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Perspective

What if we never run out of oil? From certainty of “peak oil” to “peak demand”

Krista Halttunen *, Raphael Slade, Iain Staffell

Centre for Environmental Policy, Imperial College London, SW71NE, UK

ARTICLE INFO

Keywords:
Oil industry
Oil demand
Energy transition
COVID-19

ABSTRACT

The COVID-19 pandemic sent the oil industry into turmoil on a scale not seen since the 1970s. While the sector appears to be recovering, questions remain about the extent to which the pandemic has offered a glimpse into the possible future of the industry. This future is critical to the success of climate change mitigation, which requires significant cuts to the carbon dioxide emissions from using oil for energy. Therefore, it makes sense to consider future scenarios in which global oil demand peaks and then declines alongside scenarios of continued demand growth. This is a significant departure from historical development of oil demand and the dominant discussion of many decades about “peak oil” and the fear of demand outstripping readily available supply. The implications of peaking oil demand would be massive, not only for the oil industry but also for society as whole. There is not enough understanding of what the impacts would be, or how to prepare for them. The research community needs to take a clear-eyed view of potential futures of oil, which includes considering scenarios in which demand goes into long-term decline.

1. 2020: A difficult year for the oil industry

2020 was not an easy year for the global oil industry. Even for a sector used to uncertainty, price volatility and vulnerability to political events around the world, collapsing demand and negative prices are out of the ordinary [1]. The oil industry seems to have weathered the crisis, with key financial indicators rising again in 2021 [2]. So, was 2020 just another unfortunate glitch on the industry’s journey on the path of growing oil demand? Can anything be learned from the impacts of the pandemic on the global oil sector so far?

The crisis has affected oil companies’ finances. The market capitalisations, revenues and profits of prominent international and national oil companies from 2005 to 2020 are shown in yellow and orange in Fig. 1. While the market value and financial performance of these companies have been cyclical over the 15-year period, the impacts of 2020 have been severe. For comparison, a selection of renewables and utilities (shown in green) have remained steady. Their market capitalisations, which represent market value and investor confidence, even increased in the pandemic, as the general economic slowdown led investors to the stock markets.

2. Peak oil and climate change, the great oil debates

The modern oil industry has been characterised by strong growth and prosperity, with demand increasing in 50 of the 61 years since 1960 [4]. While the market has been volatile, the overall production trend has always been comfortably upwards. The mindset of many people working in and around the industry has rightly been that of optimism and growth: there will be hard times, but the world will always need more oil, and companies that weather the storms stand to make a lot of money in the long run [5].

The key historical concern around oil has been availability: what happens when global oil supplies are insufficient to meet the world’s needs [6-11]? In 2010, an in-depth review of over 500 studies concluded that the global peak in oil supply was likely to take place before 2030, and possibly even before 2020 [12]. But the worries about reaching “peak oil” have been unfounded so far. The peak in the supply of conventional oil may already have been reached in some parts of the world [13,14], but technological advances and discoveries of new types of oil reserves have made up for production losses elsewhere [15].

The problem seems not to be that we cannot continue using oil, but that perhaps we should not. Humanity’s use of oil emits 12.5 gigatonnes of carbon dioxide into the atmosphere annually [16], directly...
contributing to anthropogenic climate change. There are many compelling developmental and economic reasons to continue to use oil; but from the perspective of climate mitigation, it is clear that the only way to stand a chance of avoiding disastrous climate change is to ramp down these emissions rapidly over the next decades [17,18].

Even though political leaders have expressed intentions to curb climate change [19] we cannot necessarily expect a complete overhaul of our fossil-based economy and energy system. The growth of carbon emissions has thus far seemed unaffected by climate pledges [16]. History shows that energy transitions, large scale shifts in the production and use of energy, tend to be extremely slow [20,21]. For example, it took the US half a century to transition from wood to coal, and another half-century to transition from coal towards gas and oil, despite each transition unlocking vastly superior energy services [22,23]. There seem to be good reasons to believe that the oil industry can continue “business as usual” for years to come, while perhaps slowly diversifying to new business areas alongside the fossil-based core business.

The counterargument is that change is essential to meet governments’ commitments to tackle climate change and achieve net-zero emissions. A sustained reduction in oil demand in the near future may seem extremely unlikely. But as such a scenario is part of the discussion, included in the scenarios assessed by the Intergovernmental Panel on Climate Change and those produced by many oil companies themselves [24,25], it is certainly prudent to consider what its implications might be.

3. Growing uncertainty about the future of oil demand

Are the scenarios in which global oil demand falls consistently and rapidly realistic? It might seem implausible, given the trajectory over the past century and continued optimism from some oil companies. The targets of the Paris Agreement are just that – targets. If this is the case, the potential implications is merely a theoretical exercise, and we would do better continuing to worry about peak oil rather than peak oil demand.

That said, the conversation has recently shifted, especially around the economics of oil production [26]. The debate is now increasingly around the uncertain timing of the transition away from oil, the proponents of this “peak oil demand” view including academics [27–29] as well as representatives of oil companies themselves [26,30,31]. Even the International Energy Agency (IEA) write in the 2021 version of the World Energy Outlook: “Oil demand, for the first time, shows an eventual decline in all scenarios” [32]. This acknowledgement that the oil market may one day be characterised by abundance rather than scarcity is a paradigm shift [33], a fundamental change in our understanding of the world.

Fig. 2 shows that the projected dates of “peak oil demand” vary significantly between recent scenarios from energy agencies and oil companies. Depicted in the larger figure, many scenarios have the demand peak either in the past or in the far future that goes beyond the projection horizon. Several organisations cover both extremes by presenting at least two scenarios, one aspirational climate mitigation scenario and another business-as-usual one. Notably, OPEC and ExxonMobil present only one scenario each, with the demand peak in the far future in both cases. Conversely, even the business-as-usual scenario from BP sees oil demand peaking before 2030.

The reason for the shift in what is considered plausible in public discussion is the growing prevalence of climate change concerns. The smaller panel in Fig. 2 shows that limiting global temperature rise to below 1.5 degrees requires the peak in oil production to have occurred already, while staying below two degrees necessitates a peak by 2027. Only scenarios associated with higher than 4 degrees of global warming are consistent with a peak in oil production occurring after 2050. Between 2020 and 2070, the total oil consumption in scenarios consistent with less than 1.5 degrees of warming is only half of what it is in scenarios of 4 degrees or more.

Oil companies and oil producing nations make production decisions primarily based on economics – how much money can be made by continued oil production. This, in turn, is affected by changes in the cost and availability of alternative technologies as well as the state of the global economy, policy decisions, public opinion, and the “license to operate” of oil companies in a warming world [43]. For example, the rise of electric vehicles over the 2010s has made them seem a viable alternative to petrol cars for many applications [44].

Fig. 3 highlights clear differences between oil and renewable energy in terms of growth in consumption and price trends. The chart on the left demonstrates that while oil still clearly dominates the energy mix, the trajectories of oil, wind, and solar energy are completely different. The
figure on the right shows that following rapid declines in cost, renewable electricity can now be bought at nearly a price comparable to that of oil. This is a very recent change and an economic enabler of a potential future energy transition. Of course, the oil, wind and solar energy are completely different in their applications, availability, and exergetic properties, and therefore not directly interchangeable in the energy system. In particular, regional variations in wind speeds and solar insolation and their intermittency present challenges for energy systems integration [45–47].

There is no denying that historically, global energy transitions have taken a long time, or that oil is highly unlikely to disappear from the energy system overnight. However, there are also examples of rapid
4. What would a low-demand future look like?

A sustained fall in the global demand for oil would have huge repercussions. Lower demand would necessitate lower production, and arguably the most powerful industry in the world would likely shrink along with the market for its core product. A quarter of all equity in the world’s financial markets corresponds to fossil fuel production [53]. Production assets and reserves would lose their value, leading to “stranded assets” and a reconfiguration of the financial system, which risks investors such as pension funds not receiving returns on their investments [54,55].

In a world of consistently low oil demand, companies would need to either find new sources of revenue or ramp down their business [56]. Petrostates relying on the oil market to balance their budgets would face similar issues [57]. Both of these would lead to secondary impacts on employees, citizens, investors, and communities. Because of the sheer size of the oil industry, the effects of any troubles would spread through the whole economy.

Lower oil demand might also cause tipping points or feedback loops that are hard to predict. For example, if a sustained drop in demand were caused by policy change, production assets acquired under the assumption of a high-price environment would not be valuable anymore. Many companies would probably seek to divest non-profitable assets. But if demand stayed low, who would want to buy all the expensive production assets? In this scenario, prolonged oversupply would be likely to lead to falling prices and economic turmoil.

Even in this scenario, not everyone might lose out. There are many companies, for example, which specialise in acquiring undesirable assets from others and making the most of them over their remaining lifetime [58]. The growing demand for petrochemicals, especially plastics, provides scope for continued oil demand, although the volume required is likely to be much less than if oil is used for energy [59]. But these are examples of a fundamentally different game from the high-volume operating environment in which most oil companies have existed for decades or more.

We already know what can happen when oil demand falls. The beginning of the COVID-19 pandemic in spring 2020 gave the oil sector a taste of declining revenues and valuations, stranded capital (such as BP writing off $17.5 worth of assets [60]), bankruptcies (including 36 US-based producers in the eight months to August 2020 [61]), and mass redundancies (including 15% of ExxonMobil’s workforce over the course of a year [62]). While the potential for job losses in a long-term decline scenario has not been widely studied for the global oil sector, research on the coal industry demonstrates the large scale of potential losses of employment and other adverse impacts on affected communities [55,63].

Of course, there are also differences. A sustained decline in demand would happen more slowly than the shock of a global pandemic, and might leave governments, companies, and people time to prepare. The possibility of mitigating adverse effects is precisely why it is important to understand what low-demand scenarios can really mean for different stakeholders.

Research on the possible effects of declining oil demand has begun [64–67]. But we are far from having a clear picture of what the potential implications of successful climate mitigation would be for the oil industry and through it for the rest of the world. It is important to understand the range of possible pathways and dynamics of the global oil sector under scenarios of rapid decarbonisation. And this information should be available not only for the industry itself, but for governments and public entities so they can prepare for future disruptions and mitigate risks.

5. Many possible oil demand futures

This piece raises the possibility that the world may at some point in the future be confronted with peak oil demand rather than peak oil. For this to even be acknowledged as a possibility by commentators across the field is remarkable. We cannot know what the future holds, or if the world will succeed in avoiding disastrous climate change. But the size and power of the oil industry mean that any long-term disruption to its fundamental operation could have huge impacts on societies, economies, and people. It is imperative that we take this possibility seriously and seek to understand and prepare for the potential transition.

As we stand on the brink of potentially irreversible changes to the Earth system from climate change, the uncertainties for the oil industry, investors, and society as whole loom ever larger. While the industry is used to risks and short-term volatility, its medium-term outlook has until now seemed relatively stable, even if terminable in the long run because of “peak oil”. In this situation, old ways of thinking may not work as well anymore.

At the time of writing, it seems that societies are beginning to emerge from the COVID-19 pandemic. Oil demand is growing, the oil price is up, and the valuations of oil companies have improved. It seems likely that the oil industry is headed towards a period of higher investment to make up for the lack of investment during the economic downturn. But this may well be the last major investment cycle of the oil industry [68].

The future of the oil industry in a warming world is uncertain, and controversies and value judgements are never far away. To make informed long-term decisions, policymakers, and the industry itself, need a clear-eyed understanding of what might happen, and what the consequences may be. Scenarios of continued demand growth, accelerating climate change, and eventual peak oil concerns are important tools to aid this understanding – as are those depicting climate mitigation, declining oil demand, and fundamental changes to the way the oil industry operates. Both types of scenarios have the power to shape our world, economies, and societies for decades to come. Ten years ago, the UK Energy Research Centre concluded “the risks presented by global oil depletion deserve much more serious attention by the research and policy communities” [69]. We believe the same is just as true today about the depletion of oil demand.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This work was supported by the Natural Environment Research Council [NE/S007415/1]; and by the European Union’s Horizon 2020 research and innovation programme under grant agreement No 837089 (SENTINEL).
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