Impact of Electric Vehicles on the Oil Industry...

Crude @ $20/BBL ?

Kirk Williams

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Agenda

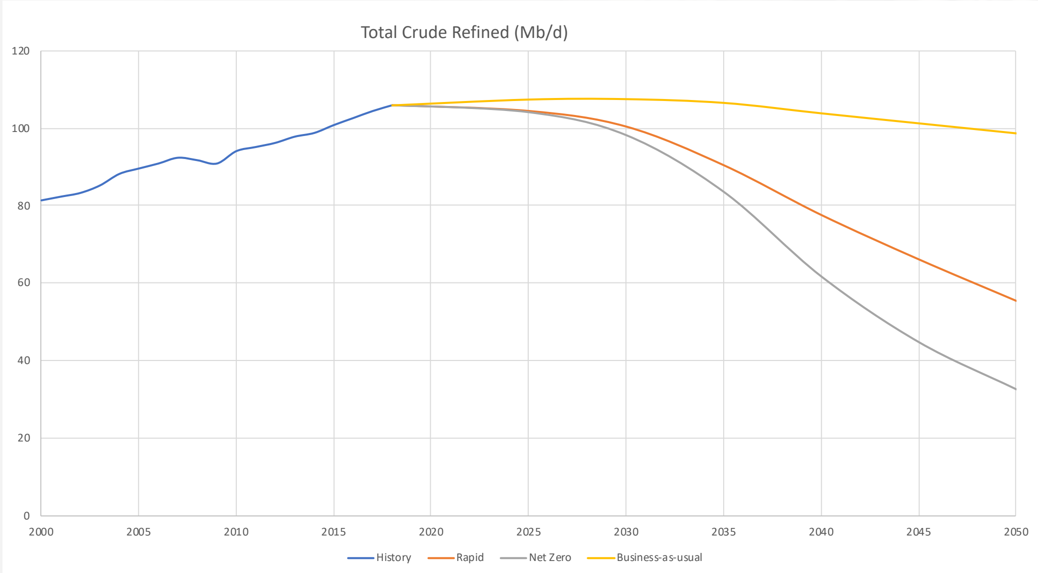
Summary

- The impact of Electric Vehicle sales on crude oil demand is likely to be more profound, larger and sooner than most predictions would suggest and perhaps present an existential risk to the oil industry.
- The impact is beyond the simple reduction in crude demand caused by the substitution of electric vehicles for oil powered vehicles. If this were the case, we would expect to see a peak in crude oil demand of around 100 million barrels per day around the mid 2030's, followed by a long slow decline in demand.
- Unfortunately, the situation is likely to be much more complicated. Because the refining of crude oil necessitated the production of all refined products, i.e. a "product barrel", it will not be possible to significantly reduce the production of Gasoline and Diesel without similar reductions in the product of other oil products, most notably JET fuel.
- While some flexibility exists to "optimize" the product barrel shape and it is simple to downgrade surplus Kerosene to Diesel, the reverse is not possible beyond some hard product specification limits and ability of refiners to shift yield from gasoline and diesel to JET is very limited and made more difficult by the heavy investment over the decades in heavy oil and light ends conversion to gasoline and diesel. The production of which has been the focus of the refining industry for almost a century, since the end of first world war.
- By the mid 2030's, it's likely that we will see increasingly stressed production in Europe, followed by the China, Japan, the rest of Asia and US, depressed gasoline and diesel prices, declining crude demand and widening arbitrage gaps between the surplus markets and the short markets. As the EV penetration spreads more widely these arbitrage opportunities will disappear and followed by a possible collapse in crude prices accompanied by very large increases in JET fuel prices.
- There are of course technological solutions that can mitigate this effect, conversion processes (e.g., hydrocracking) to maximize JET fuel production at the expense of Gasoline and Diesel, a stronger emphasis on chemicals production to soak up more of the surplus light end of the barrel. There are even some promising biotech solutions for molecular weight conversion technologies. While all are feasible, the investment and time required to commercialize and scale these is perhaps insufficient. It would require the construction of >20,000,000 barrels per day of conversion capacity using technology that is not commercially available today.
- The most interesting impact will be on crude prices, in theory this product barrel shape issue should depress prices, also widening the quality premium paid for high Jet yielding crudes, but its likely there will be some upward price pressure due to reduced upstream production investment which will put downward pressure on supply. These pressures may balance out to mitigate the price impact described here in. The message is one of uncertainty and that he historic metrics for predicting long term crude prices almost certainly don't apply.

1: EV’s and Crude Oil Demand Forecasts

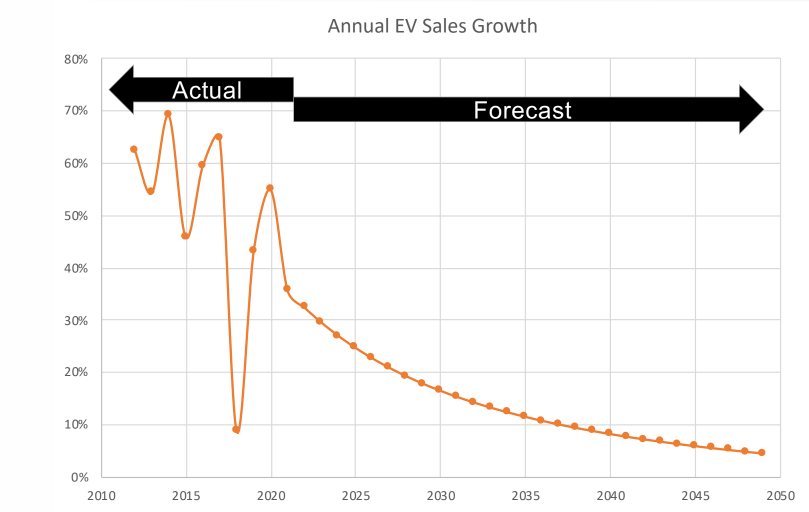
EV's and Crude Oil Demand Forecasts

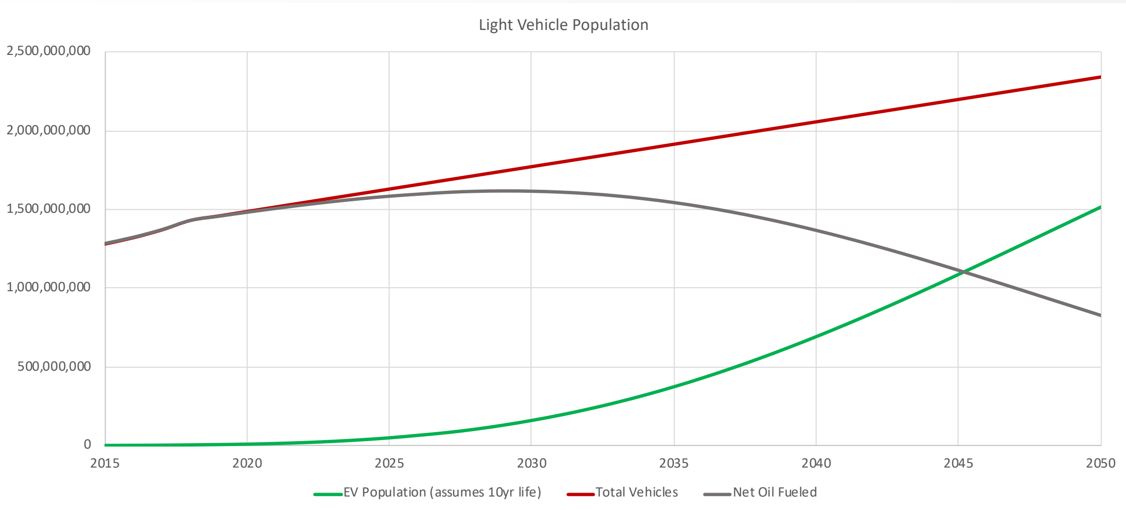
- Typical industry estimates of refinery demand for crude oil can be seen to the right (Business-As-Usual), a steady slow growth plateauing in the mid 2030's with a peak demand of around 108million b/d. This forecast predates the COVID demand issues and assumes the "Net-Zero" goals associated with the Paris Accord will not be attained. The two other scenarios shown are aligned with the IEA's "Net-Zero" simulations that illustrate the required demand profiles to reach, or approach, the Paris Accord targets by 2050.
- The auto industries forecasts for total vehicle population growth has a common consensus number is around 2 – 2.5 billion light vehicles by 2050 regardless of type.
- This fuel demand estimate is for the most part ignoring the impact of electric vehicles on transport fuel demand. The working assumption appears to be that the impact of EV population growth will be diluted, or swamped by overall light vehicle population growth, particularly in emerging markets like China and India. This is unlikely to be true.



(Based on Data from BP's 2020 Energy Outlook)

EV's and Crude Oil Demand Forecasts





Recent trends in the EV market combined with announced government policies (see slides 15 - 18) would suggest that most demand forecasts are likely to be very unrealistic. Several papers have been published looking at some very aggressive sustained market growth forecasts for EV's. For example, linear growth exceeding 20% per annum. Compounding growth at rates of this level yield enormous and unrealistic EV populations by the mid-2030's.

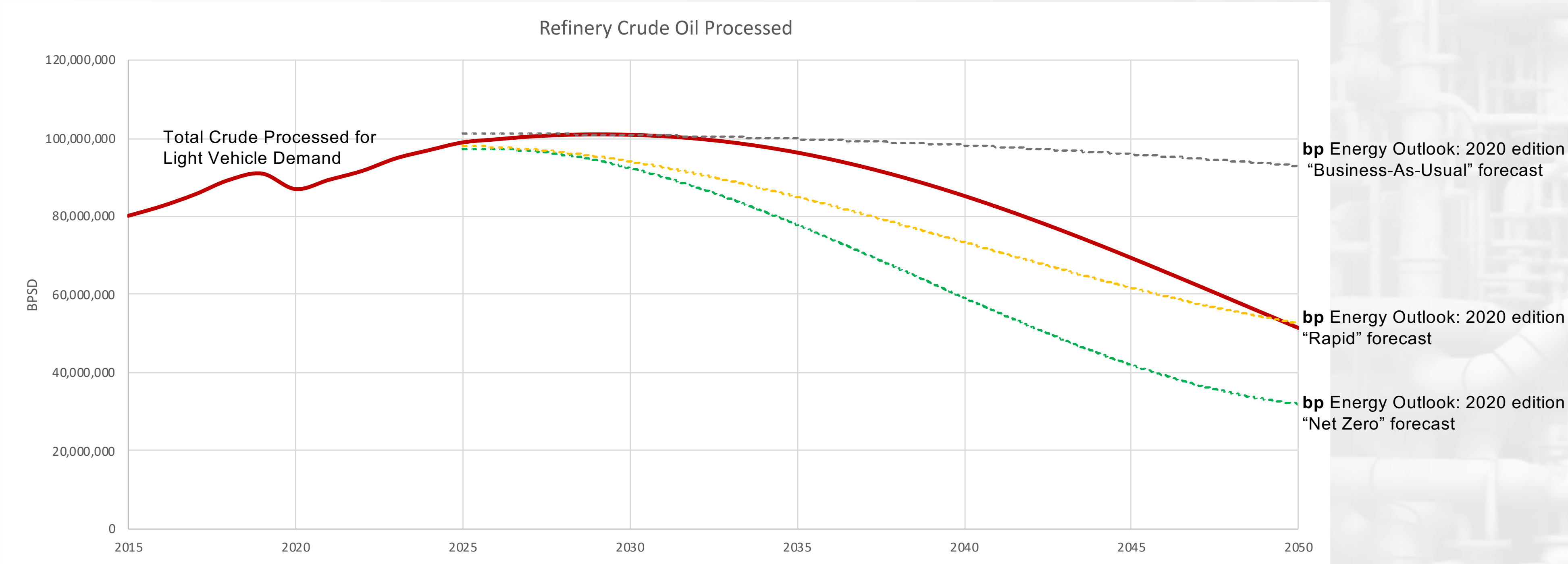
However, for the purposes of this analysis the following, more conservative, growth estimates have been used (shown in the graphs to the left). This is in line with the type of initial explosive growth from a very low base and then decreasing to more sustainable levels as the population expands. This is typical of what is seen in hi-tech markets with very high early adoption enthusiasm.

Even with this relatively conservative growth estimates its likely that EV's will account for >60% of the light vehicle population by 2050.

The impact on crude oil demand will be profound……

EV’s and Crude Oil Demand Forecasts

- Given this forecast of light vehicle population, the forecast for refinery crude oil consumption can be seen below (in red), it is predicting a peak demand of the order of 100 million barrels per day around 2030. This would be followed by an accelerating roll off in demand as the EV population begins to dominate the light vehicle market. This forecast is between the “Business As Usual” and “Rapid” forecasts of the BP’s 2020 Energy Outlook. This delay in the roll off in demand is the result of the time required to build the EV population and its impact on oil demand to work through. While this is a relatively modest demand fall off compared to the BP’s 2020 Energy Outlook “Net-Zero” scenario, it is still not a very pretty picture for the oil industry, with a near 50% demand reduction.
- Unfortunately, this estimate only tells part of the story. Underlying this demand forecast is a distortion in the demand barrel shape that will present some serious issues for the refining industry. This demand roll off is largely confined to light vehicle fuels, i.e., LPG, Gasoline and Diesel. Unfortunately, the demand for other fuels will continue to grow unabated, specifically JET fuel demand. The distortion in the product barrel is likely to have a significant impact on the market much sooner than the steady decline in primary transport fuels demand.



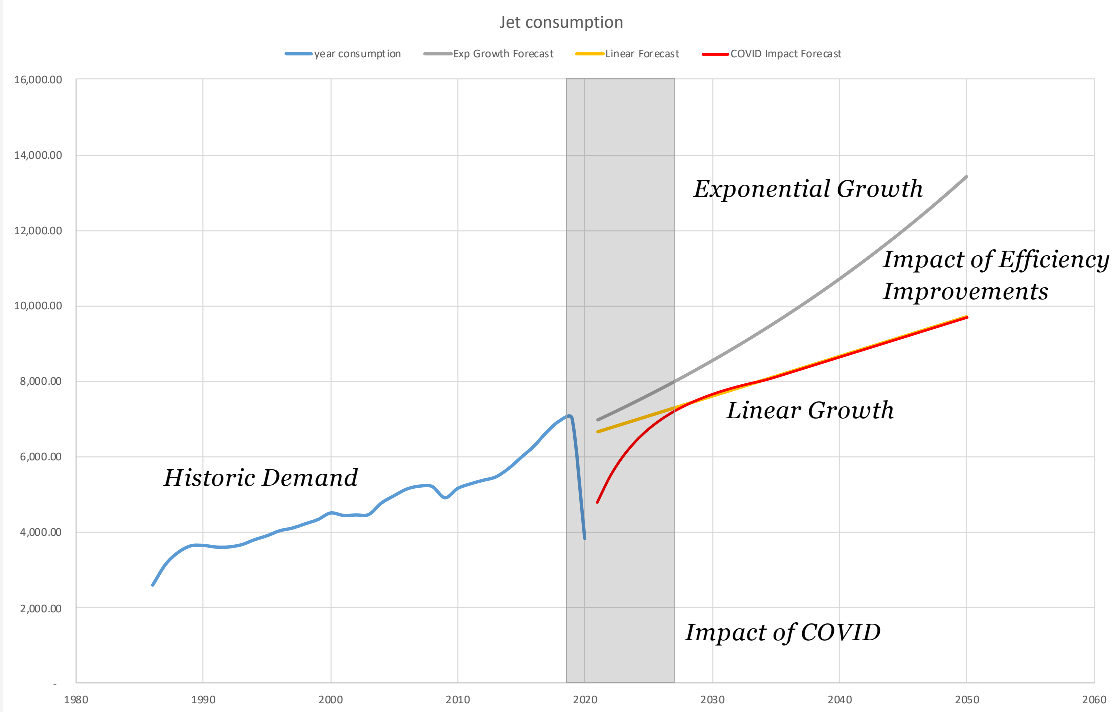
2: The Impact of Product Barrel Distortion

EV’s and Crude Oil Demand Forecasts

The Impact of Product Barrel Distortion

A look at JET fuel demand;

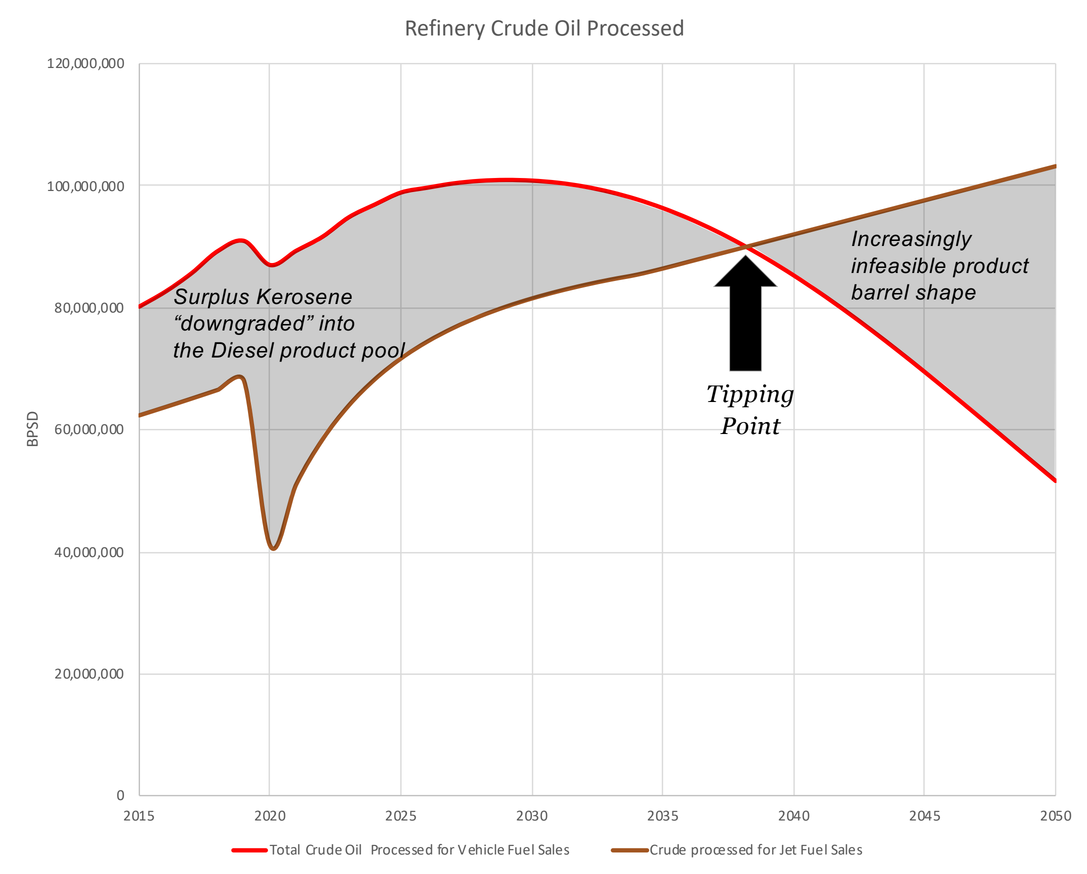
- There has been an expectation of long-term growth in the JET fuel demand as commercial aviation passenger miles continue to grow at exponential rates. Most industry forecasts have traditionally been aggressive, with a doubling of demand in the next decade.
- The impact of COVID on the airline industry, specifically passenger flights, has been profound. The impact on JET fuel demand can be seen in the chart to the right. Estimates of when passenger flight demand will recover are widely speculative. The assumption in this forecast is that demand levels will not fully recover to pre-COVID levels before 2026. Then demand will follow a linear growth as passenger miles grow exponentially (as previously forecasted by the industry).
- Growth in passenger miles demand will be offset by improved commercial aircraft fuel efficiency and a linear (conservative) growth estimate is shown to the right. *(It is not expected the electrically powered commercial aircraft will be available for general use before 2050.)*
- This will present as increasing JET fuel (or kerosene) demand on refiners while they are facing falling demand for Gasoline and Diesel.



EV's and Crude Oil Demand Forecasts

The Impact of Product Barrel Distortion

- An unfortunate reality of the refining of crude oil is that its impossible ***not*** to make all the co-products. Producing one tonne of JET fuel typically necessitates the production of 4 to 5 tonnes of Gasoline and Diesel. This issue is exacerbated by the historically long-term evolution of the refining industry to toward greater and greater conversion of light and heavy fractions into Gasoline and Diesel.
- The distortion in the product barrel shape brought about be declining Gasoline and Diesel demand and increasing JET demand will become increasingly important as the two demand curves cross in the mid to late 2030's, see the chart to the right. As the crude need to be refined to meet the JET fuel demand exceeds the crude needed to supply the Gasoline and Diesel demand the production of JET fuel will increasingly be accompanied by the production of unwanted Gasoline and Diesel.
- Initially the refiners will shift light middle distillate from Diesel to JET, then Gasoline to chemical feedstock and try to maximize the conversion processes yield of Jet at the expense of heavy naphtha and light Diesel. This will only have a marginal, short-term impact. Eventually this distortion will be come harder and harder to mitigate, and there will be unavoidable production of Gasoline and Diesel for which there is no market.
- While there is no engineering issue that cannot be solved with the application of money and time. The very long lead times and expense to implement major process changes, at scale, across the entire industry will likely make this an intractable problem.



3: Market Consequences

EV's and Crude Oil Demand Forecasts

- Market Consequences

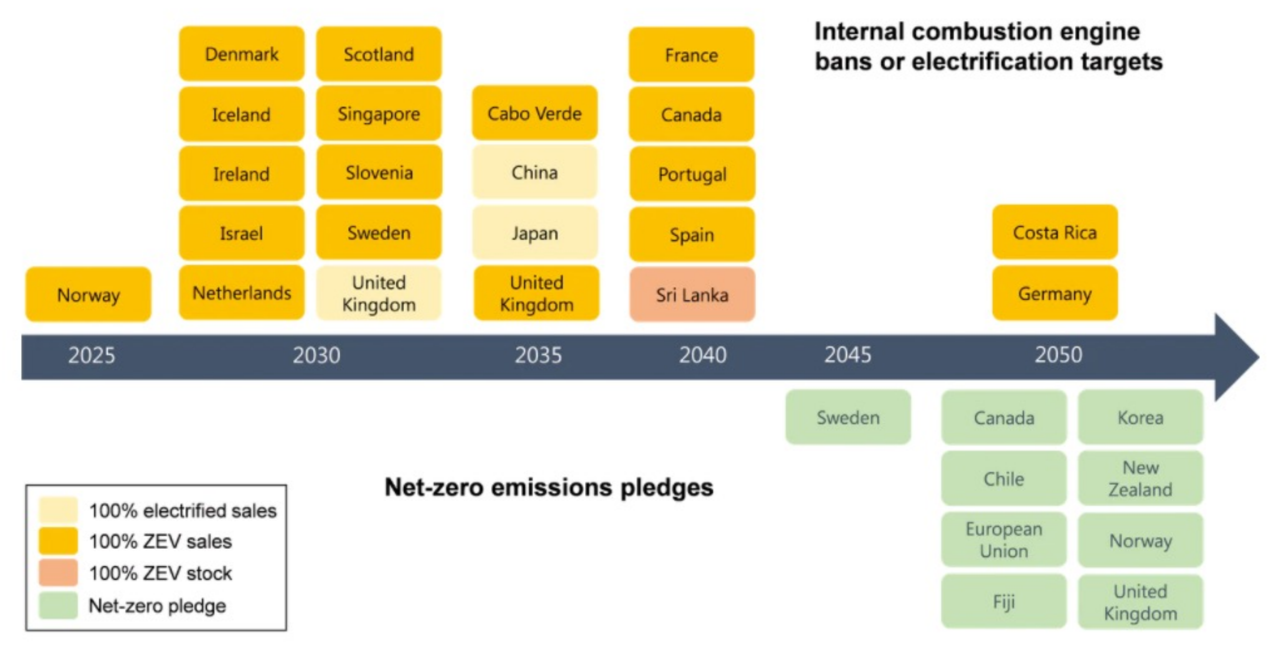
- The impact of this product barrel distortion will not initially be uniform across all markets, it can be expected that the first signs will be seen in Europe as the push for EV's in Europe is strongest. Asia will follow later, although the wild card is the speed of adoption in China, where the impact of government policy decisions are only now starting to be seen.
- The first indications of production issues will be a widening of the arbitrage gaps between Europe and Asia for Gasoline and Diesel and opposite gaps for JET fuel. This will be followed by a softening in demand for crude and more imports of finished products (JET mostly) into Europe.
- As the impact spreads, China and Japan demand will follow the European trend and crude prices will dramatically soften and then likely collapse. If the US and India become aggressive in their legislative programs around EV's the market impact will be much more severe and much sooner.

4: Summary of Government EV Legislation, Regulations and Incentives

Summary of Government EV Legislation, Regulations and Incentives

- There have been a long list of announced initiatives by Governments, initially in Norway, followed by most of the EU, Israel, Singapore, China and the UK, proposing bans on the sale of vehicle with internal combustion engines, typically in the 2030 – 2050 time frame. (see the next slide)
- A similar announcement in India has been made, although the ability of the Indian government to implement such a policy remains to be seen,
- China has long had incentives for EV’s, mostly at the city level, with removal of the high-cost restrictions on new vehicle registration for EV’s, exemptions for EV’s from vehicle the usage restrictions in heavily polluted cities such as Beijing and reduced VAT rates for EV’s. China recently announced it was looking at similar regulations to those proposed in Europe.
- The following slides summarize the recent announcements and current regulations/incentives.

Summary of Government EV Legislation, Regulations and Incentives



https://www.iea.org/reports/global-ev-outlook-2021/policies-to-promote-electric-vehicle-deployment

Sources

See list of sources in the Annexes.

Notes

Only countries that have either an ICE ban or electrification target or with net-zero emissions in law or proposed legislation have been included. Those with net-zero emissions policy documents only, e.g. Japan and China, have not been included. European Union refers to the collective pledge of the 27 member states. Some individual countries also have net-zero emissions pledges either in law or proposed legislation (Denmark, France, Germany, Hungary, Ireland, Luxembourg, Slovenia, Spain, Sweden and the Netherlands). The targets reflect the status as of 20 April 2021. Electrified vehicles here include battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), fuel cell electric vehicles (FCEVs) and hybrid electric vehicles (HEVs), depending on the definitions of each country. ZEV = zero-emission vehicle (BEVs, PHEVs and FCEVs).

Summary of Government EV Legislation, Regulations and Incentives

Current zero-emission light-duty vehicle policies and incentives in selected countries

		Canada	China	European Union	India	Japan	United States
Regulations vehicles	ZEV mandate	**British Columbia**: 10% ZEV sales by 2025, 30% by 2030 and 100% by 2040. **Québec**: 9.5% EV credits in 2020, 22% in 2025.	**New Energy Vehicle dual credit system**: 10-12% EV credits in 2019-2020 and 14-18% in 2021-2023.				**California:** 22% EV credits by 2025. **Other states:** Varied between ten states.
	Fuel economy standards (most recent for cars)	114 g CO_2/km or 5.4 L/100 km*** (2021, CAFE)	117 g CO_2/km or 5.0 L/100 km (2020, NEDC)	95 g CO_2/km or 4.1 L/100 km (2021, petrol, NEDC)	134 g CO_2/km or 5.2 L/100 km (2022, NEDC)	132 g CO_2/km or 5.7 L/100 km (2020, WLTP Japan)	114 g CO_2/km or 5.4 L/100 km*** (2021, CAFE)
Incentives vehicles	Fiscal incentives	✓	✓	✓	✓	✓	✓
Regulations chargers**	Hardware standards.	✓	✓	✓	✓	✓	✓
	Building regulations.	✓*	✓*	✓	✓		✓*
Incentives chargers	Fiscal incentives	✓	✓	✓	✓	✓	✓ *

* Indicates that it is only implemented at state/provincial/local level. ** All countries/regions in the table have developed basic standards for electric vehicle supply equipment (EVSE). China, European Union and India mandate specific minimum standards, while Canada, Japan and United States do not. *** Historically, Canada and the United States have aligned emission standards for on-road light-duty vehicles. In April 2020 the United States adopted a final rule to reduce the annual stringency conditions for the 2021-2026 model years. Soon after, Canada finalised its mid-term evaluation of the Passenger Automobile and Light Truck GHG Emissions regulation, indicating a potential separation from the US ruling, pending further consultation. ✓ Indicates that the policy is set at national level. Notes: g CO2 /km = grammes of carbon dioxide per kilometre; L/100 km = litres per 100 kilometres; CAFE= Corporate Average Fuel Economy test cycle used in the United States and Canada fuel economy and GHG emissions tests; NEDC = New European Driving Cycle; WLTP= Worldwide Harmonized Light Vehicle Test Procedure; WLTP Japan = WLTP adjusted for slower driving conditions in Japan. Building regulations imply an obligation to install chargers in new construction and renovations. Charger incentives include direct investment and purchase incentives for public and private charging.

https://www.iea.org/reports/global-ev-outlook-2021/policies-to-promote-electric-vehicle-deployment

Summary of Government EV Legislation, Regulations and Incentives

China's major cities have implemented a broad array of EV promotion policies

City	Car plate restrictions and ZEV direct access	Traffic restrictions and ZEV waivers	Lower cost or free parking	Subsidies for the use of charging infrastructure	Direct ZEV purchase subsidies	Public bus fleet electrification
Shanghai	✓	✓		✓ 2020		✓ 2025
Beijing	✓	✓				✓ 2020*
Chengdu		✓	First two hours			✓ **
Guangzhou	✓		First hour		✓ 2020/21	✓ 2020
Zhengzhou			50% off		✓ 2020	
Chongqing		✓	100% off	✓	✓ 2020	
Shenzhen	✓		First two hours		✓ 2020/21	
Suzhou			First hour			✓ 2020*
Hangzhou	✓	✓				✓ 2022
Dongguan						✓ 2020
Xi'an		✓	First two hours			✓ 2019
Wuhan		✓	First hour and then 50% off			
Tianjin	✓	✓		✓ 2020		✓ 2020*
Changsha						✓ 2020
Foshan						✓ 2019
Ningbo						✓ 2022
Nanjing			First hour			✓ 2021
Kunming			First two hours			✓ **
Jinan		✓	First two hours and then 50% off (BEV)	✓ 2020/21		✓**
Shijiazhuang		✓			✓ Dec 2020	✓ 2020*

* Indicates the full fleet electrification target applies to the city's urban area. ** Indicates that the electrification requirement applies only to new or replacement vehicles Notes: ZEV = zero-emissions vehicle. All restrictions refer to privately owned LDVs. Various other restrictions apply to commercial vehicles. The cities are ranked by size of the car fleet in 2019. For the categories subsidies for the use of charging infrastructure and direct ZEV purchase subsidies the numbers indicate the years for which the policy is active. For the category public bus fleet electrification, the numbers specify the year by which the total stock is expected to be electrified. Sources: See list of sources in the Annexes chapter.

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Summary of Government EV Legislation, Regulations and Incentives

Current zero-emission heavy-duty vehicle policies and incentives in selected countries

Policy Category	Policy	Canada	China	European Union	India	Japan	United States
Regulations vehicles	ZEV sales requirements			Voluntary to earn credits economy standards under fuel. Municipal vehicle purchase requirements.			**California:** new bus sales 100% ZEV by 2029. **California and New Jersey:** new truck sales up to 75% by 2035.
	Fuel economy standards	✓	✓	✓	✓	✓	✓
	Weight exemptions			2 tonnes over class.			**California:** 2 000 pounds over class.
Incentives vehicles	Direct incentives	✓*	✓*	✓*	✓	✓	✓*
Incentives fuels	Low-carbon fuel standards	✓*					✓*
Incentives EVSE	Direct investment	✓			✓	✓	✓*
	Utility investment						✓*

* Indicates implementation only at state/local level. Notes: ZEV = zero-emission vehicle, which includes BEV, PHEV and FCEV; EVSE = electric vehicle supply equipment. Weight exemptions support freight operators by allowing ZEV trucks to exceed strict weight restrictions by a set amount. Because batteries weigh more than diesel fuel combustion technologies, ZEV truck operators may need to reduce their cargo to meet weight restrictions, resulting in lower profits and inefficient freight delivery. Utility investment: electric utilities tend to be large companies with business interests in EV charging, but they may be unwilling or unable to invest in charging infrastructure. Leading provinces and states have enabled or directed utilities to develop plans and deploy HDV charging infrastructure. Sources: See list of sources.

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