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THE MULTIPLE PATHS TO PEAK OIL DEMAND

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This article is the first in a series on the future of energy in an increasingly uncertain world.

For decades, the world has been accustomed to steadily increasing demand for oil as the number of cars, airplanes, and ships has risen. Efficiency gains and the opportunity to substitute oil with other energy sources are casting doubts on continued demand growth, however. If these are proved right, a new era of structural decline in the oil industry will have important implications for companies, governments, and investors.

The industry consensus views steady yet slowing global demand growth as the base case in the decades ahead. But we see at least three possible disruptions to demand that on their own have the potential to result in global peak oil demand between 2025 and 2030—sooner than many forecasters expect. Even without these disruptions, if the price of oil rebounds to over $100 a barrel (in today's dollars)—indeed, several international organizations expect crude oil prices to rise to relatively high levels—then peak demand will be more than a material possibility; it will be a near certainty.

Global peak oil demand would not spell doomsday for the oil industry. Even in a world where demand for the fossil fuel is declining, sizable fresh investments in new oil production capacity will be required for several decades to replace depleting fields. Furthermore, the *combined* consumption of oil and gas will still continue to grow for a long time to come.

Companies, investors, and governments need to factor into their projections the real possibility of global peak oil demand. They should consider the implications of declining demand on capital deployment, portfolio decisions, royalty payments, and the wider geopolitical environment.

Economic Growth Is Outpacing Energy Consumption

Historically, economic growth has been the primary driver of global demand for hydrocarbons. In recent years, however, there has

PREPARING FOR THE FUTURE OF ENERGY IN AN UNCERTAIN WORLD

Participants across the energy industry are struggling to find their footing in a rapidly evolving landscape. The pace of change, and the disruption it brings, is set to accelerate before we reach a new equilibrium. And no one knows precisely what that will look like.

For decades, the industry had familiar contours: energy sources and markets operated in virtual silos, investment horizons were long, and technological development was steady but not disruptive. The uninterrupted growth of global demand for all sources—whether coal, oil, or natural gas—was taken as a given.

Now, all that is in flux. Rapid structural changes in energy markets—at times initiated by regulation but fundamentally driven by technological innovation—have intensified competition among both traditional and renewable sources. Disruptions that were unimaginable not long ago—such as the emergence of environmentally friendly electric vehicles and the substantial use of wind and solar energy in power generation—are now realities.

The myriad potential combinations of these disruptive factors and others would lead to very different outcomes for energy companies and for countries.

But whatever the outcome, industry players will need to adapt. Companies must minimize the risk of stranded assets, manage complex resource exposures, and stay on the right side of upcoming regulations. Governments must ensure that the transition to cleaner energy is not overly costly for citizens and industry, and promote long-term technologies without generating windfall profits for a few.

Industry players and governments also face a higher-order challenge: given an uncertain world, they must develop the capability to examine the assumptions behind conflicting outlooks, assess the impact of various disruptions, individually and in combination, and prepare for the range of possible energy futures.

Companies and national authorities need to navigate strategic energy decisions and engage in a dialogue with stakeholders about solutions that will help make the energy transition as effective as possible while addressing environmental challenges.

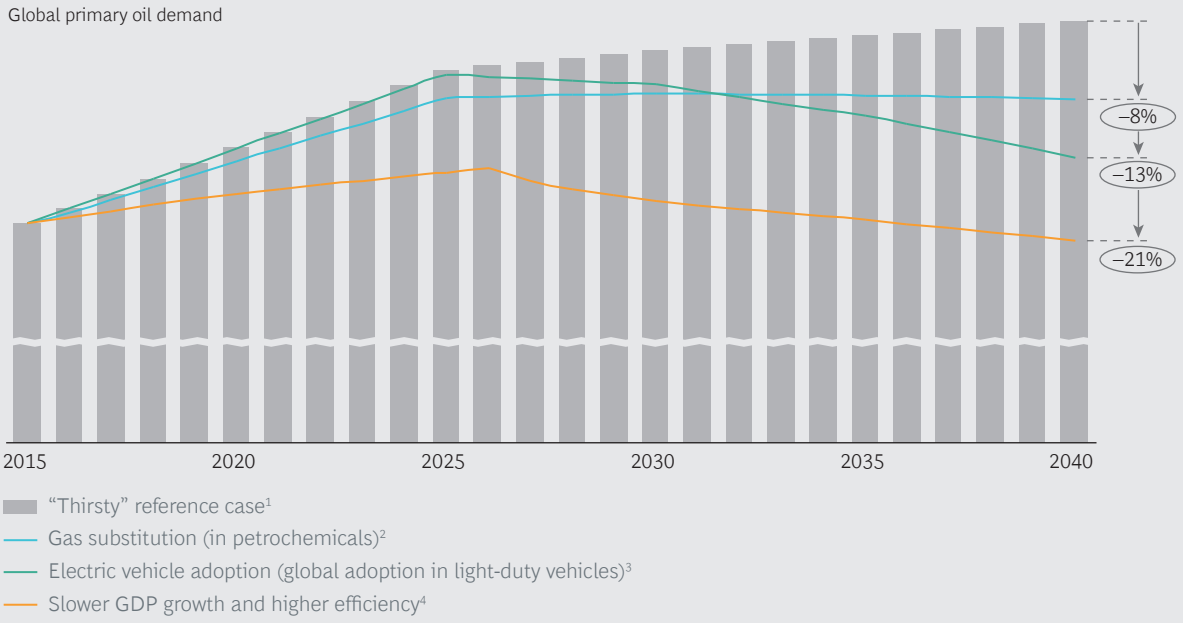
been a decoupling of oil and gas consumption from GDP growth in Western developed countries as a result of technology-driven efficiency gains and the shift from energy-intensive manufacturing-based to less energy-intensive service-based economies. Consequently, the energy intensity of GDP growth has declined sharply. For example, although the US economy has grown by about 12% in real terms since 2007, primary energy consumption has fallen by 3.6%.

Because of this secular shift, most energy forecasters assume baseline growth in oil demand of less than 1% a year, below real GDP growth. This reflects their expectation that oil demand in emerging markets, such as Asia, will rise as growing middle classes purchase more cars and energy-consuming goods, and take more flights. Demand in these markets will buoy oil consumption somewhat even as Western demand wanes, according to this view.

Three Disruptive Scenarios

Using BCG's Global Energy Scenario Model, we have explored a range of possible disruptions. Three stand out, each of which could *on its own* halt oil demand growth: widespread adoption of electric vehicles;

Any One of Three Disruptions Could Trigger Peak Oil Demand by 2030



Sources: BCG Global Energy Scenario Model; International Energy Agency, *World Energy Outlook 2015.*
[1]Average GDP gowth of 3.5% until 2040. Assumed long-term real oil price at $60/bbl. Low internal combustion engine efficiency of 6.3 L/100 KM.
[2]Gas replaces oil as petrochemical feedstock for ethylene and polyethylene. In North America and Middle East, gas takes 80% share; in Asia, it takes 50% share. No change in other regions (other parameters the same as reference case).
[3]EVs replace vehicles powered by internal combustion engines for light-duty vehicles. OECD has 90% EV penetration by 2040; non-OECD has 90% by 2050 (other parameters the same as reference case).
[4]Expected global GDP growth of 3% vs. 3.5% for the reference case. Improvements in internal combustion efficiency of 4.3 L/100 KM by 2040 in OECD countries.

a combination of slower economic growth and efficiency gains; or the substitution of oil with natural gas in heavy transport and petrochemical uses. (See the exhibit.) Each has the potential to disrupt consumption rapidly and at scale.

To test the impact of our three disruptions, we built a "thirsty" reference case that is favorable to oil demand. We assumed real GDP growth of 3.5% per year from 2015 to 2040, together with an inflation-adjusted oil price of $60 per barrel. This price is about half that predicted by several of the world's leading energy organizations but is consistent with the breakeven level assumed in many oil company investments.

Applying these assumptions gave us compound annual growth in oil demand of 0.9% from 2015 to 2040. We assumed that demand growth slows gradually over that period as energy demand decouples from GDP growth in an increasing number of economies and as Asia catches up with Western countries in energy efficiency.

We then tested our reference case using each of the three disruptions. In the real world, public-policy interventions play an important role in changing behaviors. In our model, however, we assumed that each disruption can be competitive in the long term without such interventions.

- **Electric Vehicle Adoption.** In a sign of the growing popularity of electric-powered vehicles, automakers such as Tesla, General Motors, and Volkswagen are planning to roll out affordable models for the mass market by the end of the decade. Even so, electric vehicles remain a drop in the automaking ocean: about 1 million are sold each year, about 1% of global new car sales.

  Electric vehicles will either remain a niche story or substantially replace the internal combustion engine over the next few decades. The principal factors that would enable this substitution are a decrease in the unsubsidized total cost of ownership of electric vehicles compared

with that of conventional cars; far greater convenience, particularly for long-distance travel, as a result of more charging points and faster charging; and the expectation that electric cars will retain their value (even as increased regulatory penalties erode that of conventionally powered vehicles). If these factors were in place, they would produce an S-curve effect of strong and rapid penetration in global markets.

By assuming a scenario in which the cost of an individual battery falls close to $100 per kilowatt hour, infrastructure investment enables faster charging, and batteries become more durable, we could see electric vehicles account for 90% of the developed market car fleet by 2040 and a similar proportion of the emerging market fleet by 2050. (We have excluded the potential for rapid uptake of electric vehicles in heavy road transportation because we consider that to be more uncertain.) The outcome of this scenario would be peak oil demand between 2025 and 2030.

- **Slower GDP Growth and Increasing Efficiency.** To test this disruption, we assumed global economic growth of 3% a year in real terms—below that in our reference case—but combined this with fuel efficiency gains driven by tougher regulatory standards on vehicle specifications. We also assumed advances in efficient self-driving technology and the use of lighter materials in vehicle manufacturing. Because of these factors, we modeled a decrease in average automobile fuel consumption to 4.3 liters per 100 kilometers within OECD countries by 2040, half the current consumption, and 6.3 liters per 100 kilometers in countries outside the OECD. We assumed similar efficiency gains for heavy-duty vehicles. The outcome of this scenario would be peak oil demand in 2026, although overall demand would be far lower because of slower economic growth.

- **Gas Substitution.** We postulated a world where cheap, abundant natural gas, derived from both conventional and unconventional sources, was available in a major region outside the US, at a price consistently below $5 per million British thermal units, in line with US prices at the beginning of the shale boom. (US gas prices are currently about half what they were at the start of the shale boom.)

  Such a development would result in greater substitution of naphtha, a derivative of crude oil, with natural gas–derived ethane as a feedstock for petrochemicals, a transition that is already underway in the Middle East and is well advanced in the US. If a major energy-consuming country, such as China, were to start producing cheap gas, this would lead to a significant substitution effect in petrochemicals. Our model indicates that oil demand would peak in 2025 and then plateau.

  In the case of an oil price slightly higher than our assumed $60 a barrel, low gas prices would increase adoption of the fuel in heavy road and maritime transport. This would break the fragile demand plateau and cause demand to decline.

While these three disruptions would trigger peak demand at an oil price of $60 a barrel, if oil prices returned to pre-2014 levels, peak demand would be a virtual certainty, even when we exclude significant substitution of gas for oil in petrochemical and transport applications, which are more likely with high oil prices.

Each disruption would, on its own, lead to peak oil demand. And a combination of them would produce the same results. In consequence, we believe peak oil demand in the next two decades is a material possibility. Since the world would no longer need all its hydrocarbon reserves, some of these reserves, on the expensive side of the supply curve, would be stranded. The effect of slowing demand on crude oil prices will depend on the supply picture. We will consider this topic in a subsequent article.

The Implications of a Post–Peak Demand World

The oil industry isn't about to breathe its last breath. Even if global demand declines sharply, the following factors will provide support:

- The world will still need a huge amount of oil: when we examined our three disruptions individually and in combination, we found that in most situations more than 80 million barrels per day will be needed by 2040, compared with 92 million today. This amount would continue to decline as a result of our disruptions, but only slowly.
- About 3 million to 7 million barrels a day from existing fields are lost every year from total production, depending on investment levels, simply because reservoirs become depleted. Part of this will need to be replaced by new fields, presenting an opportunity for upstream players that can extract oil at a competitive cost.
- Demand for both oil and gas combined will continue growing by at least 0.5% a year.

The possibility that oil demand will begin a long-term structural decline raises important questions for companies and governments, including the following:

- **Business Model.** How can companies reshape their business model for a new demand environment? How should they change their focus, regionally and along the value chain, to access shifting profit pools?
- **Resource Competitiveness.** What measures can actors across the value chain take to maximize the competitiveness of their resources and assets? How can they drive efficiency gains and use new management tools, technologies, and digital solutions to move to the higher value and lower risk part of the supply curve? (See *Big Oil's Road to Reinvention,* BCG Focus, February 2016.)
- **Resource Stewardship.** Will we see increased competition between governments as they attempt to prevent their nation's reserves from becoming stranded, through sweetened royalties and other incentives? How should companies position themselves for this eventuality?
- **Investment Focus.** How can companies rethink the way they deploy capital? How should they account for disruptions from substitution, technological advances, and regulatory developments—across all energy sectors—to ensure that capital deployment does not result in stranded assets?
- **Oil Versus Gas Exposure.** While switching portfolios toward gas has clear merits because of the fuel's stronger underlying growth, are players paying enough attention to the continued attractiveness of the price environment, which will depend on locations and positions on the value chain?
- **Non-Fossil-Fuel Diversification.** How should oil companies balance their efforts between diversifying into new areas and focusing on getting their breakeven extraction cost as low as possible to decrease their risk of stranded reserves?
- **Geopolitical Shifts.** How far will demand from emerging, oil import–reliant, and mostly Asian, countries rebalance energy geopolitics and change the face of existing relationships and dependencies?
- **Managing Transition.** Peak oil demand could change the economics of oil-dependent regions by endangering investment, jobs, and tax revenues. Are companies and governments ready to make the difficult decisions to reskill their workforces and forge new non-oil-based economies?
- **Decommissioning Liabilities.** In a growing market where investment levels are high, fields are expanded and their

lifetimes prolonged, effectively pushing abandonment liabilities out in time. In a shrinking market with lower investment, these liabilities are instead brought forward. How will companies deal with the pressure this places on their balance sheets and cash flows? (See "The North Sea's $100 Billion Decommissioning Challenge," BCG article, March 2017.)

In an industry characterized by slow, steady evolution and long investment horizons, the end of steadily rising oil demand could arrive far more quickly than many have anticipated. As companies, governments, and investors address seismic shifts in the energy landscape in the coming years, peak oil demand needs to be high on their agenda. For oil companies to continue to thrive, they need to recognize the real possibility that oil demand may soon decline and formulate a strategy to address all possible futures.

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