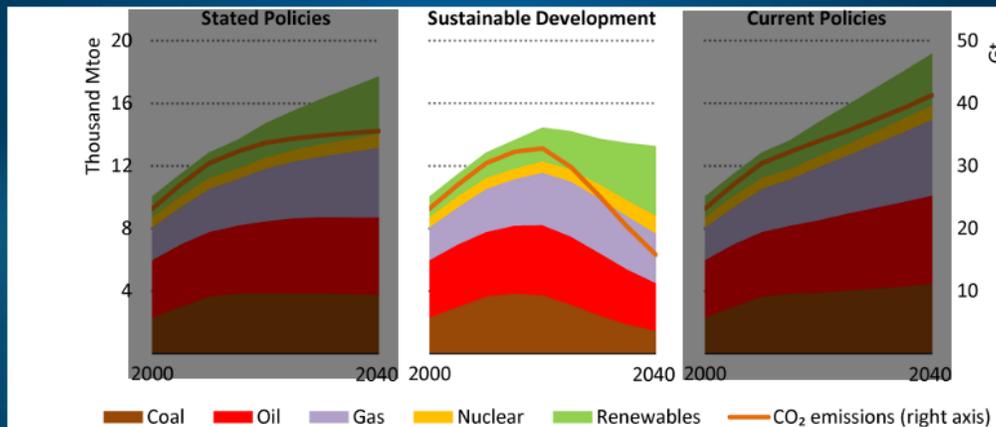
In addition to pressure from citizens and governments, the oil & gas industry also faces growing financial pressures from ESG (environmental, social, and governance) investors,

lenders, and insurers. Financial players are increasingly incorporating rapid energy transition into their frameworks for evaluating current investments.

More broadly for the financial sector, regulators including central banks are increasingly assessing the systemic risks of climate change and an energy transition. The Bank of England's December discussion paper on 'proposals for stress testing the financial stability implications of climate change' is a recent example.

Risks to fossil fuel demand

International Energy Agency Sustainable Development Scenario



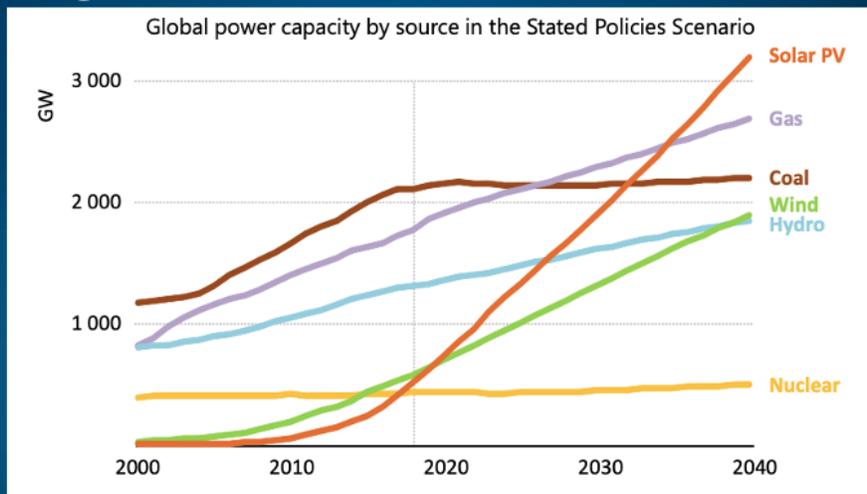
Source: IEA WEO 2019

Let's focus on just a couple of those risks.

First, the risk of lower demand. This chart (focus on the center panel) shows the evolution of the world's energy demand under the International Energy Agency's "Sustainable Development Scenario". This case is consistent with meeting all of the UN's sustainable development objectives, including a sharp reduction in CO2 emissions.

In that case, global oil consumption falls from about 100 million barrels per day (Mb/d) currently to about 60 Mb/d by 2040...a massive reduction in demand in a relatively short time period.

Rapid growth of renewables...



Source: IEA WEO 2019

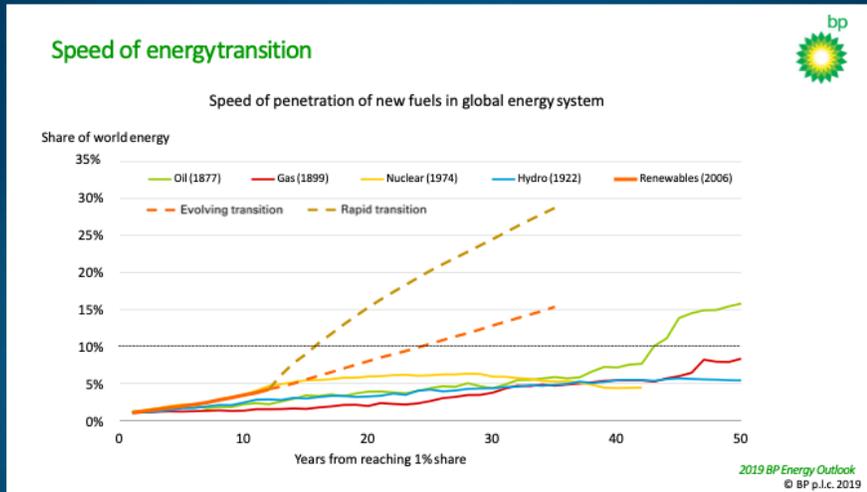
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Part of the decline in fossil fuel consumption in aggressive transition scenarios like the IEA's SDS is from improved efficiency...but much of it is from substitution of renewable energy.

And it's not only a matter of a rapid transition scenario. This chart shows the rapid growth of renewables for power generation in the IEA's LESS aggressive transition—the Stated Policies Scenario, which at a global level only succeeds in stabilizing CO₂ emissions (rather than reducing them sharply in the SDS).

Even here, renewables – especially solar power– displace coal and natural gas as the largest input to power generation in the world.

...but transitions take time



Source: BP 2019

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Given expectations of dramatic increases in the use of renewables, it is important to reflect on the pace of previous evolutions of the energy system.

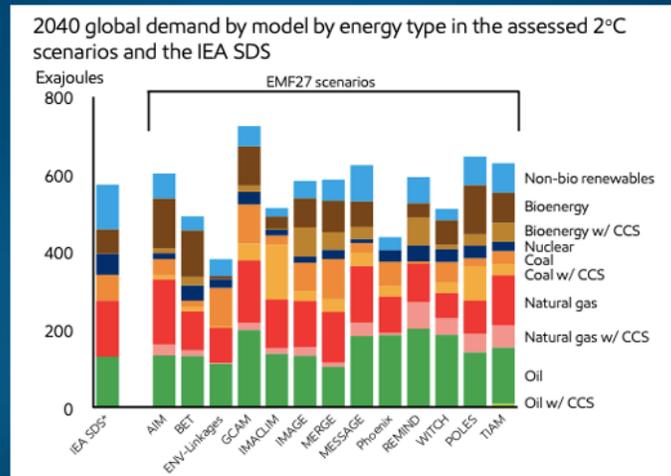
This chart shows the time (in years) needed for new forms of energy to grow in the global energy system. The year next to each fuel in the legend represents the year in which that fuel reached one percent of total world energy consumption. And you can see that, in the history of the world energy system until now, no energy form has reached 10% of the global mix WITHIN 40 YEARS of its introduction.

Instructively, the fastest-growing energy source in history was oil: You can see the quick jump in oil's market share between years 40 and 50 on the chart—corresponding to the years 1917-27. During that period the rapid growth of oil was driven by a combination of factors including massive discoveries in Texas and the Middle East; the rapid growth of the personal automobile fleet; and strategic choices such as the British navy's shift from coal to oil in its fleet. This demonstrates the range of economic incentives, technological innovations, and political choices needed to drive change in the global energy system.

Compare that with today's experience with renewables, which (so far) have gained market share in the world energy system faster than any other energy form—mirroring the rapid (early) growth of nuclear power in the 1970s and early 1980s. For renewables to grow in a manner consistent with a rapid transition to a lower carbon future (at least in this BP scenario), renewables would need to reach about 30% of global energy use within the next 20 years...a change that is unprecedented in the history of the world energy system.

Oil and gas in successful transitions

Range of 2-degree scenarios



Source: Exxon Mobil 2019 based on Stanford EMF

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With the prospect of – or aspiration for – rapid growth of renewables, what does the future hold for oil & gas?

This chart shows a range of outcomes for the world energy system in 2040 under relatively SUCCESSFUL transitions (those putting the world on a trajectory to limit the increase in global temperatures to 2 degrees Celsius), under a study organized by Stanford University's Energy Modeling Forum.

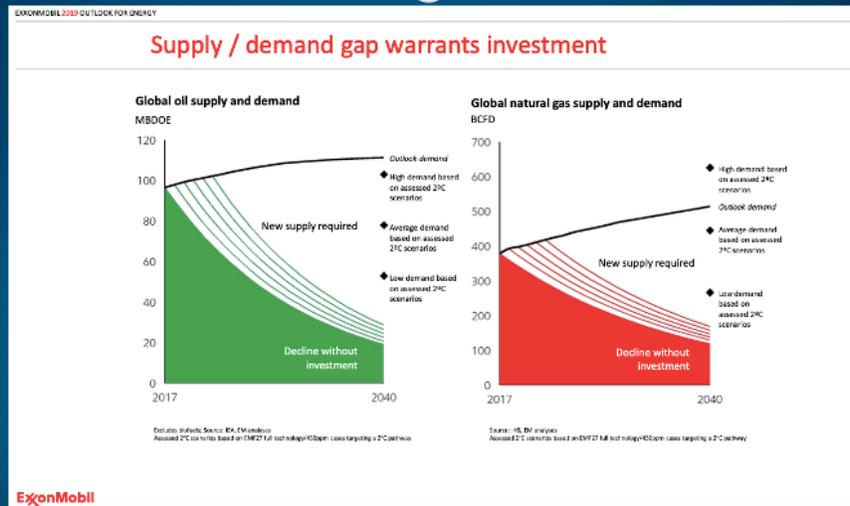
While the range of potential outcomes is quite wide, there is significant agreement between independent energy modelers that oil & gas – complemented by carbon capture & storage (CCS) – can continue to play a significant role in the future energy system. On average, these scenarios show oil & gas accounting for very roughly about 40% of global energy use by 2040 in these successful transition cases (down from just under 60% today).

An important caveat: I noted earlier that public discussion is moving rapidly. These scenarios were based on the original IPCC target of limiting the increase in

temperatures to 2 degrees Celsius. More recent public discussion has seen the emergence of an even more aggressive aspiration: of Net Zero emissions by 2050. It is not my purpose here to comment on the probability of any particular scenario being realized!

- Because the Net Zero by 2050 scenario has emerged relatively recently as an aspiration in the global climate discussion, as of this writing, the industry and other analysts of the global energy system have not yet produced scenarios consistent with this more aggressive trajectory.
- Obviously the implications for the future role of oil & gas in the world energy system will be more constrained in more aggressive transitions.

Need continued oil/gas investment



Source: ExxonMobil (2019)

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This chart shows that, with no future investment in new oil & gas production, the current global base level of supply would decline significantly. The IEA estimates that global oil production would decline by 8% annually with no new investment (and by about 4.5% annually with no investment in new fields but with continued investment in existing fields).

The various lines show declines from different points in time, based on different scenarios for when investment stops. The dots on the right of each chart show the range of demand outcomes under the 2-degree scenarios discussed on the previous chart. Since the lowest demand outcome in 2040 is still higher than the investment-constrained supply outcomes, the bottom line is that NEW investment in oil & gas supply is needed even in scenarios of a successful (2-degree) transition.

Once again with the caveat that the decline in global oil & gas demand under the more aggressive Net Zero by 2050 scenarios hasn't yet been modeled, and this conclusion (of future investment being needed in new oil & gas supply even in a successful transition) may no longer hold in the most aggressive transitions scenarios.

How energy firms are responding

- ▶ Seeking policy/regulatory clarity
- ▶ Scenarios for strategic planning in face of uncertainty
- ▶ Greater disclosure/transparency re: risks and planning
- ▶ Hardening facilities to more extreme climate (adaptation)
- ▶ Wide variety of strategic responses (partial list; not mutually exclusive!)
 - ▶ Wait for clarity (re: policy, cost/scalability/profitability of alternatives)
 - ▶ Move from oil to natural gas
 - ▶ Focus on high-margin, quick turnaround resources
 - ▶ Diversify—wind, H₂, bioenergy, power, EV charging, recycling
 - ▶ Return cash to shareholders via buybacks/dividends

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So how is the oil & gas industry responding to the prospect of a rapid change in the global energy system?

This list is not exhaustive (and not mutually exclusive). But it demonstrates that the industry is playing both offense and defense—for example, investing in renewables while hardening existing facilities to withstand stronger storms & higher sea levels.

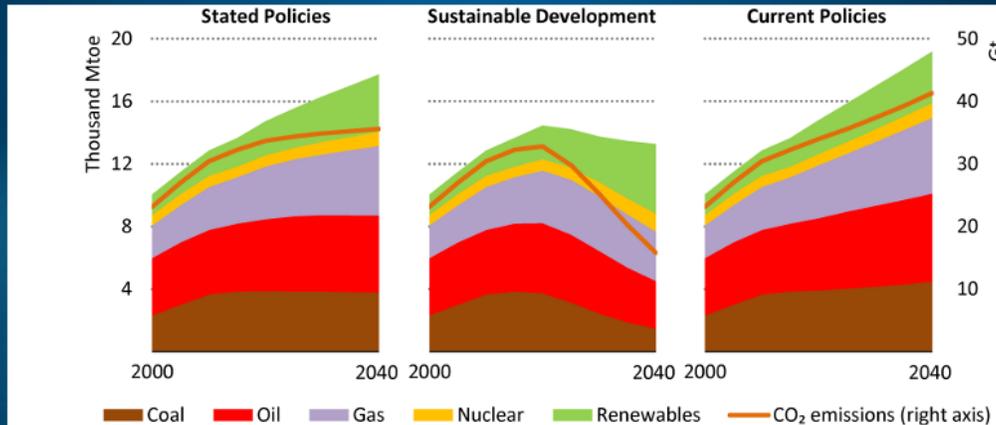
Until very recently, companies expected that change would come slowly to the energy system (see slide 7): Through their large annual capex and depreciation of existing capital stock, they'd have time to evolve along with the energy system. Accordingly there was a sense that the risk of stranded (undepreciated) assets was manageable.

But again: The emergence of the more aggressive Net Zero by 2050 aspiration – the potential for an even more rapid transition of the global energy system – is causing companies to rethink their approach. We've seen more aggressive transition strategies announced over the past year or so, especially by European companies including Shell, Repsol, Equinor, Total and most recently BP.

Seeking policy clarity



International Energy Agency World Energy Outlook 2019 scenarios



Source: IEA WEO 2019

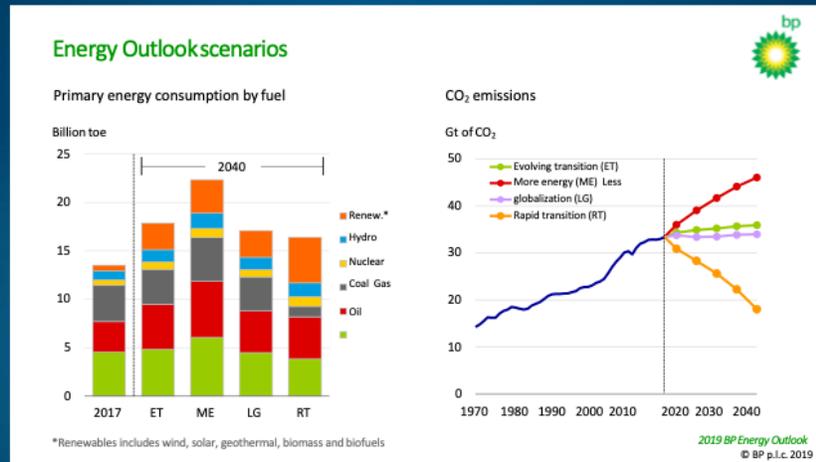
A bit of elaboration on a few of the themes raised on the previous slide.

One constant refrain from the oil & gas industry has been for greater policy clarity.

This chart (a repeat of slide 5) shows the IEA's three scenarios. For here, focus on the center & right hand panels. We've already discussed the center panel, which shows global energy demand under the IEA's Sustainable Development Scenario. The right hand panel shows the Current Policies scenario—in other words, a business as usual case based on policies that are on the books today.

As mentioned earlier, global oil demand in the SDS falls from about 100 Mb/d today to about 60 Mb/d. In the Current Policies scenario, oil demand rises to about 120 Mb/d. In other words, the high-low range between these two scenarios for oil demand in 20 years is 100%! This highlights the difficulties companies face in planning – and investing – for the future. And given the long lead times with investments in oil and gas, and the long economic lives of company assets, this helps to explain why companies are begging for greater policy clarity.

Scenarios for strategic planning



Source: BP 2019

And given the huge uncertainties facing these companies and the markets they serve, companies are increasingly moving to scenario-based approaches to inform their strategic thinking and investing...and in their communication!

Macro risks



- ▶ Macro risks from climate change itself
- ▶ Availability of energy for economic growth
 - ▶ Risk of price spikes without sufficient investment
- ▶ Sovereign risk for fossil fuel-dependent producers
- ▶ Exposure of banks/financial services firms to fossil fuel industry

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Stepping away from the industry, let's conclude with some thoughts on the potential for broader risks to the global economic and financial systems.

Most importantly, obviously, is the risk of climate change itself to future economic growth, and to the financial system. Many analysts have begun to assess the implications of warmer temperatures, more extreme weather events, and rising sea levels: This is not my area of expertise and I'll leave it for others to explain.

Recall my earlier slide showing the strong relationship between access to energy and quality of life. Considering the massive range of potential outcomes and the long investment cycles in the global energy industry, there is a considerable risk that industry may not be able to "thread the needle"—investing precisely in the right forms of energy at the right times and in the right quantities.

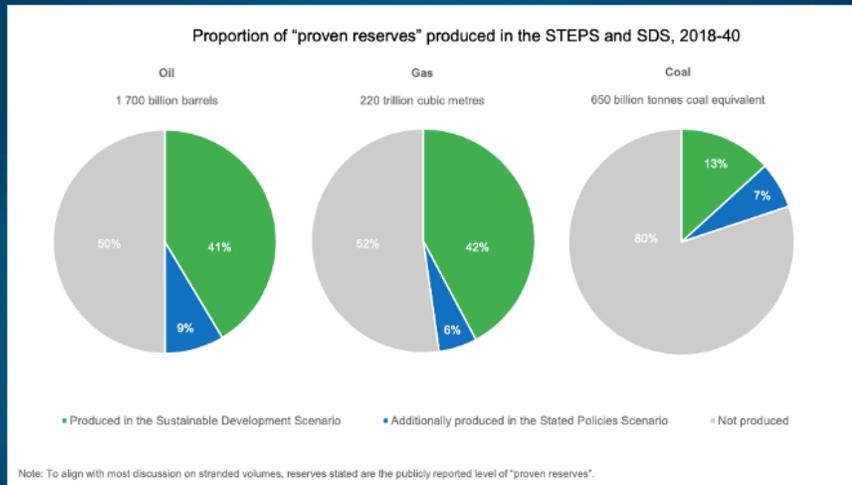
- For example, if the industry dramatically slows its investments in oil & gas, and renewables fail to scale up rapidly (remember slide 7), there is a risk of sharp energy price increases. And this could pose significant adverse risks to the global macroeconomy and financial system.

In contrast, a rapid transition away from fossil fuels could pose substantial risks to the economies and government revenues for resource-rich economies.

- ..and a risk of economic distortions for countries rich in resources for the energy transition, such as Cobalt, Nickel, and other metals used in making batteries.

Finally, for financial markets and their regulators, a key area of concern is the exposure to the fossil fuel industry & potential losses stemming from a rapid transition away from fossil fuels.

Stranded assets: Carbon “budget”

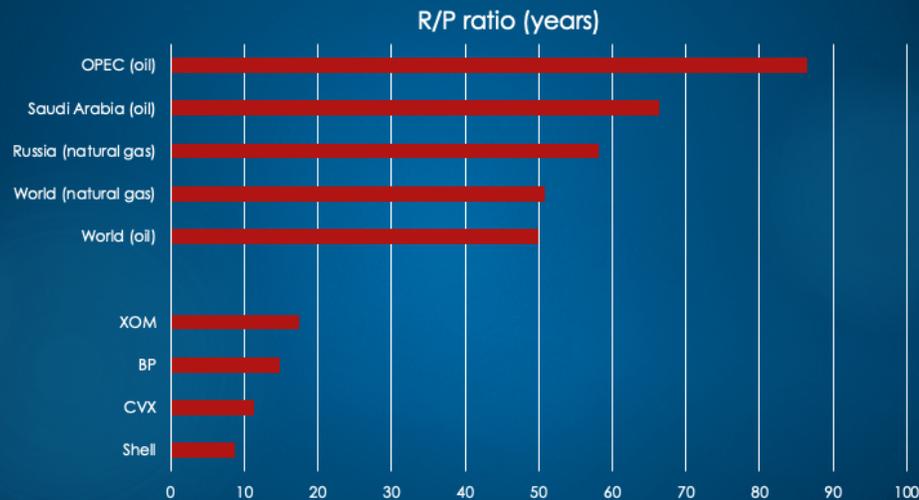


Source: IEA 2020

Some elaboration on the “stranded assets” theme.

This chart shows the IEA’s estimate of the share of current fossil fuel proved reserves that would be produced under various scenarios. In their most aggressive transition scenario (the SDS), only about 40% of current global oil & gas reserves – and less than 15% of coal reserves – would be produced by 2040. In other words, a majority of current fossil fuel reserves risk being ‘left in the ground’ in more aggressive transition scenarios.

Whose stranded assets?



Source: BP 2019 and company reports

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But let's look more closely at proved reserves. This chart shows current proved reserves relative to current production, expressed in years.

It shows that the IOCs have proved reserves-to-production ratios of 10-15 years. That makes business sense: Those are reserves sufficient to keep the pipeline of future projects full over a meaningful business horizon, with 'meaningful' driven by the lead times needed to bring new projects online.

Meanwhile, the world as a whole has about 40 years' worth of proved reserves of oil & gas. And for some large resource holders (Russia for natural gas; Saudi Arabia & total OPEC for oil) that ratio is even bigger.

So if the question is which reserves risk being 'left in the ground' as the world transitions away from fossil fuels, the large sovereign resource holders would appear to be prime candidates. Of course, this ignores the vastly different economics of global proved reserves. Saudi crude oil production is very low-cost (and has a low carbon intensity of production). But it does raise the question of the sustainability of the

current situation: In a carbon-constrained future, holders of large, low-cost fossil fuel reserves should make efforts to monetize their resources by out-competing other suppliers and grow their market share.

But that is not what is happening today. OPEC and certain cooperating non-OPEC countries (including Russia) have been cutting oil production in an effort to support prices—an indication that their current dependence on oil revenues is outweighing the risk posed by a rapid energy transition. At the same time, however, countries like Saudi Arabia are also trying to reform their economies and government fiscal systems to reduce their dependence on fossil fuel revenues. If successful, this could position them to change strategy in the future to grow market share and live with lower prices in an effort to monetize their fossil fuel resources. But much depends on the success of those reforms, illustrating the potential for sovereign risks in a rapid energy transition.

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