The Abdullah Bin Hamad Al-Attiyah International Foundation for Energy & Sustainable Development

Research Series Issue 19: March 2018

ABDULLAH BIN HAMAD AL-ATTIYAH INTERNATIONAL FOUNDATION
FOR ENERGY AND SUSTAINABLE DEVELOPMENT

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Al-Attiyah Foundation Research Series

Expert energy opinion and insight

Peak Oil and Gas Demand

The subject of peak oil and gas demand has recently risen to prominence. From concerns over 'peak supply' in the early 2000s, there is now debate over whether the demand for oil and gas is set to decline and, if so, when and how quickly. This decline could be driven by the adoption of electric vehicles, improvements in efficiency, and the substitution of gas by renewable energy. Underlying these trends is the intersection of technological advances and a policy push from governments to reduce oil use, primarily because of concerns over climate change. Such a peak would have major consequences for oil and gas producing companies and countries. If imminent, it would require urgent efforts at diversification and a rethink of near-term investment plans. This paper examines major forecasts for oil and gas demand to 2050 and their drivers.

Executive Summary

- **Global energy demand** is likely to rise up to 2050, but at a slowing rate.
- Major forecasts generally show **rising but slowing oil demand** up to 2050, but there are credible scenarios with a peak in the mid-2030s, driven particularly by electric vehicles (EV).
- **EV adoption** is very hard to predict currently.
- **Gas demand** is also set to rise but is vulnerable to competition from renewables.
- Major oil and gas producers need to watch closely for **early-warning signs** of slowing demand in key geographic and sectoral markets.
- The exact date of peak demand is less important for oil and gas producers than the **level and the trajectory post-peak.**

Implications for Hydrocarbon Resource Holders

- **Longer-term oil prices will be subdued** by slowing demand growth and more competition for a limited market.
- **Gas/LNG demand growth is likely to continue to 2050,** and countries with large, low-cost resources are the likely winners of any struggle for market share.
- **Countries could secure and boost gas/LNG demand** by developing new markets and encouraging gas-friendly policies.
- **Economic diversification and hedges** against declines in oil (and gas) demand are increasingly important in the medium-term (2030 onwards).

Energy demand forecasts show a wide spread – but still room for surprises

Forecast Comparisons

A number of leading energy organisations have produced forecasts of future oil and gas demand. These include oil companies (BP, ExxonMobil and Statoil), governmental agencies (International Energy Agency, Energy Information Administration (US), and OPEC), environmental NGOs (Greenpeace), and consultancies and think-tanks (Wood Mackenzie, RethinkX).

All major forecasts analysed here show energy demand growth slowing down over time, as economies mature and become more oriented to services, population growth slows, and efficiency improves. However, none apart from Greenpeace and Statoil's 'Renewal' case has an actual fall in primary energy demand by 2050; even the IEA's '450' scenario (required to limit the increase in atmospheric CO_2 concentrations to no more than 450 ppm) has some, albeit very slow, growth.

The main forecasts yield about a 40% increase in primary energy demand by 2050, or about 1% per year from now on. In contrast, primary energy demand grew 2.2% per year on average during 2000-2016, despite the global financial crisis.

No forecast identified show the opposite possible, if somewhat unlikely, trend – a continuation or even acceleration of energy demand growth, which might come from new technologies (robotics, hypersonic flight, space travel, etc.).

Nevertheless, within a general trend of growing energy demand, the distribution between the three fossil fuels and renewables can vary greatly (nuclear energy's share stays at a fairly low and flat level in most scenarios).

Oil Forecasts

Forecasts for oil, which run up to 2030 to 2050, are in Figure 1.

Some of the forecasters provide different scenarios relating to a faster replacement of oil (for example BP's 'ICE Ban' and 'Extra-Fast Transition' scenarios, Greenpeace's 'Revolution' and 'Advanced Energy', IEA's '450'). Note that not all forecasts start from the same level, because of slightly different starting dates (2015-17) and because of different definitions of 'oil' (mainly whether including NGLs and biofuels).

The wide spread of projections can be roughly divided into four groups:

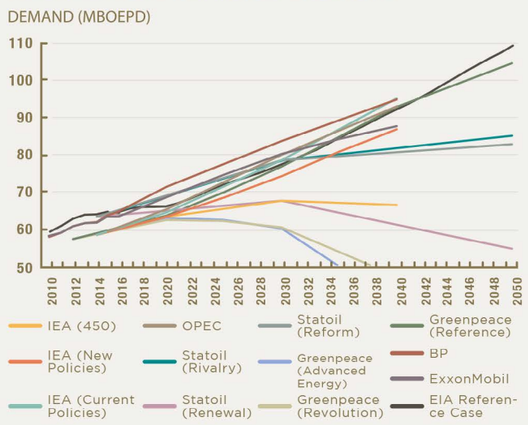
1 – Immediate demand peak and drop (Greenpeace, RethinkX 'TaaS disruption', IEA '450') – these are essentially advocacy rather than forecasts, showing what could happen in the case of very strong policy measures or technological breakthroughs;

2 – Near-term peak in 2020-25 at ~100 Mbpd (Statoil 'Renewal', BP 'EFT') – these cases include aggressive but plausible moves to EVs and other non-oil technologies;

3 – Medium-term peak in 2030-35 at ~110 Mbpd (Statoil Reform, BP ICE Ban) – these include more moderate but still fairly quick shifts to non-oil technologies. Shell also sees a possible peak in the 2030s because of EV adoption;

4 – No peak within the forecast period, with demand reaching 110-120 Mbpd by 2040 and 115-130 Mbpd by 2050 (ExxonMobil, EIA, OPEC, IEA 'Current Policies', Wood Mackenzie). Without giving exact forecasts, Russia and Saudi Arabia also say that they see no peak by 2050.

FIGURE 02: **GAS DEMAND FORECASTS**[2]



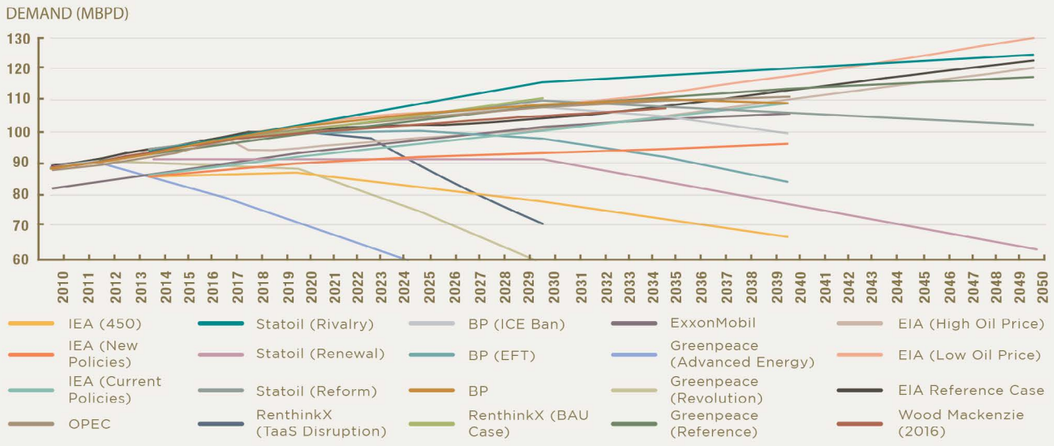
Gas Forecasts

The forecasts for gas demand show less spread (Figure 2).

Most forecasts show steadily rising gas demand out to 2050, with an average annual increase of about 1.6%, reaching around 105-110 million boe per day by 2050 (about 610-640 Bcf/day or 6300-6600 BCM/year). Natural gas overtakes coal in about 2030-35, remains well ahead of renewables throughout, but does not surpass oil.

The Greenpeace 'revolution' scenarios do show a sharp decline in gas demand, but they are, of course, advocacy with probably unrealistic assumptions on the pace of renewables deployment, particularly as they also have coal and nuclear power being phased out. Some scenarios of a faster energy transition (Statoil 'Renewal' and IEA '450') have a plateau in gas demand in the 2030s, and two other Statoil scenarios have a plateau in the 2040s. These scenarios require a slowing or even falling overall energy consumption, plus rapid expansion of renewables.

FIGURE 01: **OIL DEMAND FORECASTS**[1]



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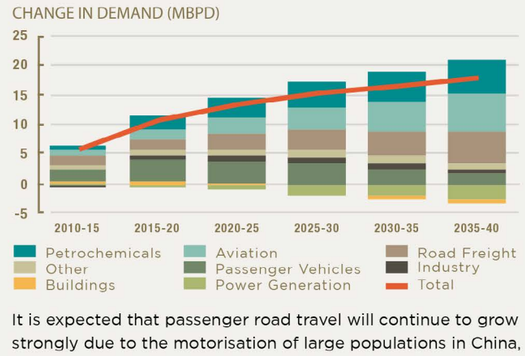
Fear of peak oil demand centres on passenger vehicles

Most of the attention on peak oil demand has concentrated on EVs, due to their high media profile, recent technological and commercial advances, and potential to break the near-monopoly of oil in ground transport.

Passenger vehicles make up the single largest category of oil use, with road freight second. The IEA's forecasts show that this remains true to up to 2040, in their New Policies scenario, but that the focus of growth shifts (Figure 3).

FIGURE 03: **CUMULATIVE OIL DEMAND CHANGE BY SECTOR**[3]



It is expected that passenger road travel will continue to grow strongly due to the motorisation of large populations in China, India and other developing countries. The US has 795 road vehicles per 1000 people, China 154 and India 151 (of which only about 20 are passenger vehicles). Passenger vehicle ownership grows at about twice the rate of GDP for developing countries, but increasing congestion probably will limit ownership to well below US levels in most places.

Geographically, demand will continue shifting towards developing countries: Wood Mackenzie sees OECD demand falling by 3 Mbpd by 2035 while non-OECD demand rises 16 Mbpd[4].

In the IEA's New Policies scenario, passenger vehicle demand starts to decline in the 2025-30 period, due to the penetration of EVs. Growth is supplied by the aviation + shipping, road freight and petrochemicals sectors, each of which add about 0.2 Mbpd each year from 2020 to 2040. But overall annual demand growth slows down sharply, +0.54 Mbpd each year in the 2020-25 period to just +0.24-0.28 Mbpd annually in 2030-40.

The adoption of EVs is driven by four trends, the first two current, the last two more in potential:

1 - Continuing improvements in battery cost, capacity and range, along with a positive image;

2 - Subsidies and policies aimed at the reduction of oil use (through fleet efficiency standards), local air pollution (mostly from diesels) and carbon dioxide emissions. The UK and France plan bans on gasoline and diesel cars from 2040; Norway from 2025; and China from an as-yet undetermined date;

3 - Ride-sharing (such as Uber and Careem) and, in future, autonomous vehicles. Higher-usage vehicles spread the higher up-front cost of batteries over more mileage, while autonomous vehicles may recharge while waiting for passengers;

4 - The use of EV batteries with smart-charging to balance the grid, especially as variable renewable input increases.

EV adoption trends are highly uncertain. Battery vehicles still have significantly higher up-front costs than internal combustion engine (ICE) vehicles; their ranges are shorter; charging networks are still being built out; and range in extreme (low and high) temperatures is reduced. On the other hand, fuel and maintenance costs are lower and performance can be considerably better.

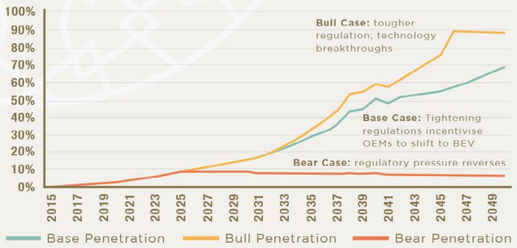
A typical EV today would cost about €25,000 compared to €18,000 for a gasoline vehicle, but cost, at EU prices, €920 in fuel, insurance and maintenance annually versus €3,080[5]. This suggests a simple payback period of less than 4 years, or even better for a high-use vehicle.

Markets with high penetration today, such as Norway (28.8% of sales in 2016), have been driven by unsustainable subsidies. Worldwide, EV sales across major markets in 2016 were just 1.1% of the total[6]. Such a fast-growing but very immature market today leads to a wide spread in scenarios (as the example in Figure 4 indicates), where EV penetration by 2050 could be anywhere from 10% to 90%. Around 2025 is a key point of divergence, from where it may be easier to judge how quickly electric transport is taking off.

TABLE 01: **COMPETITORS TO OIL IN DESCENDING ORDER OF EASE OF SUBSTITUTION**[7]

Area Of Use	Use, Mbpd[8]		Factors reducing long-term demand
	2015	2040	
Power generation	5.4	2.9	Gas, renewables, efficiency, nuclear
Buildings	7.6	6.0	Efficiency, gas, CHP[9], distributed renewables
Industry	5.8	6.5	Gas, efficiency, waste heat integration, electricity, concentrated solar
Pasenger vehicles	23.9	24.6	Electrification, efficiency, biofuels, CNG, autonomous/shared, public transport
Road freight	16.3	19.7	Electrification, efficiency, LNG/CNG, biofuels, rail
Shipping	5.0	6.2	LNG, ?electrification, ?hydrogen
Petro-chemicals	10.7	15.7	Recycling, efficiency, biomaterials, maturing economies
Other[10]	10.8	11.3	Bio-materials & alternatives
Aviation	5.8	9.3	Biofuels, high-speed rail, ?electrification, ?hydrogen

FIGURE 04: **ELECTRIC VEHICLE PENETRATION SCENARIOS**[11]



Vehicle fleets take a long time to turnover – 14.8 years in the case of the US. Even after a complete ban on new ICE sales, EVs would not make up a majority of the fleet for another decade.

The size of the fleet is not the only issue for oil demand; electric vehicles are likely to drive more kilometres than ICE vehicles, because of lower fuel costs.

Road freight could also be electrified to an extent – Tesla unveiled an electric truck in November 2017 – but is more likely to be limited for now by range and the size, weight and cost of batteries. Short-range shipping, such as ferries, and even aviation could use batteries but this will only have a small impact on demand.

Gas' future is brighter, but more uncertain

Gas demand, by contrast to oil, is concentrated in power generation, industry, petrochemicals and buildings (space and water heating and cooking). A small but possibly growing segment is in transport (LNG shipping and CNG and LNG trucks, trains and passenger vehicles). A significant and rising amount is reinjected for enhanced oil recovery, though this will eventually be available for future production.

As a relatively clean fuel, with minimal air pollutants, high efficiency and about half the CO_2 emissions of coal, gas has gained support as a 'bridge' fuel to a renewable energy future. Or, in the visions of some companies such as Shell, it could be a 'destination' fuel, a core part of the energy complex to 2050 and beyond.

Despite the lesser spread in gas demand forecasts shown in Figure 2 compared to oil, the future of gas is actually more uncertain. Gas faces strong competition in power generation, heating and industry from coal on the one hand (cheap but dirty), and renewables on the other (clean, falling in cost but intermittent), and perhaps advanced nuclear power. Gas' near-term future is promising, but longer-term demand requires it to keep its cost competitive, reduce its environmental impact further, capture new markets, and attract enough support from policymakers at least to face a level playing field.

The interaction between peak oil and gas demand is complicated. On the one hand, if there is strong action on climate change, this will discourage oil use, and probably favour gas use in the short term but reduce it in the longer term (unless carbon capture and storage (CCS) for gas is widely deployed). On the other hand, gas can substitute for oil in numerous applications – power, industry, petrochemicals, buildings, and to an extent transport. If EVs are widely deployed, a large part of their charge is likely to come from gas-fired power plants, at least in the medium term.

Oil and gas producers need to watch for milestones

At the moment, the share of EVs is too small, and the technology too immature and costly, to make confident projections. To detect a possible peak in oil demand well ahead of its occurrence, oil producers need to watch carefully technological progress, consumer preference and market penetration of electric and autonomous vehicles, particularly in flagship markets – notably Western Europe, Japan, South Korea, China and California.

Even if oil demand does not actually drop, the marked slowing in growth seen in many of the forecasts during 2025-35 would pose a problem for oil markets. It gives very little room for expansion for major producers with large remaining resources – Saudi Arabia, Iraq, Iran, Russia, US – unless they squeeze out other production with lower oil prices.

Substantial investment will still be required to develop new production in the face of natural declines, but this will be difficult to plan in the face of falling and volatile prices and an increasingly unfashionable industry.

The composition of the demand barrel will also change. Fuel oil demand will be reduced to low levels, a cut given impetus by the 2020 IMO shipping fuel regulations. Gasoline demand will stagnate or fall with the rise in EV sales, while the call on naphtha, NGLs and ethane for petrochemicals will rise. Middle distillates – diesel and jet – will see strong demand from shipping, road and train freight and aviation, though partly offset by falling diesel for light vehicles in Europe. This will require a shift of refining configurations. The shale oil-induced move to very light crude slates is problematic for producing enough middle distillates, which would favour medium-gravity crudes typical of the Middle East. Crude-to-chemicals processes such as those proposed by ExxonMobil and Saudi Aramco may better align varied crude slates with required product outputs.

Gas producers need to secure markets during the imminent changeover from coal. That requires them to:

- **Target new consumers** (new geographies, such as Africa and South Asia; new consumer types, such as shipping; and conversions from coal in China and India);
- **Improve their environmental credentials**, by reducing methane leakage and beginning to deploy carbon capture and storage on gas-fired power and industry;
- Develop their ability to **combine effectively with renewable power**, possibly by investing in diversified power generators, and encouraging market designs that reward back-up capacity.

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Conclusions

A peak in overall energy demand by 2050 is very unlikely, except in the event of a global economic crisis or conflict. However, most major forecasts assume there will be a slowing of demand growth, and a shift away from coal and oil and towards gas and renewables, driven by demographic change, economic maturity, environmental goals and technological advances.

Except in very aggressive scenarios of environmental policy, oil demand is set to peak in the mid-2030s at the earliest, or more likely the 2040s or beyond. Petrochemicals, aviation and shipping, and road freight will support demand, while use in power and industry falls. The key uncertainty is the speed and size of deployment of electric vehicles.

The share of EVs today is so small that predictions are very difficult. It should become clearer in the early 2020s; EVs will anyway take a significant time to penetrate the existing vehicle fleet.

Major oil producers and companies should watch the competitiveness and deployment of non-oil technologies, including EVs but also battery trucks, LNG shipping and non-oil petrochemical feedstocks.

Gas demand is more confidently predicted to continue rising, but it faces competition from cheap coal and cleaner renewables. Major gas producers need to continue improving the environmental performance of their fuel, and developing new markets, geographically and by sector.

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6. International Energy Agency, Global EV Outlook 2017, https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf

7. International Energy Agency World Energy Outlook 2017, New Policies scenario; author's research

8. International Energy Agency, World Energy Outlook 2016, p117

9. Combined Heat & Power

10. Lubricants, bitumen, agricultural use & others

11. Morgan Stanley, 'On the Charge' (31st August 2017)

Approximate Energy Conversion Factors

Crude Oil	To	Tonnes	Barrels	Tonnes/y
From		Multiply by:		
Tonnes		1	7.33	-
Barrels		0.1364	1	-
Barrels/day		-	-	49.8

Gas	To	bcm NG	bcf NG	mtoe	mt LNG	MMBTu	mboe
From		Multiply by:					
1 bcm natural gas		-	35.3	0.90	0.73	35.7	6.16
1 bcf NG		0.028	-	0.026	0.021	1.037	0.18
1 mtoe		1.111	39.2	-	0.805	39.7	6.84
1 million tonnes LNG		1.36	48.2	1.23	-	48.6	8.37
1 MMBtu		0.028	0.98	0.025	0.021	-	0.17
1 million boe		0.16	5.71	0.1464	0.12	5.8	-

Energy source/fuel Conversions		
	Electricity	1 kilowatt hour = ~3,412 Btu
	Natural gas	1 cubic foot = ~1,037 Btu
		1 therm = 100,000 Btu
	LNG	1 mtpa = ~1.3698 bcma
	Motor gasoline	1 US gallon = ~120,476 Btu
	Diesel fuel	1 US gallon = ~137,452 Btu
	Heating oil	1 US gallon = ~138,500 Btu

Energy Related Units	
1 metric tonne	1.1 short tons
1000 Litres	6.2898 barrels = 1 cubic metre
1 kilocarorie (kcal)	4.18 kJ or 3.96 Btu
1 kilojoule (kJ)	0.24 kcal or 0.948 Btu
1 Btu	0.252 kcal or 1.055 kJ
1 kilowatt-hour (kWh)	860 kcal, or 3600kJ or 3412 Btu

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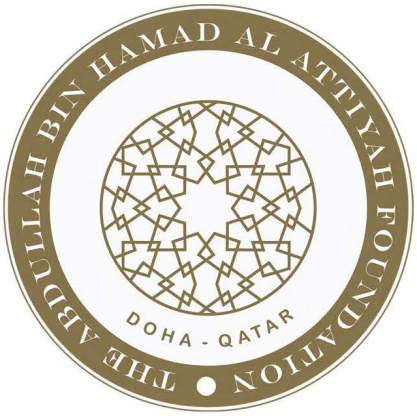

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