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ELECTRIC VEHICLES AND THEIR IMPACT ON OIL DEMAND: WHY FORECASTS DIFFER

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Introduction

While the passenger vehicle sector represents only about one-quarter of the oil demand barrel, the sector receives a significant amount of attention from some governments and the media. This is due largely to the belief that a rapid transition from conventional oil-powered cars to electric vehicles (EVs) is both possible and necessary to reduce greenhouse gas emissions and improve urban air quality. Numerous studies analyzing the impact of EVs on oil demand have been published. To determine whether the enthusiasm around the potential for EVs to reduce fossil fuel consumption is warranted, the author reviewed several of these studies and found that it was difficult to derive insight from comparing these published forecasts, because they were not calculated on the same basis and they failed to provide some key underlying assumptions. To bridge that gap, the author conducted a survey of 15 of these forecasters representing governments, think tanks, consultants, investment banks, and oil companies to obtain comparable data along with their underlying assumptions, with the agreement that the sources of the data would not be disclosed.

Summary

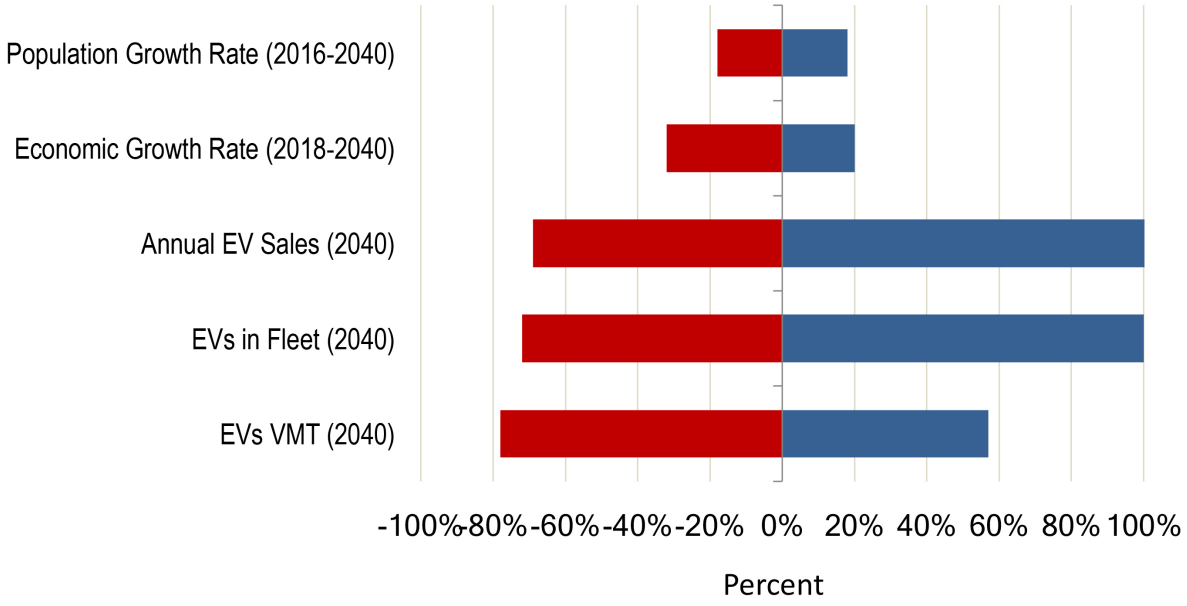
The review showed that none of the passenger vehicle forecasts projected much oil demand growth over the next 25 years. This was an area where there was clear agreement among forecasts. In many cases, demand remained flat after peaking. A few forecasts, particularly two-degree carbon scenarios, showed a considerable decline in demand in this sector by 2040. However, even in these cases, no decline in demand is projected before 2020, and there isn't much decline before 2030. It should also be noted that any decline in oil demand from the passenger vehicle sector could be offset by demand growth in the petrochemical, aviation, or freight transport sectors, which have fewer and more costly substitutes for oil. The pace of demand growth matters. If the world doesn't move off oil at a rapid clip, it is important that policy makers recognize the need for investment in new oil supplies to prevent supply shortages and accompanying oil price spikes.

The review also showed that forecasters had widely disparate views of the underlying drivers of demand. Figure 1 illustrates the wide range around the mean of the highest and lowest

forecasts of the underlying components of demand. The forecasts on the two-degree carbon trajectory generally assumed significantly lower population growth and higher electric vehicle sales and usage than the other forecasts. In fact, it is possible that these carbon scenarios reflect what needs to happen to get on the two-degree trajectory as opposed to the forecasters' view of what is *likely* to happen. Other forecasts had significantly lower EV penetration relative to the mean, reflecting the view that there will be only incremental and relatively slow change in the passenger vehicle sector rather than disruptive change.

Figure 1. Wide differences in forecasters' views of key demand drivers

Percent Increase/(Decrease) of Highest and Lowest Forecasts Around the Mean of All Forecasts



Source: CGEP Survey & Analysis

Demographic changes and economic growth are large drivers of global oil demand, and even without EV penetration, their slowing growth rates will continuously weaken the rate of oil demand growth over the long run. Rising income and urbanization in developing countries are counterbalancing forces. Two-degree carbon forecasts tend to assume lower population growth, which exacerbates the expected decline in passenger vehicle sector oil demand. There is no consensus on the impact of a two-degree carbon scenario on economic growth. A variety of economic growth assumptions are used, which have the effect of either exacerbating (in the case of low economic growth) or minimizing (in the case of high economic growth) the decline in oil demand.

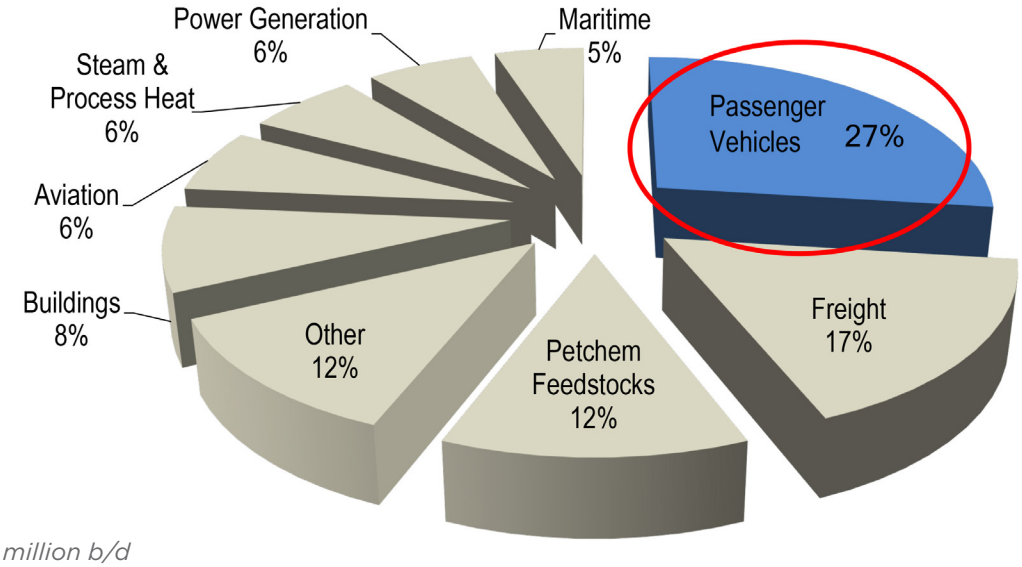
Technology change and government policies to encourage EV adoption are the most uncertain factors affecting the trend in passenger vehicle sector oil demand. For example, if battery pack costs are reduced to $100/kWh sooner than the mid-2020s, it would encourage

a more aggressive shift to EVs. Similarly, government policies incentivizing or mandating EVs or other alternatives will reduce oil demand more quickly. However, the impacts on oil demand of automation and the development of mobility services are less clear. Fleets of autonomous vehicles available on demand could reduce the cost of driving and make it more convenient, thereby increasing travel and energy demand. But autonomous vehicle fleets might be electric because EVs have lower operating costs than conventional vehicles and city governments may direct them to be electric for clean air purposes. Additional research is needed to understand the oil demand impacts of autonomous vehicles and new models of mobility.

Rationale for Studying the Passenger Vehicle Sector

As shown in figure 2, passenger vehicles represented only about one-quarter of global oil demand in 2016. This equates to about 25 million barrels per day out of an estimated demand of 94 million barrels per day.

Figure 2. Global oil demand by sector (% share, 2016)



Basis 94 million b/d
Source: International Energy Agency 2017 World Energy Outlook

However, passenger vehicles receive an inordinate proportion of government and media attention because the sector is highly visible (many people purchase cars) and some governments believe that a rapid transition from conventional to electric cars is now possible and will help them reduce greenhouse gas and other emissions. In fact, a number of governments around the world have recently mandated the phaseout of fossil fuel–powered cars beyond 2030 or 2040.

Figure 2 serves as a good reminder that many other sectors besides passenger vehicles use

oil. Even if passenger vehicle sector oil demand use were to decline, total oil demand wouldn't necessarily decline, if there were growth in oil demand for petrochemical feedstock, aviation, and freight movement. Finding substitutes for these biggest oil demand growth sectors is difficult and costly. Thus, continued growth in those sectors could offset any decline in the passenger vehicle sector.

Given high interest in the passenger vehicle sector, many forecasts with different levels of electric vehicle penetration have already been published. Thus, it made sense to survey the work that has already been done on this sector. While some passenger vehicle oil demand forecasts are in the public domain, it was difficult to compare them because they didn't define the passenger vehicle sector consistently (e.g., some included two-wheelers and light trucks and others did not) and they forecasted over different time periods. In addition, most of them did not publish the underlying drivers behind their forecasts. Therefore, it was difficult to determine whether electric vehicle penetration or other factors, such as varying rates of economic growth, were responsible for differences in their passenger vehicle oil demand forecasts.

Methodology

To compare existing long-term passenger vehicle oil demand forecasts more consistently, a survey of forecasters was undertaken in the first quarter of 2018 to collect comparable data and their key underlying assumptions. About 20 published forecasts were collected, and 15 forecasters who were willing to participate were surveyed. They represented governments, think tanks, consultants, investment banks, and oil companies. There were still data gaps because not all the participants reported all the data the author requested, and so only drivers with multiple forecasts will be reported on in this report. The largest gap in the data was caused by an insufficient number of forecasts for fuel efficiency of conventional passenger vehicles.

Since unpublished data was collected, it was agreed that sources would not be disclosed. The charts in this report will identify the type of forecaster (e.g., government, oil company, or other) but not identify the specific entity.

A few forecasters provided multiple scenarios. In fact, a number of them had scenarios representing global greenhouse gas emissions reductions that have a 50 percent probability of limiting the temperature change to two degrees Celsius. Since these scenarios require a sharp reduction in passenger vehicle oil demand but aren't necessarily the forecaster's "base case," they have been identified separately on the charts in this report. These two-degree scenarios include those by governments, oil companies, and other forecasters.

Underlying Drivers of Oil Demand Growth: Global Population and Economic Growth

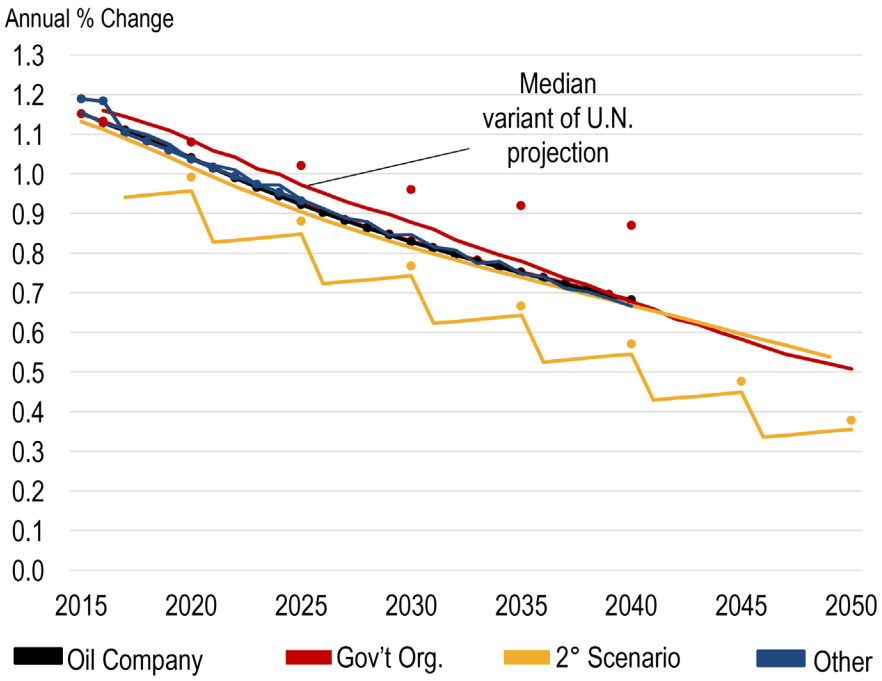
Presented here are two underlying drivers of passenger vehicle oil demand that can have a large impact on demand growth even without electric vehicle penetration. They are world population growth and economic growth. Population growth affects oil demand in several ways—it affects economic growth and directly affects the size of the vehicle fleet and miles traveled. Global economic growth influences income and the number of vehicles people can afford to purchase as well as how many miles those vehicles travel, often to commute to work.

The rates of population and economic growth are declining, which should slow the rise of passenger vehicle oil demand. However, rising incomes and urbanization in developing countries are counterbalancing forces that promote vehicle ownership and travel.

Global Population Growth

Figure 3 shows the various forecasts used for global population growth by the surveyed entities. If there are only circles, it means that forecasts were provided for every five years instead of for every year.

Figure 3. Forecasts of global population growth



Source: CGEP Survey & Analysis

All the population forecasts used show population growth continuously slowing between now and 2050. The primary reason for this is the reduction in fertility rates due to rising urbanization and education levels.

Many forecasts are based on the median variant of the United Nations population projection. The median variant is the case that UN researchers deem as the most likely scenario.

An important observation from the survey is that a number of the two-degree carbon scenarios used a lower population forecast than the UN median case. The rationale for this is unclear. These lower population growth assumptions seem to be consistent with the UN's 80th percentile projection. By the year 2100, the UN median and 80th percentile population projections differ by more than 1 billion people. To illustrate the potential impact on oil

demand of this difference, in 2015 7.3 billion people used about 93 million barrels per day of oil. Thus, on average 1 billion people used about 13 million barrels per day of fuel.

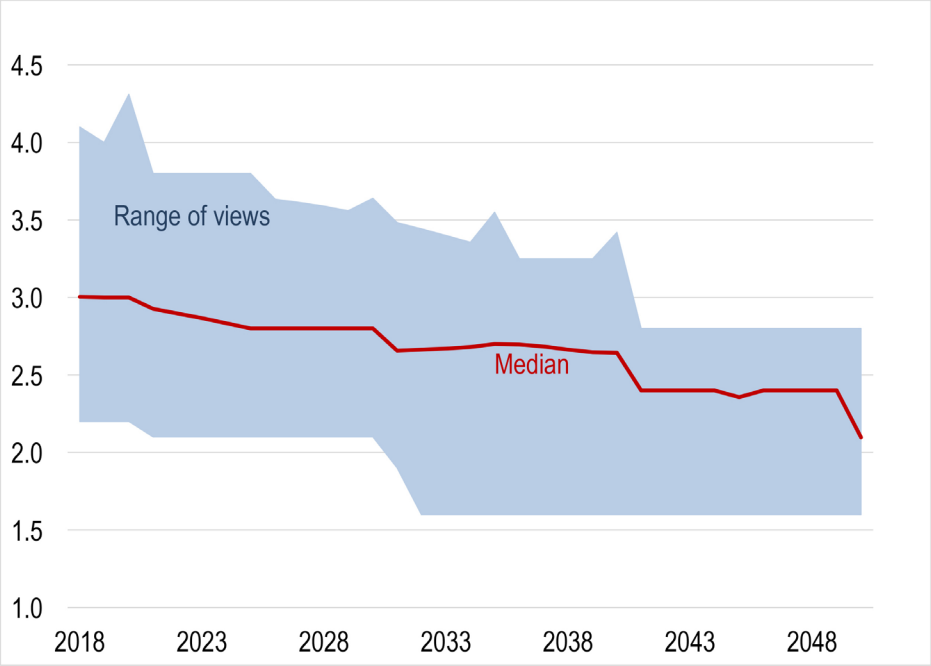
Since several two-degree carbon cases use low population growth projections, they will thus have even lower oil demand forecasts than would be expected from their high electric vehicle penetration rates. Their business-as-usual oil demand forecasts are likely starting from a significantly lower demand outlook.

Global Economic Growth

Figure 4 shows the range of global economic growth forecasts and the median of the forecasts. All forecasts assume that the rate of economic growth will decline over time owing to a deceleration of population growth and a decline in the share of the population at the productive working age. The population ages owing to the combination of low fertility rates and rising life expectancy.

Figure 4. Forecasts of global economic growth

Real global GDP growth (annual % change)



Source: CGEP Survey & Analysis

The highest global economic growth forecasts tend to be those from governments and investment banks. The bottom of the range was set by an oil company, and it represented a scenario with significant protectionism and geopolitical risk. While it is not shown here, there was a wider range of views for economic growth in non-OECD nations than in OECD nations.

The most interesting observation is that there was no consistency in assumptions about global economic growth among the various two-degree carbon forecasts. There were assumptions of (1) stronger economic growth, (2) weaker economic growth, (3) a transition from weaker to stronger economic growth post-2030, and (4) no difference in economic growth from the base case. Economic growth is an important driver of oil demand, and those differences in assumptions have the effect of either exacerbating (in the case of low economic growth) or minimizing (in the case of high economic growth) the decline in oil demand.

Electric Vehicle Penetration

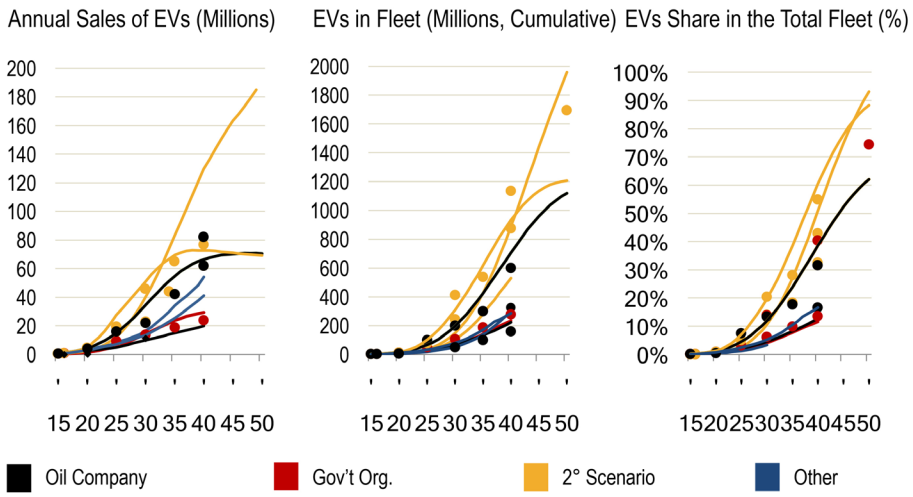
The outlook for global EV penetration is highly uncertain. Some countries, like China, have strong policy drivers, and others, like the United States, do not. It is unclear what degree of penetration would occur without strong policy drivers. It would depend partly on when battery costs fall sufficiently to make these vehicles competitive with conventional ones. It would also depend on when and whether mainstream consumers perceive the EV to be equal to or more attractive than the conventional vehicles they drive today. At what point do the perceived benefits (e.g., faster acceleration, lack of noise, avoidance of gas stations, coolness, environmental goodness, and government incentives) outweigh the lessening challenges of EVs (range, battery life, limited recharging infrastructure, recharging time, etc.), if at all?

The author gathered forecast data on global and regional EV penetration in the passenger vehicle fleet and the volume of miles traveled (VMT) by EVs. In forecasting the loss in oil demand from EVs, it is important to understand whether EVs are being used as a second car or for short commutes, or whether they are capturing most of the miles driven.

Global EV Penetration

Various forecasts for global annual electric vehicle sales, the cumulative size of the electric vehicle fleet, and EVs' share of the global auto fleet are shown in figure 5.

Figure 5. Forecasts of global electric vehicle penetration



Source: CGEP Survey & Analysis

The graph of global "Annual Sales of EVs" shows that sales of EVs are modest before 2020. The middle and right-hand graphs show how much longer it takes for cumulative EVs to become a significant part of the global auto fleet. People generally hold onto their existing cars for many years, delaying the pace of EV penetration. In the United States and Europe, the average age of passenger vehicles is about 11 years, and it is much higher in some other regions. Even in rapid penetration scenarios, EVs don't become a substantial part of the fleet until 2030 or beyond.

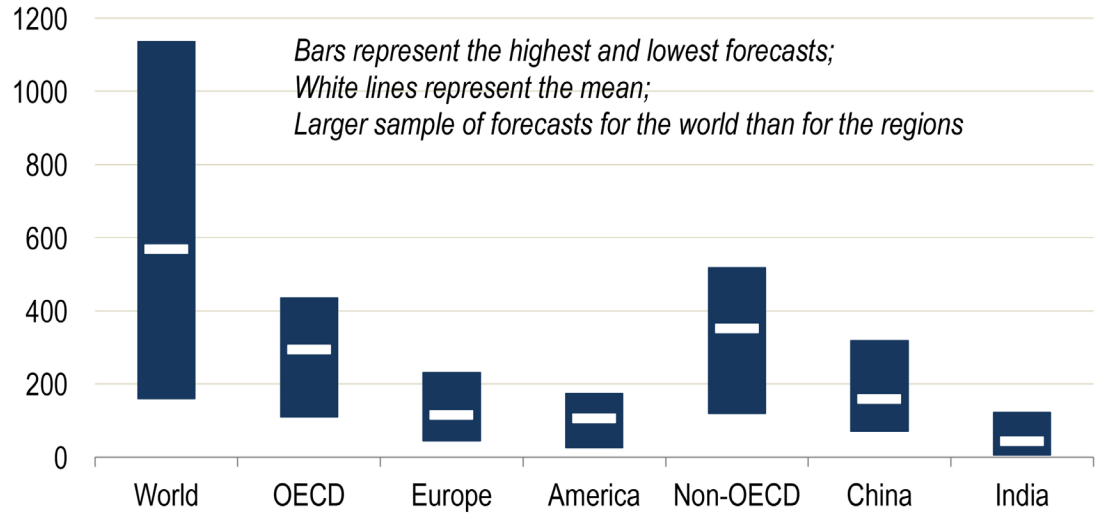
The graph depicting "EVs Share in the Total Fleet" indicates the wide gap in the degree of EV penetration between two-degree carbon and other forecasts. In 2040, views of EV penetration in the global auto fleet ranged from 15 percent to 60 percent. The highest two-degree carbon EV penetration forecasts also tend to assume lower overall fleet sizes due to weak population growth and/or government policies discouraging vehicle use. This would exacerbate the reduction in oil demand. It is unclear whether the forecasters of the two-degree carbon scenarios think this is what needs to happen to meet the two-degree trajectory or whether they believe it is the most probable forecast.

Regional Views of EV Fleets

Figure 6 shows the forecast data collected on the range of views of the cumulative EV fleets by region for the year 2040. The range of views on penetration is reflected by the length of the bars. Note that the range in views for the global fleet is wider than the ranges for regional fleets. That happened because fewer regional forecasts were submitted than global ones and forecasters with some of the more extreme views didn't submit regional data. The white horizontal line through each bar indicates the mean of forecasts for that geography.

Figure 6. Forecasts of regional views on the size of the EV fleet in 2040

Millions, cumulative



Source: CGEP Survey & Analysis

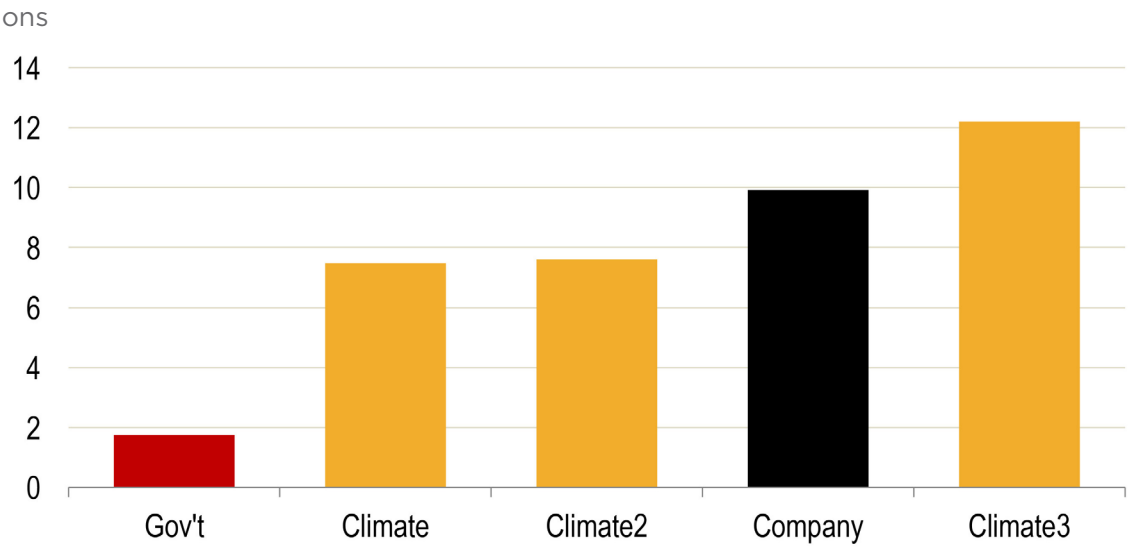
A wide range of uncertainty around EV penetration across all the regions can be observed. However, fewer EVs are generally expected in America and India than in other regions. The author speculates that the reasons for weak EV penetration in these regions is the absence of supporting federal policy in America and the inadequacy of power and other relevant infrastructure in India.

Global Annual Vehicle Miles Traveled by EVs

Miles driven by EVs versus conventional vehicles have a large impact on oil consumption. For example, if EVs are used only for short commutes and if conventional SUVs are used for most other miles driven, then EVs won't reduce oil demand much. Alternatively, if EVs are used for a disproportionate amount of the miles traveled, then they will have a large impact on oil demand.

Unfortunately, few forecasts of vehicle miles traveled by EVs were submitted. However, a wide range of views can be observed in the few received, as shown in figure 7.

Figure 7. Forecast of global annual VMT by EVs in 2040*



*Source: * Includes plug-in hybrids running in electric mode*
Source: CGEP Survey & Analysis

The highest forecast (called Climate 3 in this chart) assumes that by 2040 more than half of the passenger vehicle fleet is electric. Thus, EVs account for a substantial share of total vehicle miles traveled in that forecast. The second highest forecast was by an oil company who believes that while EVs aren't a large part of the global fleet, they account for a substantial share of the VMT. This forecast is consistent with the view that there will be a new model of mobility where automated electric vehicle fleets provide transportation on demand in urban areas and thus become responsible for a disproportionately large share of the total miles driven.

The advent of autonomous fleets providing transportation on demand raises the questions of whether and when these fleets will be fully autonomous and whether they are likely to be composed of electric or conventional vehicles. There are several reasons why they may be electric. First, mobility services are most likely to arise in areas with high population density, and city governments may require them to be electric to reduce local air pollution. Second, the economics of EVs improves with highly utilized fleet vehicles because the higher up-front capital cost of EVs is amortized over a larger number of vehicle hours. In addition, EVs have lower operating costs than conventional vehicles owing to lower electricity costs than gasoline or diesel fuel and lower maintenance costs owing to fewer moving parts.

There is also an important question about whether autonomous transportation on demand will increase VMT, offsetting the efficiency gains associated with autonomous driving. If you lower the cost of driving (e.g., no pay for a driver and lower variable costs) and make it more convenient to travel, people will likely travel more. Energy demand may increase owing to higher VMT, but it is uncertain whether this will boost electricity demand or gasoline/diesel demand.

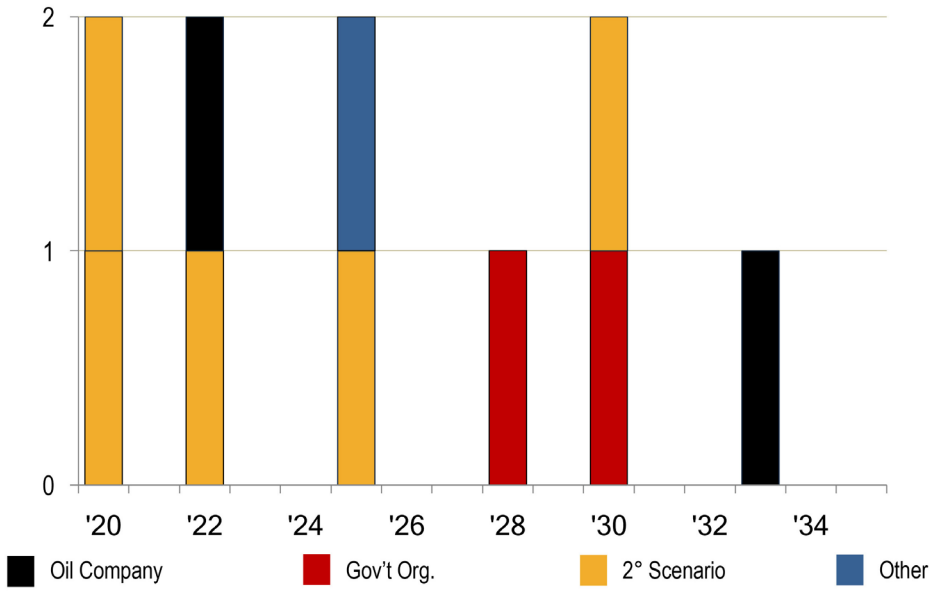
Battery Cost

A key underlying driver of EV penetration is that battery pack costs will reach $100/kWh, which will make EVs competitive with conventional vehicles without subsidies by governments or the automotive industry. Forecasters were asked the year in which they believe battery costs will reach that cost level. Battery pack costs are generally believed to be over $200/kWh today.

Figure 8 shows that two-degree carbon forecasts tend to assume an earlier breakthrough in battery costs than other forecasts.

Figure 8. Forecast of when battery prices reach $100/kWh

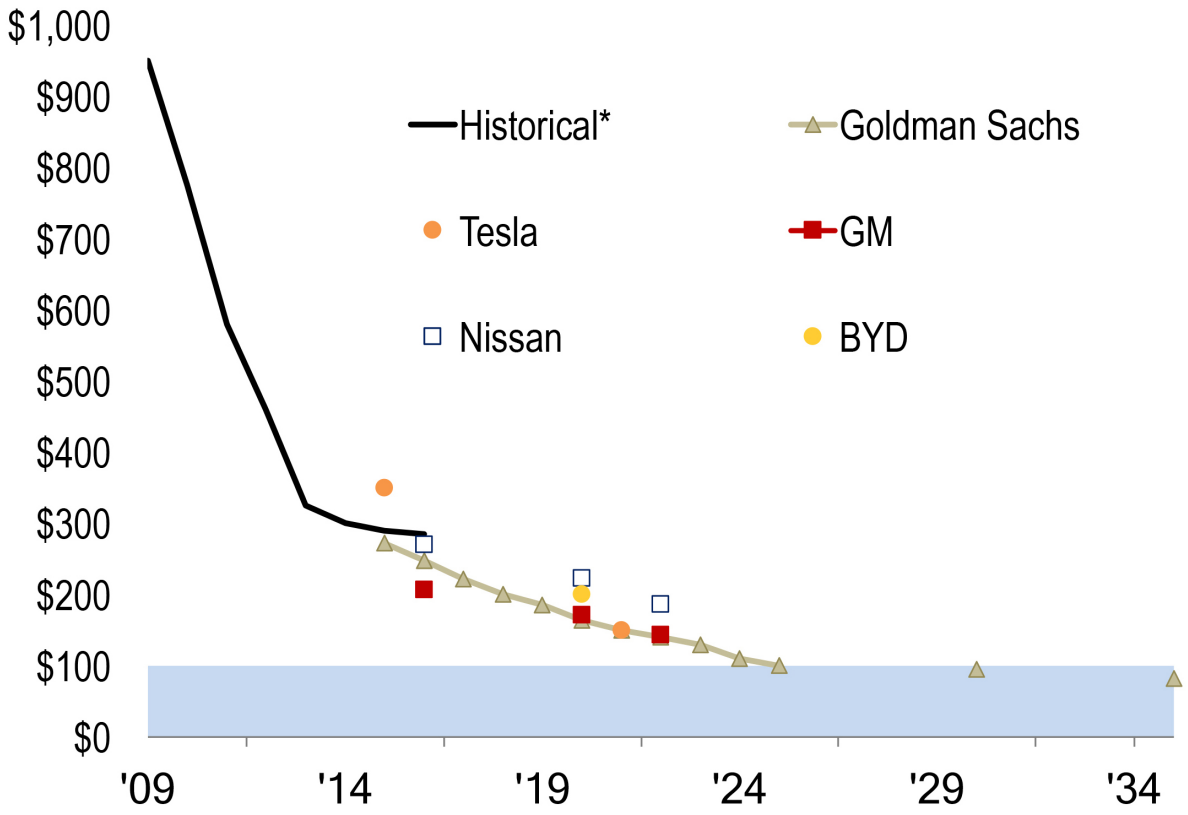
Number of forecasts reaching $100/kWh in each year



Source: CGEP Survey & Analysis

There are other published views to compare these survey results with, including those of automotive manufacturers. They expect battery costs to fall to $100/kWh in the mid-2020s and not in the early 2020s, as some of the more aggressive survey participants suggested.

Figure 9. Automotive battery cost projections ($/kWh)



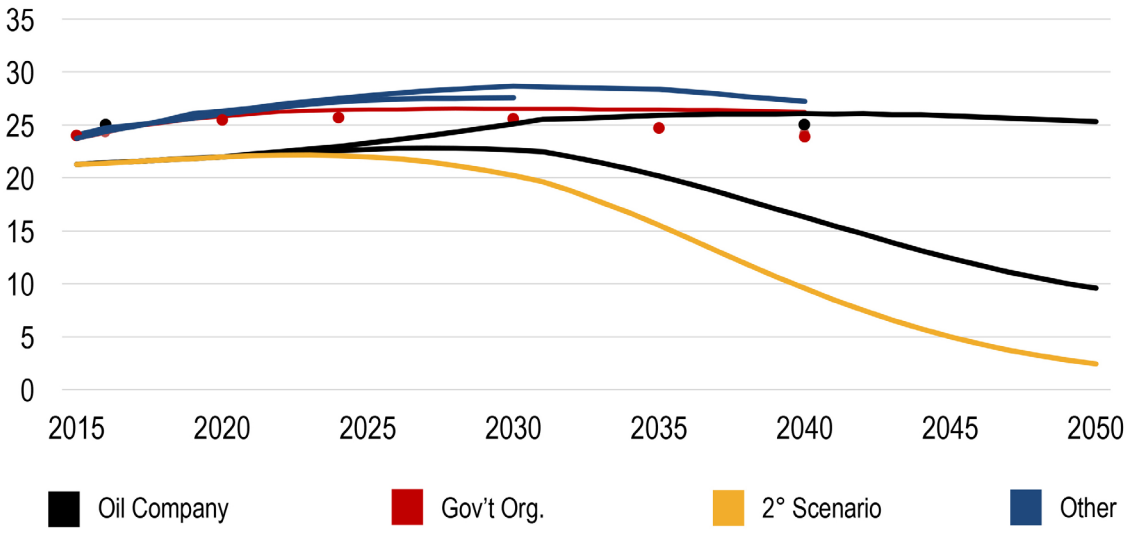
Source: BNEF, EIA, Car Manufactures, Goldman Sachs "Future of Oil Demand: Not the Drivers You May Think" dated July 23, 2017, WM "A New Energy Paradigm: EV, Renewable Energy and the Implications For Oil and Gas" Calgary Energy Forum June 27, 2017 (Prajit Ghosh)

Forecasts of Global Passenger Sector Oil Demand

Figure 10 contains the various forecasts for global oil demand in the passenger vehicle sector. It includes only the forecasts that stated demand on the requested comparable basis.

Figure 10. Forecasts of global oil demand in passenger transport

Millions of barrels per day



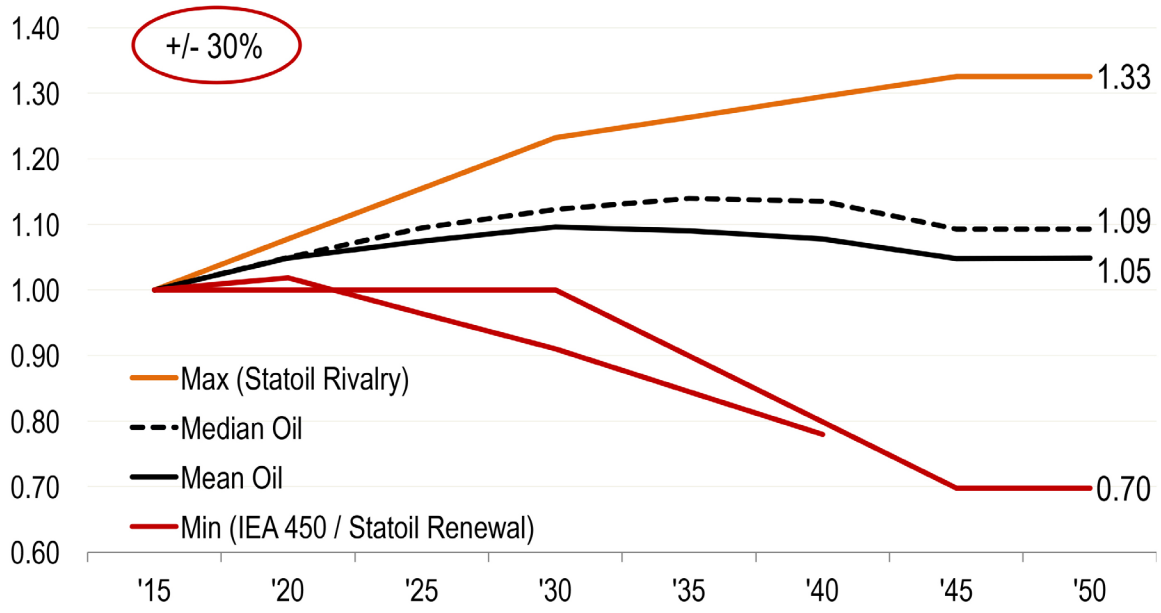
Source: CGEP Survey & Analysis

The chart shows that little growth is expected in passenger transport oil demand beyond 2020. In many cases, demand remained flat thereafter throughout the forecast period. In a few cases, a considerable decline is anticipated. In the lowest forecast, representing a two-degree carbon scenario, oil demand falls by 12 MMBD or by over 50 percent by 2040.

Owing to the plethora of government policies aimed at reducing oil use and emissions from the transportation sector, the passenger vehicle sector is not considered to be a growth sector despite many people buying vehicles for the first time in developing countries. However, as mentioned earlier, a decline in passenger vehicle oil demand does not necessarily mean that total oil demand will decline. There may be strong-enough growth in petrochemicals, aviation, and trucking to offset any decline in the passenger vehicle sector. In fact, figure 11 depicts the highest and lowest total global oil demand forecasts published in 2017 along with the median and mean and shows that the expected range around the mean from the highest and lowest forecasts is 30 percent in both directions. In other words, there is equal upside and downside risk to the total oil demand forecast. That is in sharp contrast with passenger vehicle sector oil demand forecasts, where there is no upside and considerable downside risk.

Figure 11. Ranges in Total Global Oil Demand Outlooks

Oil demand forecast ranges (2015 = 1)



Source: BP, Exxon, Carbon Tracker (3 scenarios), Statoil (3 scenarios), EIA, IEA (3 scenarios), OPEC, 2017

Areas for Future Research

Based on the research summarized in this paper, the greatest areas of uncertainty that would benefit from future research are the impact on energy and oil demand of autonomous vehicles and new mobility services. It is important to increase understanding in these areas because it is possible that lowering the cost of driving and the convenience of autonomous taxis may increase driving and energy use.

It is also important to revisit the timing of battery costs falling to levels that compete with internal combustion engines and how issues surrounding the battery supply chain (e.g., availability of lithium and cobalt) will affect cost. In addition, the slow pace at which new mines are opening could slow the rate of battery production and EV penetration.

Overall, unless the world moves rapidly to a two-degree carbon scenario, it would take decades and significant policy drivers for the world to transition away from oil. It would also likely require more than a slowdown in the rate of demand growth in the passenger transport sector. It would likely require policy drivers that reduced oil use for petrochemical feedback, air travel, and freight transport.

ABOUT THE AUTHOR

Marianne Kah is an Adjunct Senior Research Scholar and Advisory Board member at the Center on Global Energy Policy. She had been the Chief Economist of ConocoPhillips at its Houston headquarters for 25 years where she was responsible for developing the company's market outlooks for oil and natural gas, and was the company's expert in scenario planning. She is also a Director of Petroleum Geo-Services. Ms. Kah has a B.S. from Cornell University and Master of Public Administration from the Maxwell School of Citizenship and Public Affairs at Syracuse University.

The views represented in this commentary represent those of the author not the Center on Global Energy Policy or Columbia University.

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