2022 Road Fuel Outlook

Peak demand is on the horizon

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BloombergNEF

Executive summary

The demand for mobility has flourished over the last 100 years, with a burgeoning population and rising prosperity. Oil-derived fuels have powered this growth and shaped the way people and goods move. The next 30 years will see this upended as new drivetrains, shared mobility and, eventually, autonomous vehicles reshape road transport's reliance on oil. Road fuel demand is set peak in 2027 in BNEF's Economic Transition Scenario (ETS), where changes are driven by techno-economic trends and market forces, and no new policies are assumed to be enacted.

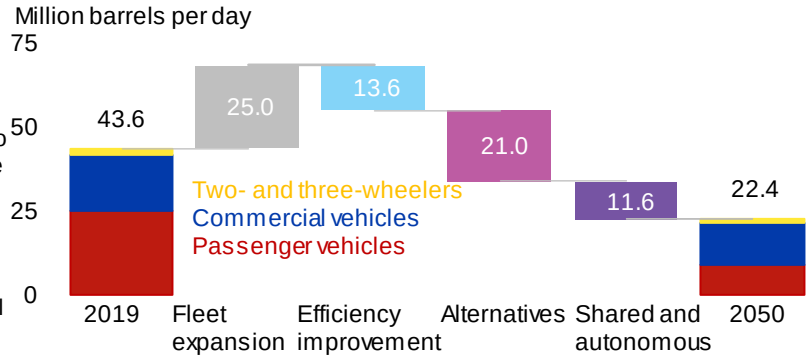
- **Delayed impact:** Road fuel demand peaks in five years, however, the impact of advancements is not materially felt until almost a decade later. Efficiency improvements disrupt growth this side of 2030, before alternative drivetrains and autonomous vehicles cut into road fuel use in the longer term.
- **Different outcomes:** Fuel producers with exposure to markets like the US or Europe are poised to see sales of diesel and gasoline decline significantly from current levels over the next decade. On the other side of the world, in markets like India and China, demand growth that 'could have been' fails to materialize.
- **Booming freight** movements are set to support commercial truck fuel consumption through to the 2030s. However, as more corporates with large fleets, like DHL, Ikea and Amazon, pledge to become net-zero emitters, sales of electric light trucks in particular take off.
- **Avoided demand:** Over 31 million barrels per day of road fuel demand is avoided by 2050 due to the penetration of zero tailpipe emission vehicles like EVs and fuel cell vehicles.
- **Minimum mark:** Despite almost 2.4 billion electric or fuel cell passenger vehicles, commercial trucks, two and three wheeled vehicles driving on the world's roads in 2050, road fuel use is set to remain above 20 million barrels per day.
- **Economics** alone do not get the world close to net zero. In 2037, fossil-derived fuel demand will remain at levels registered in 2010. By 2041 that declines to volumes last seen in 2000.

2027 Peak in road fuel demand in BNEF's Economic Transition Scenario

31 million b/d Road fuel demand avoided due to the penetration of zero tailpipe emission vehicles in 2050

2.4 billion Zero tailpipe emission vehicles on the road in 2050

Global road fuel outlook – Economic Transition Scenario



Source: BloombergNEF. Note: Includes biofuels. Excludes buses. Under the Economic Transition Scenario, changes are driven by techno-economic trends and market forces, and no new policies are assumed to be enacted.

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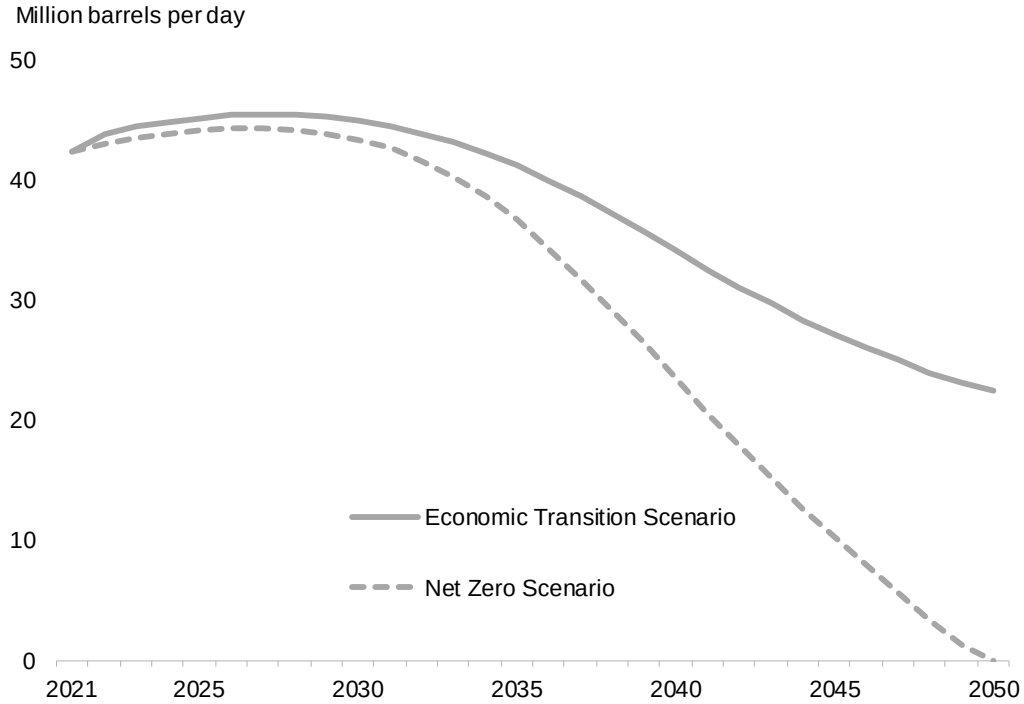
Scenarios and outlooks at BNEF

Road fuel demand scenarios



Source: BloombergNEF, IEA. Note: Road fuels include fossil and bio derived gasoline, diesel and LPG. Scenarios above include an estimate for buses.

- This research forms part of the library of energy transition scenarios at BNEF.
- The core scenario used in BNEF research is our Economic Transition Scenario (ETS). This scenario employs a combination of near-term market analysis, least-cost modeling, consumer uptake and trend-based analysis to describe the deployment and diffusion of commercially available technologies in the absence of new policy regimes and uncover the underlying economic fundamentals of the energy transition to 2050.
- In addition to the ETS, BNEF develops a range of global, sector-based, and country-level scenarios. This includes a set of climate scenarios that investigate pathways to reduce greenhouse gas emissions in line with the Paris Climate Agreement.
- Scenarios are future-focused simulations combining a number of uncertain parameters into an internally consistent narrative. They are predominantly used for medium-to long-term investigative studies and may also include sensitivities to key variables. Scenarios differ from forecasts which are usually shorter-term predictions of what we think will happen.
- All figures in this report refer to the ETS, unless otherwise stated. For more on the scenarios underpinning the 2021 Road Fuel Outlook, and others like the Net Zero Scenario, see;

Long-Term Electric Vehicle Outlook

New Energy Outlook

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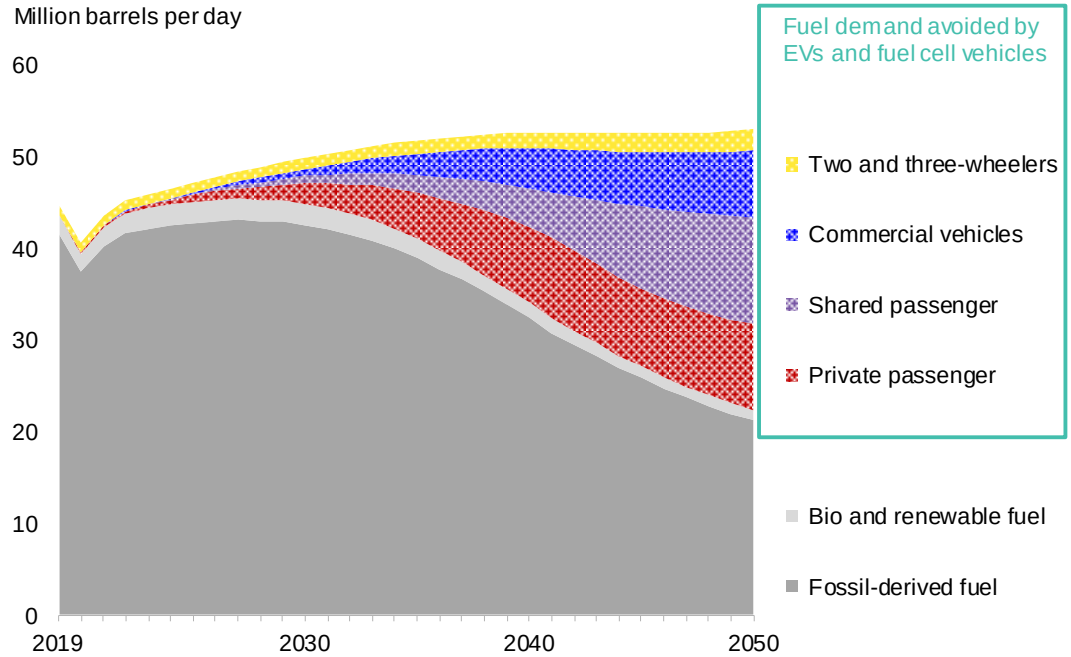
The outlook

Zero tailpipe emission drivetrains hit demand hard

Road fuel demand and fuel demand displaced by electric and fuel cell vehicles – Economic Transition Scenario



Source: BloombergNEF, IEA. Note: Road fuels include fossil and bio derived gasoline, diesel and LPG. This research excludes buses.

- The proliferation of alternative drivetrains and shared mobility services in the passenger car, commercial truck and two- and three-wheeler markets will have a profound effect on the future of road fuel in the transport sector and, in turn on the refining, fuels marketing and upstream sectors.
- Technology changes are at the core of this transition, but other factors are also playing an important role. Policymakers are driving the automotive market toward low-carbon options and improved fuel efficiency. Automakers and large fleet operators are also, in turn, aiming for long-term decarbonization.
- The impact of advancements is not materially felt until almost a decade later. Efficiency improvements disrupt growth this side of 2030, before alternative drivetrains and autonomous vehicles cut into road fuel use in the longer term.
- In our Economic Transition Scenario, the penetration of zero tailpipe emission vehicles like EVs and fuel cell vehicles erode over 31 million barrels per day (b/d) of road fuel demand by 2050. However, over time and by segment, advancements impact each market differently.

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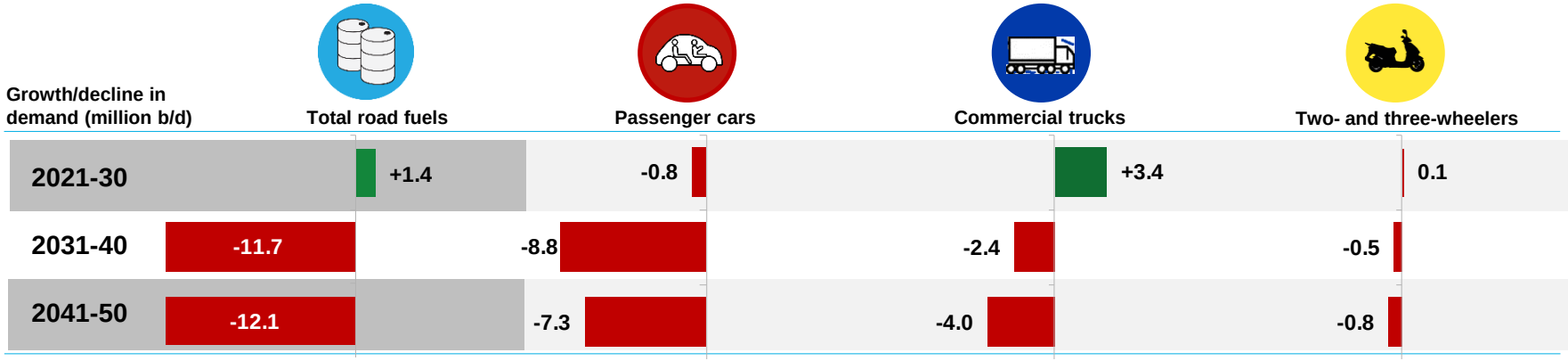
Trucks postpone the peak, but not for long



Source: BloombergNEF. Note: Includes biofuels.

- The rapid penetration of alternative drivetrains and shared mobility services in the passenger vehicle and two-and three-wheeler markets has likely caused demand in these sectors to peak already, or plateau at best in the coming decade.
- Booming freight movements are set to support commercial truck fuel consumption through to the 2030s. However, as more corporates with large fleets, like DHL, Ikea and Amazon, pledge to become net-zero emitters, sales of electric light trucks in particular take off. Investment by vehicle manufacturers like Daimler, Tesla and Volkswagen lead to more electric and fuel cell heavy trucks, meaning oil-powered kilometres face further competition later in the outlook.
- In this research note we will explore the drivers of change in the passenger car, commercial truck and two-and three-wheeler segments.

Passenger cars

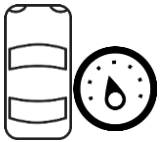
Shared and autonomous cars drive the future

*For more of the data behind this report, see **BNEF's Transport Data Hub***

Constructing the demand outlook

This analysis is based on our Long-Term Electric Vehicle Outlook (web | terminal). Our passenger vehicle demand outlook uses the following four-step approach:

Fleet expansion/ miles traveled



We project growth in transportation demand and the passenger vehicle fleet…

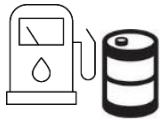
Fuel economy improvement

…and assume legislated vehicle fuel economy improvements are met, followed by a gradual improvement in the fuel economy of new vehicles in the long term…

EV uptake/shared and autonomous mobility services

An electric kilometer is assumed to displace an equivalent conventional mile. We assume plug-in hybrid electric vehicles (PHEV) drive roughly 47% of their miles on electricity in 2019, improving to 80% by 2055. Intelligent mobility – sharing/ride hailing and autonomous vehicles – displace kilometers driven by private cars

Fuel-consumption outlook



Fuel consumption is estimated based on ICE fleet size, efficiency and utilization

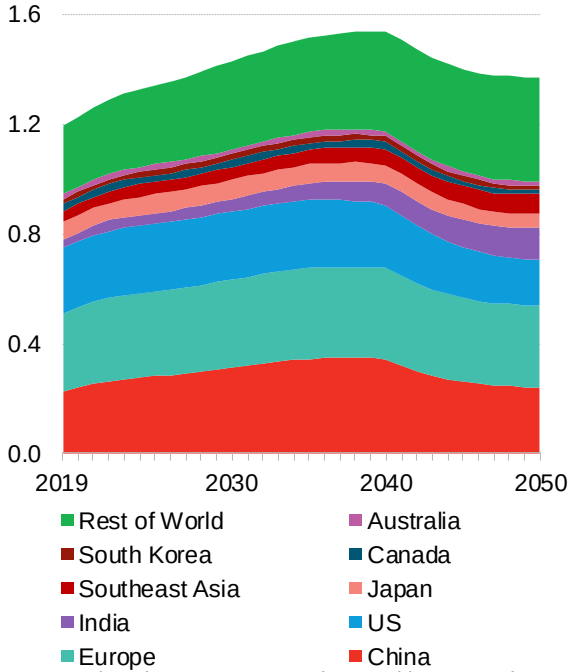
Source: BloombergNEF.

Fleet expansion and utilization

Less cars needed to travel more kilometers

Passenger car fleet

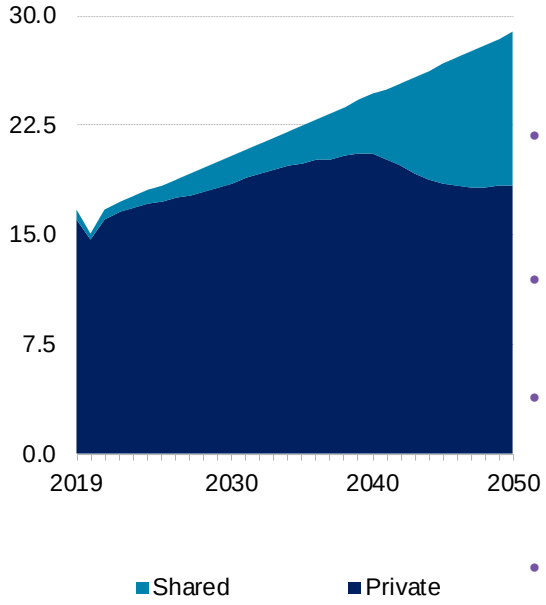
Billion units



Source: BloombergNEF. Economic Transition Scenario.

Passenger vehicle utilization

Trillion kilometers



Source: BloombergNEF. Economic Transition Scenario.

- Population and GDP growth are key drivers for mobility and road-fuel demand. As GDP per capita has grown over the decades, so too have the number of vehicles per person. Growth in shared and autonomous mobility is set to change this relationship, particularly in markets where autonomous vehicles are expected to play a larger role, like the US and China.
- In the ETS, globally the passenger car fleet peaks at just over 1.54 billion units by 2039, up from around 1.26 billion cars in 2021. This is lower than many other forecasters, as we see ride-hailing, car-sharing, urbanization, demographics and – eventually – autonomy, cut into vehicle demand growth.
- Fast-growing markets like India and Southeast Asia lead the growth in the vehicle fleet by 2050. China, Europe and the US remain at similar, or lower levels to 2019 due to autonomous vehicles supplanting private vehicle ownership.
- By 2050, the uptake of shared and hailed services like Uber and Didi, and eventually autonomous vehicles, increases shared kilometers rapidly to over 36% of total passenger vehicle kilometers. The higher utilization of these vehicles, and favourable economics, leads to this fleet turning over and electrifying quicker than the private passenger car fleet.
- Despite non oil-powered vehicle kilometers growing rapidly, switching drivetrains alone is not the most efficient way to reach net zero. Even a modest 10% reduction in kilometers traveled by car globally in 2050 could yield major benefits and make the decarbonization journey much easier. For more, see *Vehicle Electrification Is Easier If There Are Fewer Cars* (web | terminal).

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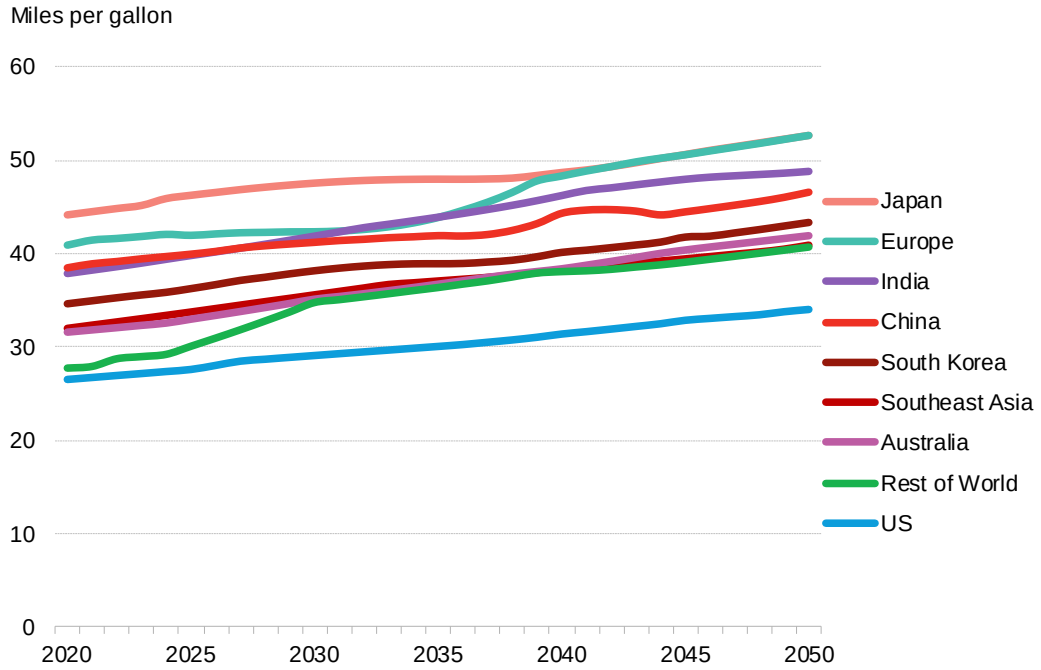
Fuel economy

Improvements in internal combustion engine efficiency slows

Fuel economy of new ICE vehicles



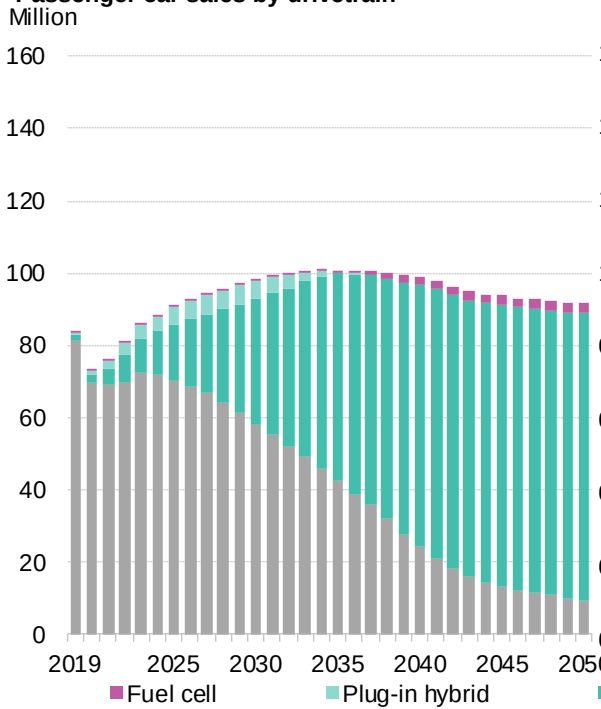
Source: BloombergNEF. Economic Transition Scenario. Note: France taken as an indicator for Europe.

- By 2030, car fuel economy mandates impact fuel consumption more than any other factor. Some regions like Japan and Europe have policies in place as far out as 2030. Markets without mandates are impacted by regulations in larger markets as they either legislate to mirror, or inherit these fuel-economy improvements as they import second-hand cars. Mandates in general require the average fuel economy of all new vehicles sold by an automaker to improve at a certain rate.
- Regions with a lower penetration of EVs, like Japan, require the fuel economy of new ICE vehicles to improve greatly in order to meet mandates. One way to achieve this is to sell high levels of full hybrids, such as the Toyota Prius, which we include with ICE vehicles. For regions with a large diesel fleet, like Europe, the shift toward gasoline ICE vehicles makes meeting these mandates harder as diesel cars are in general more fuel-efficient than equivalent gasoline cars.
- Automakers have turned to non-ICE vehicles to comply with regulations. As EV sales increase, improvements in the fuel economy of new ICE vehicles will slow once mandates are met. Automakers will be unlikely to invest heavily in further ICE fuel-economy improvements, if they can comply with regulations more economically. But, the increased use of light-weight materials and new engine technology will continue to improve the fuel economy of ICE vehicles, albeit at a slower pace.
- For more, see *Stage Set for End of Gasoline, Hybrid Cars With EU Vote* (web | terminal), *China Fuel Economy Rules Push Auto Giants to Sell More EVs* (web | terminal), and *US MPG Standards Attempt to Erase Trump-Era Retreat* (web | terminal).

Alternative drivetrains

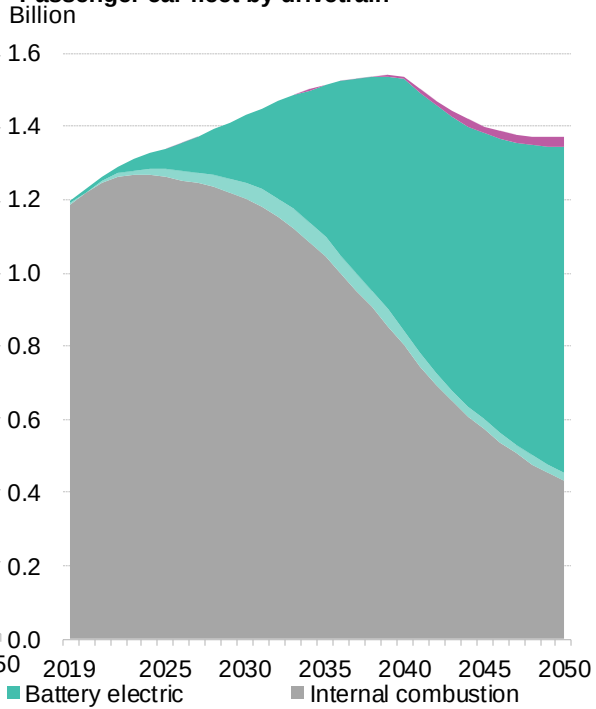
Peak car, but when and where varies

Passenger car sales by drivetrain



Source: BloombergNEF. Economic Transition Scenario.

Passenger car fleet by drivetrain



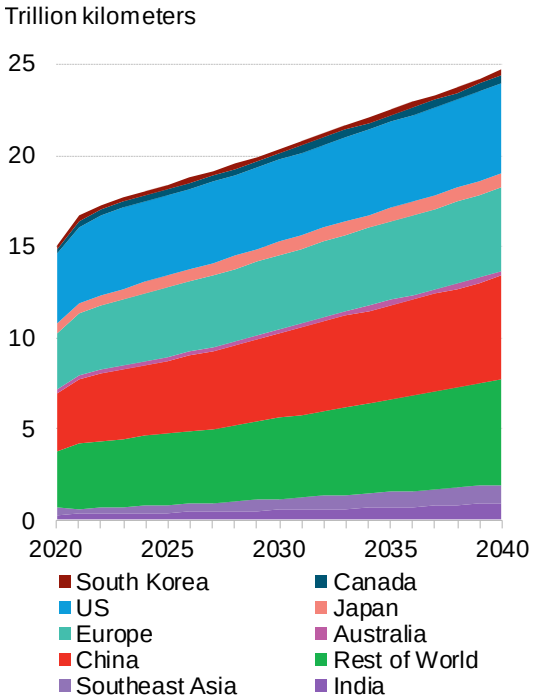
Source: BloombergNEF. Economic Transition Scenario.

- In our ETS, by 2050, some 79 million, or 86% of all new passenger vehicle sales, and just over 835 million, or 67% of the global passenger vehicle fleet, are battery electric or plug-in hybrid electric vehicles.
- Sales of ICE passenger cars peaked in 2017 in the ETS. However, by 2050, 431 million ICE cars remain on roads around the world, compared to 1.25 billion in 2021.
- Fuel cell vehicles start to be sold at volume in a few markets in the latter half of the 2030s, but with only 28 million on the road by 2050, they represent roughly 2% of the passenger car fleet.
- In the ETS, by 2050, the share of ICE vehicle sales is set to fall below 5% in most large markets like the US and China. However, penetration varies geographically over time. For more, see *EV Outlook Highlights: EV Adoption Gap* (web | terminal).
- In developing markets, lower average vehicle purchase prices mean that EV price parity takes longer. Other barriers include a lack of stringent fuel-economy regulations, lower availability of public charging infrastructure and grid constraints.

Shared and autonomous mobility outlook

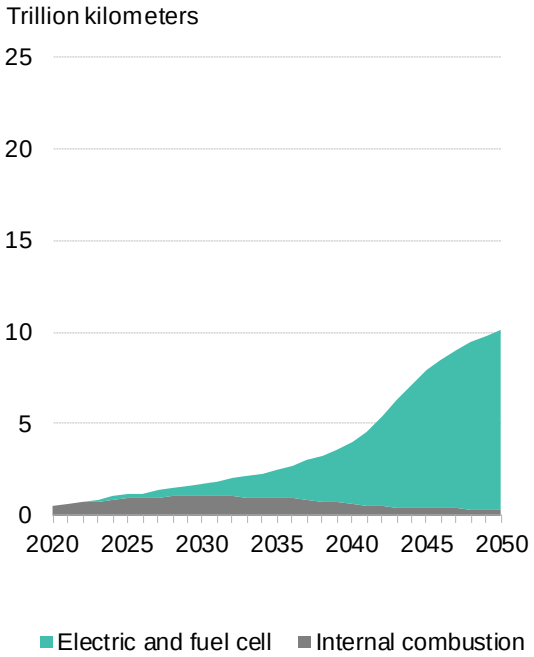
Total kilometers jump 73% in 2050 versus 2021 while car fleet grows 12%

Total kilometres growth by region



Source: BloombergNEF. Economic Transition Scenario.

Shared and autonomous mobility kilometers



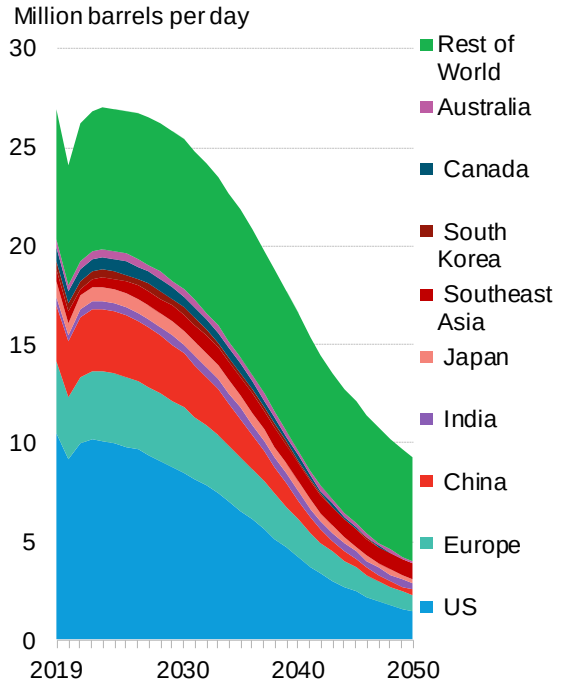
Source: BloombergNEF. Economic Transition Scenario.

- As highlighted earlier, growth in shared and autonomous mobility is set to change car ownership patterns in our outlook. Despite lower ownership rates, kilometres continue to grow in the ETS.
- In the outlook, the passenger car fleet grows by just over 12% by 2050, compared to 2021 levels. Kilometres traveled globally are set to grow by over 73% as shared and autonomous mobility use increases.
- Shared mobility is starting to gain a meaningful share of kilometers traveled. But, the impact of shared mobility on road-fuel consumption is limited over the next decade so far as ride-sharing/hailing platforms such as Uber, Didi and Grab continue to use ICE, or hybrid vehicles.
- EV and fuel cell adoption by shared mobility services is faster than privately-owned cars due to favorable economics. In the ETS in 2020, EVs accounted for 5.5% of shared kilometers traveled. This shifts quickly, passing 50% by 2032 and 97% by 2050.
- Autonomous vehicles arrive at scale in the second half of the 2030s. By then EVs are set to be cheaper than equivalent ICE vehicles and as a result these cars are primarily electric.
- For more on shared mobility, see *Mobility Services and Modal Shifts* (web | terminal).

Passenger cars road-fuel outlook

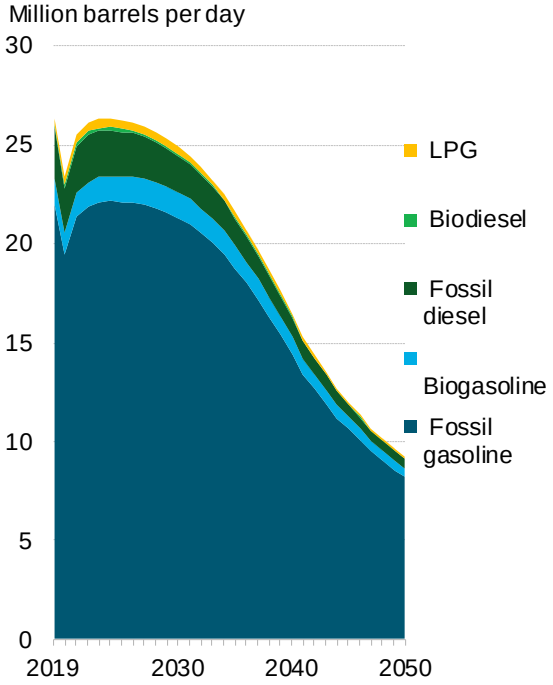
The peak has passed

Demand by region - Economic Transition Scenario



Source: BloombergNEF, IEA. Note: Includes biofuels.

Demand by fuel - Economic Transition Scenario



Source: BloombergNEF. Note: Includes biofuels.

- In our ETS, road-fuel demand from passenger cars has already peaked. By 2050 consumption declines to 10.1 million b/d, a 64% decline from 2021 levels. But this hides fuel and regional differences.
- By 2030, the US and Europe combined consume over 1.5 million b/d less than in 2021, a near 11.5% decline.
- Consumption in China, the growth engine over the past two decades, is set to remain broadly flat in the 2020s before declining. Southeast Asia, India and the rest of the world combined grow, but fail to offset declines elsewhere.
- Diesel engine passenger car sales continue to decline, predominantly due to falling European sales. As gasoline cars replace diesel, gasoline demand receives a boost. Diesel cars are usually larger, and as a result less efficient than an average gasoline car. They also travel on average double the distance of gasoline cars in markets like Europe – as such, the impact on fuel is disproportional to sales and fleet. For more, see *Could Norway Be a Canary in...an Oil Well?* (terminal).
- The role of biofuels grows in our ETS. While the blend of biofuels increases as policies mandate higher levels, the outright volume declines as total demand declines outpaces any increase in blending rates.

Commercial trucks

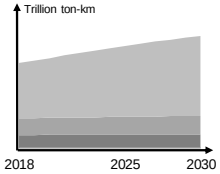
Trucks postpone an oil peak, but not for long

*For more of the data behind this report, see **BNEF's Transport Data Hub***

Constructing the demand outlook

This analysis is based on our Long-Term Electric Vehicle Outlook (web | terminal). Our commercial truck demand outlook uses the following four-step approach:

Road freight demand

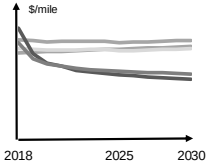


We project growth in road freight demand based on Gross Value Added (GVA) from industry and agriculture …

Fleet and sales

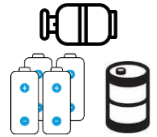
…and assume a load factor per segment. We derive the fleet and sales needed to meet that road freight demand.

Total-cost-of-ownership and drivetrain split



We use the relative total cost of ownership (TCO) of different drivetrains – adjusted for model and fueling infrastructure availability – to estimate the annual adoption of each alternative drivetrain

Fuel-consumption outlook



Fuel consumption is estimated based on fleet size, efficiency and utilization

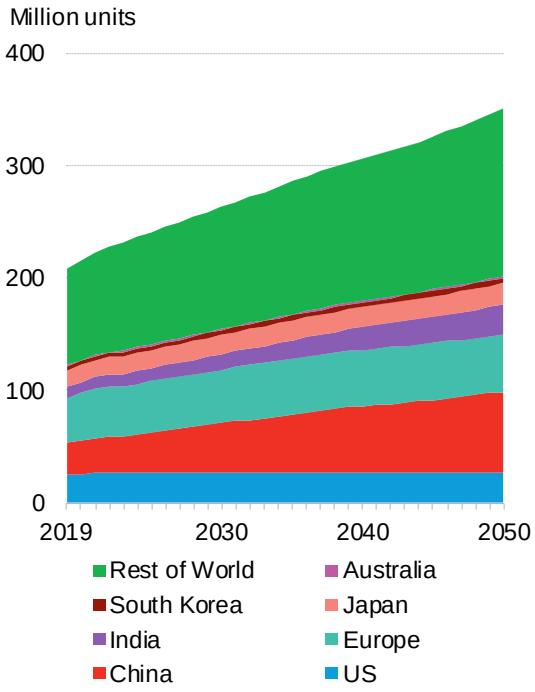
Source: BloombergNEF

Note: The methodology is further explained in our Long-Term Electric Vehicle Outlook (web | terminal). Industry includes manufacturing, construction, materials, water, electricity and some other segments of the economy. See appendix for description of segments.

Fleet expansion and utilization

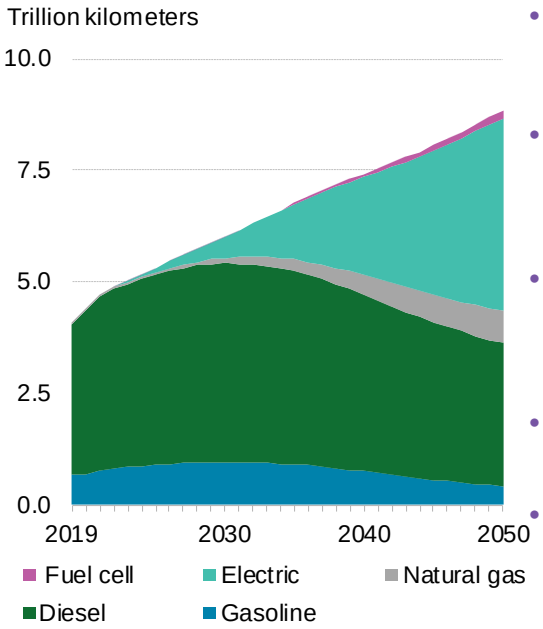
Light trucks decarbonize early, heavy trucks lean on diesel

Commercial truck fleet



Source: BloombergNEF. Economic Transition Scenario

Total kilometres by drivetrain

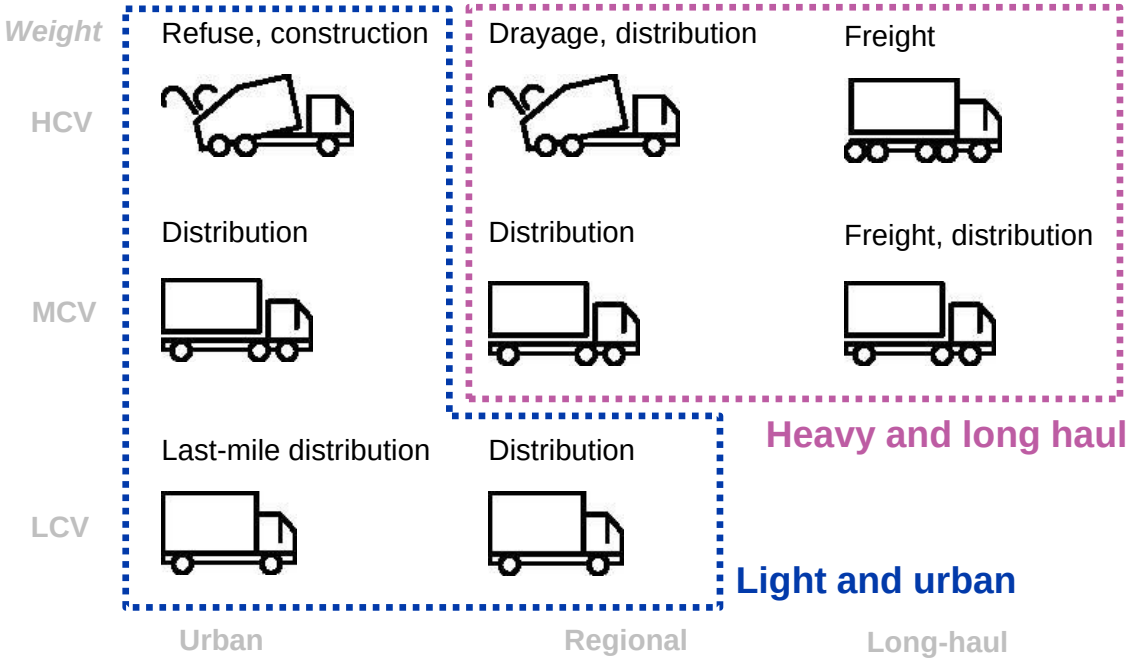


Source: BloombergNEF. Economic Transition Scenario

- As economies grow, the demand to move goods also grows. In our ETS this relationship holds. By 2050, global freight demand grows by 61% compared to 2021, requiring more trucks in the global fleet, and more energy.
- India demand almost triples by 2050 to become the largest market for freight movements. Growth in China is at a slower pace than in the past, and demand in 2050 is set to be about 40% higher than in 2021. Europe and the US see stable, but modest, demand growth over the next 30 years.
- In our ETS, the global commercial vehicle fleet grows from 226 million units in 2021 to 350 million in 2050. City restrictions, fuel-economy regulations and commoditization of fuels such as natural gas incentivize the penetration of alternative drivetrains.
- Oil powered kilometres, including hybrid diesel miles, account for 90% of kilometers in 2030, 63% in 2040 and 41% in 2050. This compares to over 99% in 2021.
- While electric drivetrains penetrate lighter segments, heavier segments see multiple drivetrains penetrate the market depending on drive cycle and use. In some segments alternatives are already cost competitive.
- For more, see *Cleaning Up Commercial Vehicles* (web | terminal) and *Batteries Jump Ahead of Fuel Cells in Heavy Truck Race* (web | terminal).

Market segments

- The market for commercial vehicles consists of a large variety of vehicles and use cases to meet a range of end-user demand for freight, logistics, service and other specialized operations.
- To capture the diversity of the market, we build our outlook on a bottom-up basis to incorporate weight class and the drive cycle of different commercial vehicles.
- We use light-, medium-and heavy-commercial vehicles (LCV, MCV and HCV) with weight cutoffs that may differ between countries and regions –the main difference being in LCVs.
- The duty cycle is the combination of the load carried, the length of the route, the fuel efficiency, the driving schedule, as well as other factors. As a proxy for that, we use the average distance traveled by a truck within each segment, and we also use varying efficiencies for urban, regional and long-haul routes.
- For the purpose of this research note, we look at two segments, light and urban, and heavy and long haul.

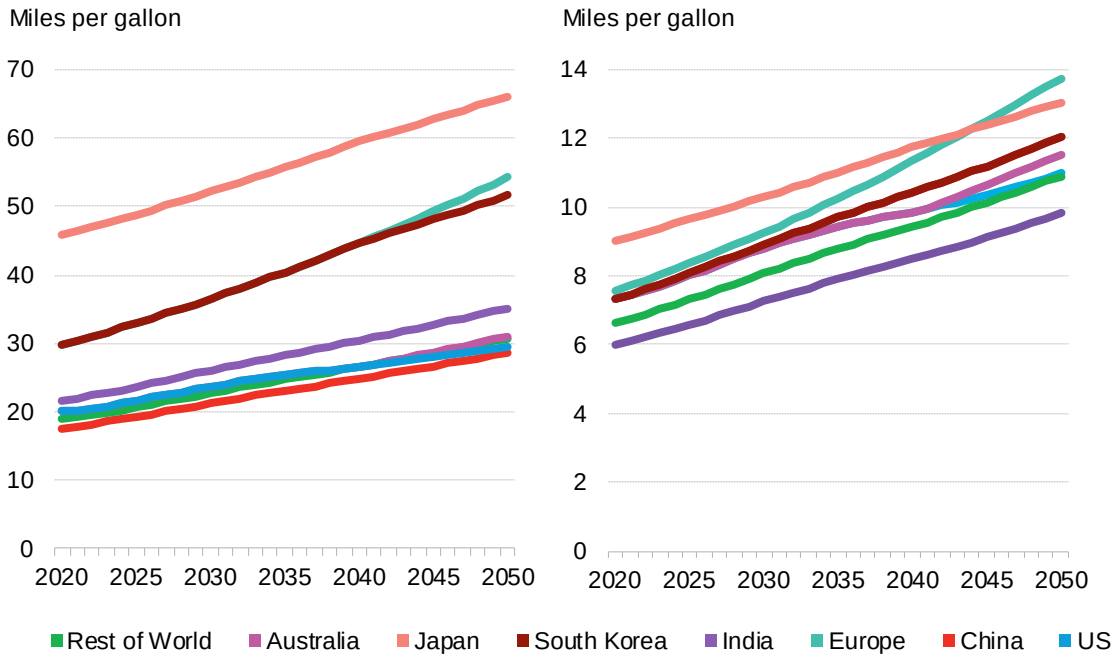


Source: BloombergNEF. Note: Weight classes defined by region in appendix, weight classes vary by region

Fuel economy

Efficiencies improve as newer mandates bite

New light commercial vehicles



Source: BloombergNEF. Economic Transition Scenario

New heavy commercial vehicle sales

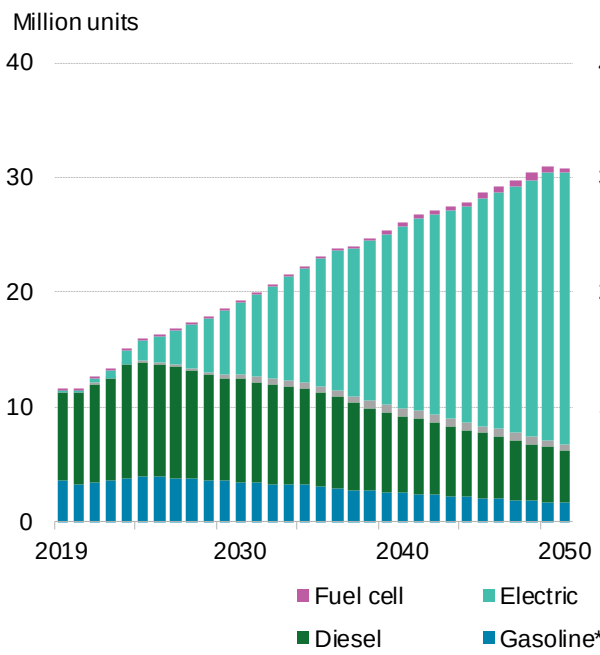
Source: BloombergNEF. Economic Transition Scenario

- Fuel economy mandates are relatively new to the commercial vehicle segment. China and the US. mandated fuel economy improvements in 2012 and 2014 and European standards came into force in 2020. In some markets, like the US, light commercial vehicles fall under mandates for non-commercial vehicles. This depends on use case and classification.
- Historically, unlike the passenger vehicle market, fuel economy levels of commercial vehicles have not improved markedly.
- Regulations vary greatly across region, drive cycle and weight class. They can also depend on the specification of the commercial vehicle, for example if a commercial vehicle has a tractor trailer configuration or if it is rigid.
- The US and China each have policies in place to improve fuel economy by 2027 and 2021, and the EU by 2030.
- For more, see *US MPG Standards Attempt to Erase Trump-Era Retreat* (web | terminal).

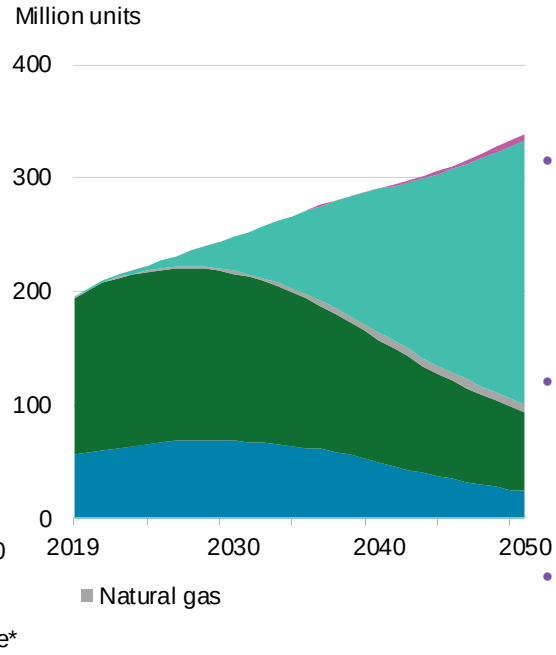
Light and urban segment

Corporates flip fleets away from oil-powered vehicles

Sales



Fleet



Fuel cell | Electric | Natural gas | Diesel | Gasoline*

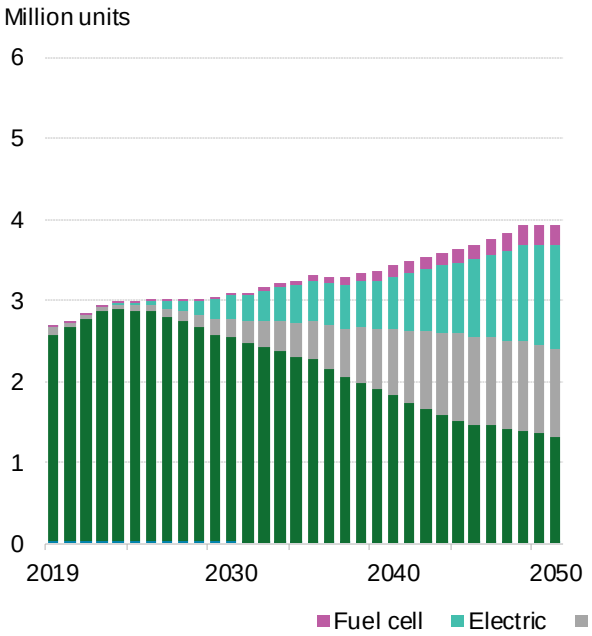
Source: BloombergNEF. Note: Gasoline includes LPG vehicles. Source: BloombergNEF. Economic Transition Scenario

- In our ETS, the proliferation of urban deliveries, sometimes referred to as the 'Amazon' effect, increases demand for freight in the light and urban segment. As more corporates with large fleets, like DHL, Ikea and Amazon pledge to become net-zero emitters, sales of electric light trucks in particular boom. This profoundly impacts road fuel demand.
- The fleet grows by 130 million to nearly 338 million units in 2050 compared to 2021. In 2030, more than one in 10 vehicles in this segment is electric, growing to over two in three by 2050. Favorable economics is the reason behind this, but there is potential for much further upside: city policies on local pollution and noise, access restrictions, corporate sustainability targets and, potentially, consumer demand may further accelerate this trend.
- Compressed natural gas (CNG) sales also grow, but favorable economics for electric commercial vehicles, particularly in the US, Europe and China will limit the role of CNG trucks in this segment. Alternative drivetrains penetrate the US, Chinese and European markets first. Inexpensive heavy commercial vehicles and infrastructure constraints limit the penetration of electric HCVs in India.
- Despite already favorable economics, incumbent manufacturers have been slow to develop lighter electric trucks. Newer manufacturers, such as Arrival and Rivian, and non-traditional competitors, such as Chanje, are introducing electric light trucks. We expect supply-side restrictions to ease further in the next couple of years.

Heavy and long-haul segment

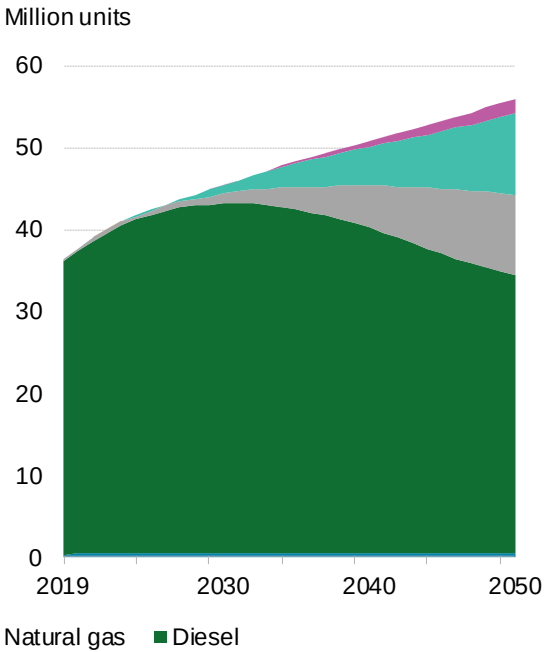
Fuel cell and electric arrive, but not any time soon

Sales



Source: BloombergNEF. Economic Transition Scenario

Fleet



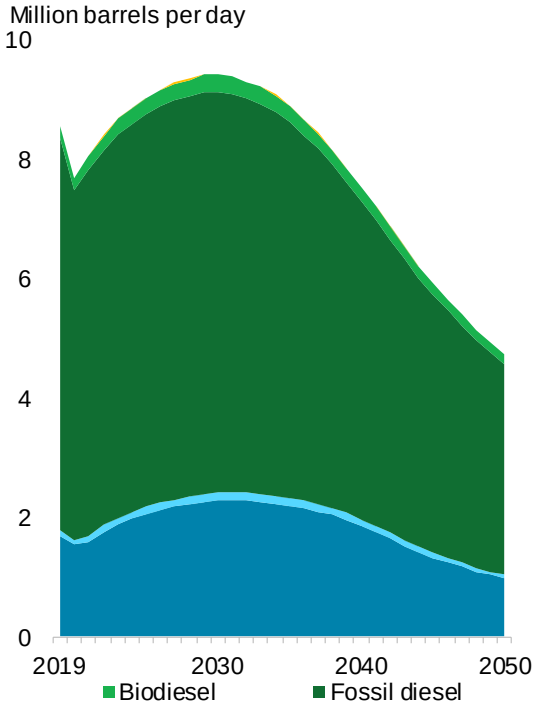
Source: BloombergNEF. Economic Transition Scenario

- In our ETS the heavy and long-haul commercial vehicle fleet grows by 17 million vehicles versus 2021, to over 56 million units by 2050. It is more difficult for alternative drivetrains to penetrate this segment due to functionality, range and weight requirements. Diesel commercial vehicles account for 61% of the fleet in 2050, down from over 98% in 2021, but still a far higher share than other segments.
- Natural gas commercial vehicles, mainly LNG, penetrate the market increasingly but begin to face competition from zero-carbon technologies later in the outlook. Infrastructure projects and government policy in Europe and China support uptake of natural gas and electric trucks, be it through incentives, emissions mandates or infrastructure projects to build charging networks or refueling terminals.
- In our ETS, fuel cell truck sales exceed 100,000 units by 2038. However, by this point the technology competes with an already-established electric truck market – and the additional infrastructure requirement slows penetration of fuel cell trucks. These sales are concentrated in countries which combine fuel cell vehicle deployment targets with plans to build out fueling infrastructure and have favorable hydrogen production costs, like China, Germany or South Korea.
- For more, see *Vehicle Total Cost of Ownership Model* (web | terminal) and *Batteries Jump Ahead of Fuel Cells in Heavy Truck Race* (web | terminal).

Road fuel outlook by segment

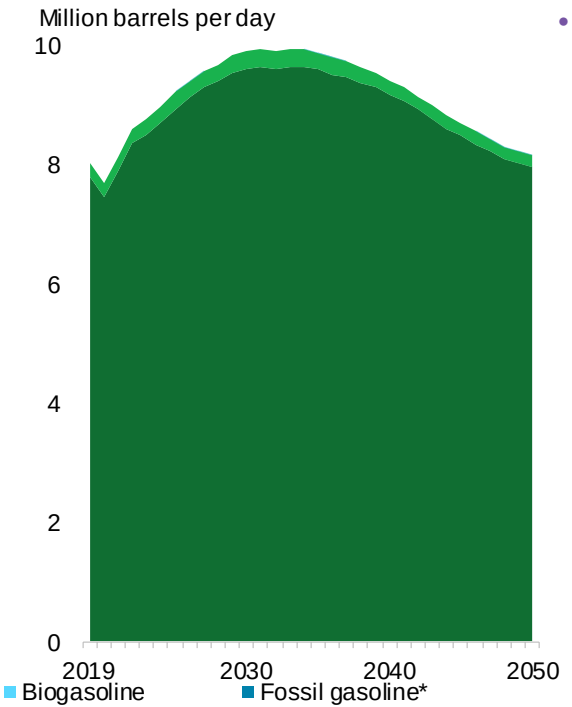
Demand diverges

Light and urban road fuel demand



Source: BloombergNEF. Economic Transition Scenario

Heavy and long haul road fuel demand



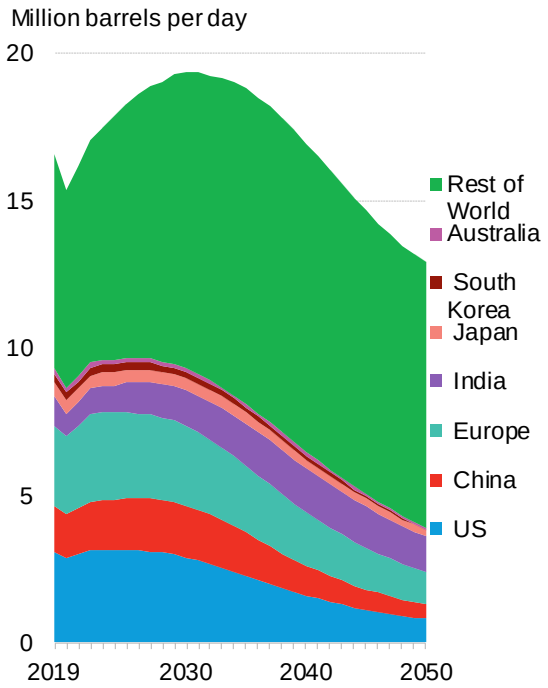
Source: BloombergNEF. Economic Transition Scenario

- The light and urban segment, and the heavy and long-haul segment consumed roughly 8.1 and 8.14 million b/d of road fuels in 2021. Regulation and alternative drivetrains impact each segment very differently in our ETS;
  - Road-fuel demand in the light and urban segment peaks at 9.5 million b/d in 2030 before declining rapidly to 7.5 million b/d in 2040, and 4.7 million b/d in 2050.
  - Demand in the heavy and long-haul segment peaks at 9.7 million b/d in 2034 before falling to 9.2 million b/d in 2040, and 8.4 million b/d in 2050. Fuel-economy improvements erode more fuel consumption than alternative vehicles in this segment. Diesel demand remains higher than 2021 levels in 2050.
  - While regulations and alternative drivetrains have a significant impact on demand in the future, other factors will add to better efficiency in the commercial vehicle market. As much as one third of kilometers traveled in the US and Europe are without any payload. Operational efficiencies and technology are expected to improve this.
  - Additionally, as fast-developing markets such as India and China become more regulated and develop infrastructure, they are likely to shift toward larger vehicles and limit overloading of smaller commercial trucks. Tractor-trailer vehicles are also likely to replace rigid vehicles. This makes commercial vehicles more efficient on a fuel per freight ton mile basis.

Commercial vehicle road fuel outlook

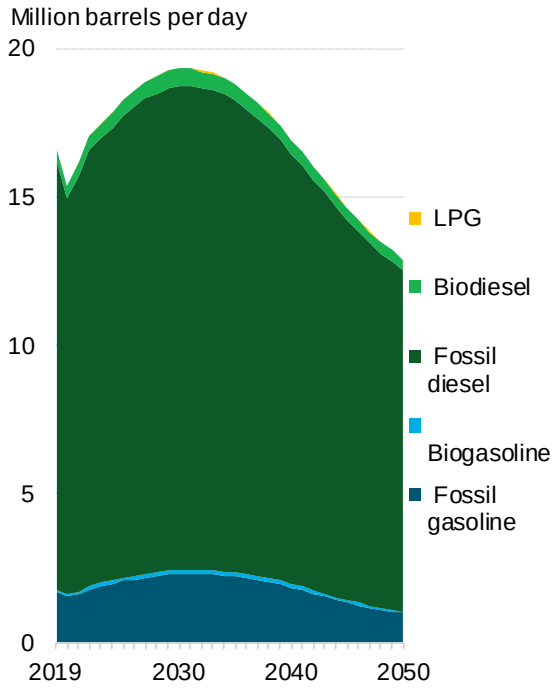
Demand growth throws diesel a lifeline

Demand by region - Economic Transition Scenario



Source: BloombergNEF, IEA. Note: Includes biofuels.

Demand by fuel - Economic Transition Scenario



Source: BloombergNEF. Note: Includes biofuels.

- Across all segments, commercial vehicles consumed over 16.2 million b/d of oil in 2021, 0.5 million b/d, or 3.3% of which was bio-derived. In the Economic Transition Scenario, the role of bio-derived fuels grows as biodiesel (including renewable diesel) consumption grows, helped by policy support and new supply in large markets like Europe and California.
- In the ETS, demand for road fuels from commercial trucks grows to 19.4 million b/d in 2031 before fuel-economy improvements and alternative drivetrains cause a gradual decline in consumption to reach 17 million b/d by 2040, and 12.9 million in 2050.
- The US and Europe lead the decline in fuel consumed in the commercial truck sector. In 2034, Europe surpasses the US as the largest consumer of road fuels in the segment before India takes the title in 2045.

Two- and three-wheelers

Electrification and peak demand limit the need for road fuels

*For more of the data behind this report, see **BNEF's Transport Data Hub***

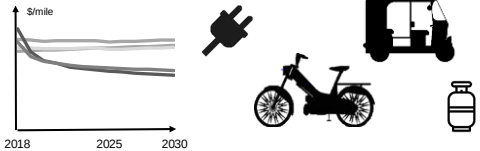
Constructing the demand outlook

This analysis is based on our Long-Term Electric Vehicle Outlook (web | terminal). Our two- and three-wheeler demand outlook uses the following four-step approach:

Fleet expansion/ miles traveled

We project growth in sales and the two- and three-wheeler fleet by segment, moped, scooter and motorcycle

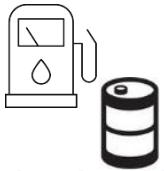
Total-cost-of-ownership and drivetrain split



We estimate total cost of ownership and upfront prices for various ICE and electric two-wheelers in the top four markets.

We estimate EV moped, scooter and motorcycle sales by using Generalized Bass Diffusion growth curves.

Fuel-consumption outlook



An electric vehicle is assumed to displace an equivalent conventional vehicle.

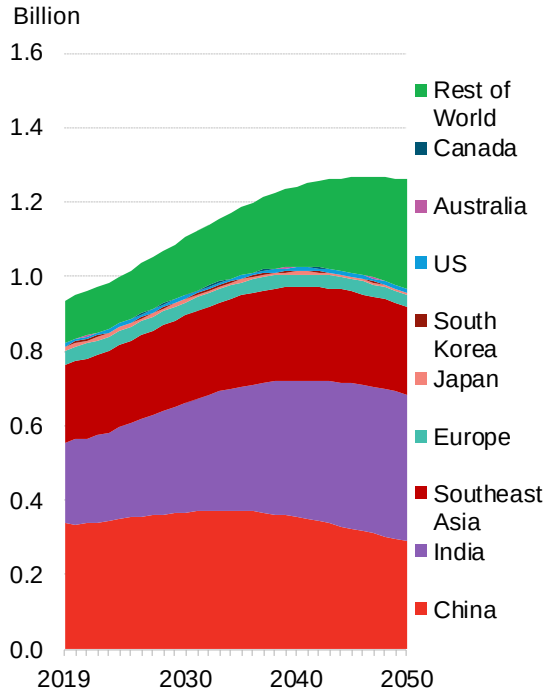
Fuel consumption is estimated based on ICE fleet size, efficiency and utilization

Source: BloombergNEF

Fleet expansion and utilization

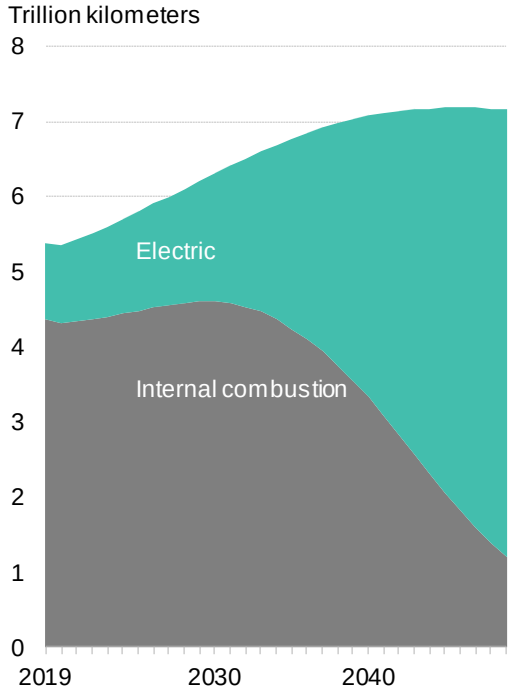
Electric kilometers meet almost all new demand

Two-wheeler fleet



Source: BloombergNEF. Economic Transition Scenario

Two-wheeler kilometres by drivetrain



Source: BloombergNEF. Economic Transition Scenario

- Population and urbanization growth trends are supporting two-wheeler sales in the developing world. Urban dwellers will continue to spend more on transportation as they become richer, and those in congested regions with inadequate public transit will continue to find two-wheelers better-suited to crowded streets than passenger cars. China, India and Southeast Asia remain the dominant markets through 2050.
- In the ETS, the global two-wheeler fleet grows by almost 300 million vehicles by 2050. India is set to overtake China to have the largest two-wheeler fleet in 2039. Globally, two-wheeler ownership peaks or begins declining in many major markets by 2040.
- Almost 20% of kilometres are already electrified thanks to a large share of electric kilometres in China. This quickly grows to 26% by 2030 in the ETS, and to 49%, and 83% by 2040 and 2050 respectively as other markets catch up.

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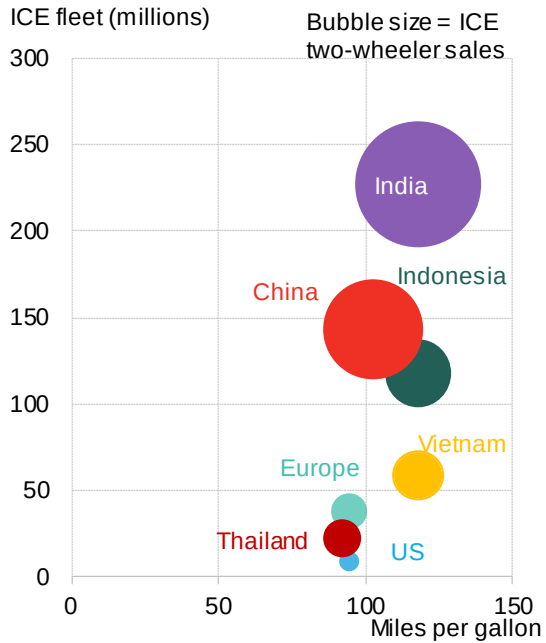
Fleet expansion and utilization

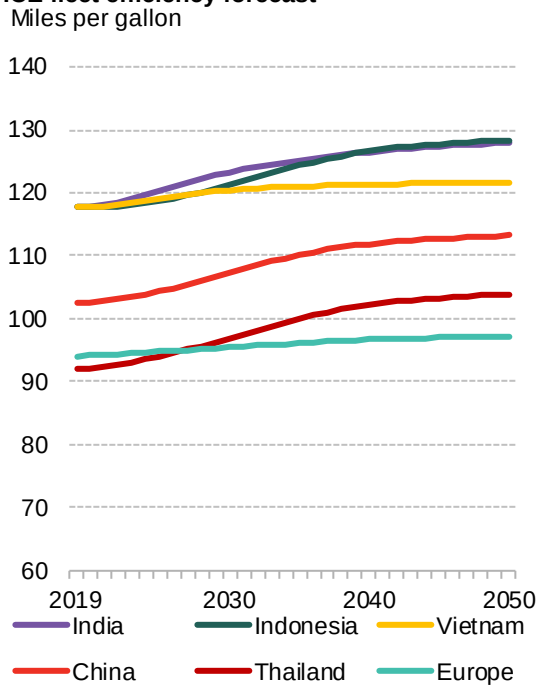
Vehicle size dictates the fuel economy of fleets

Ice fleet fuel economy



Source: BloombergNEF. Economic Transition Scenario

ICE fleet efficiency forecast



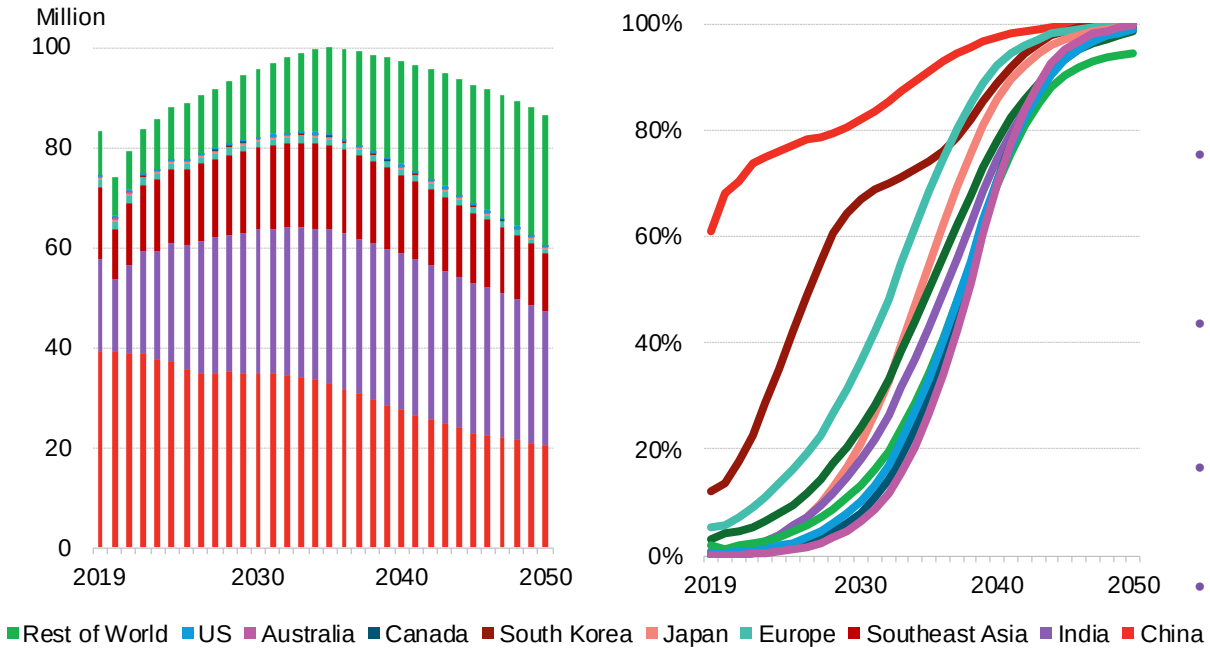
Source: BloombergNEF. Economic Transition Scenario

- Unlike passenger cars, the fuel efficiency of new ICE two-wheelers has not notably improved over time. The fuel economy of passenger cars has increased in line with regulations in key markets, but on the whole, these policies have not impacted two- and three-wheeler efficiency, instead impacting powertrain more.
- China introduced more stringent fuel economy standards covering two-and three-wheeled vehicles in July 2020. These were made mandatory for new type approvals from July 1, 2020 and for all new vehicles from August 1, 2021. This regulation replaces the first fuel economy standards that were issued for two- and three-wheeler in 2008 and that applied from July 1, 2009.
- India has one of the world's most efficient ICE two-wheeler fleets, made up primarily of low-powered motorcycles. The fuel efficiency of small engine motorcycles (~100cc) can reach as high as 160-180 miles per gallon.
- The US fleet consists mainly of larger, more powerful, motorcycles and is therefore one of the least-efficient two-wheeler fleets in the world. The fuel efficiency of a 1,000cc performance motorcycle is around 30-50 miles per gallon.

Two wheelers - alternative drivetrains

Sales electrify quickly – but peak soon

Two-wheeler sales



Source: BloombergNEF. Economic Transition Scenario

Electric penetration

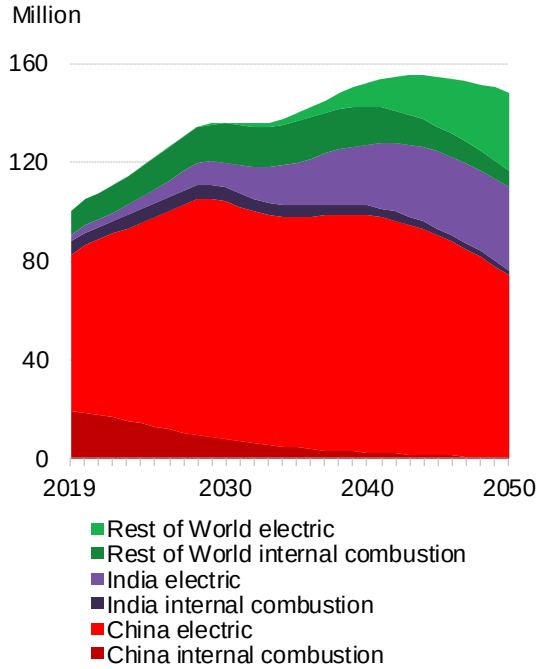
Source: BloombergNEF. Economic Transition Scenario

- In our ETS, sales in China have already peaked, while sales in India and Southeast Asia grow until 2038 and 2034, respectively. Nearly 40% of global two-wheeler sales have already electrified. Nearly all of these use lead-acid batteries, but lithium-ion batteries are becoming more common.
- China is the global leader in two-wheeler electrification by a wide margin, but Vietnam and South Korea have already achieved EV sales shares above 17%, and Europe has reached an EV sales share above 7% in 2021. India's EV sales share is currently at 1.3%, but growing fast.
- Policy has been the primary driver of this growth. Taiwan, South Korea, India and various European governments all offer EV subsidies, and both Taiwan and Hanoi (the epicenter of Vietnam's two-wheeler market) have announced plans to ban ICE two-wheeler sales.
- Only low-performance, lead-acid units are price-competitive with ICE two-wheelers, but falling lithium-ion battery pack prices will soon make high-performance, lithium-ion units price competitive.
- Upfront prices will vary across markets but continue to fall. This will make electric two-wheelers increasingly cost competitive on a total-cost-of-ownership basis with comparable ICE two-wheelers.

Three wheelers - alternative drivetrains

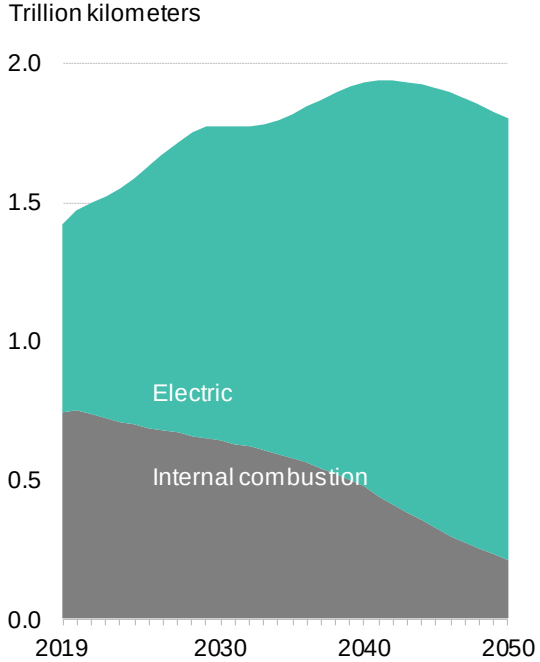
China's declining fleet changes the global market

Three-wheeler fleet



Source: BloombergNEF. Economic Transition Scenario

Three-wheeler kilometres by drivetrain



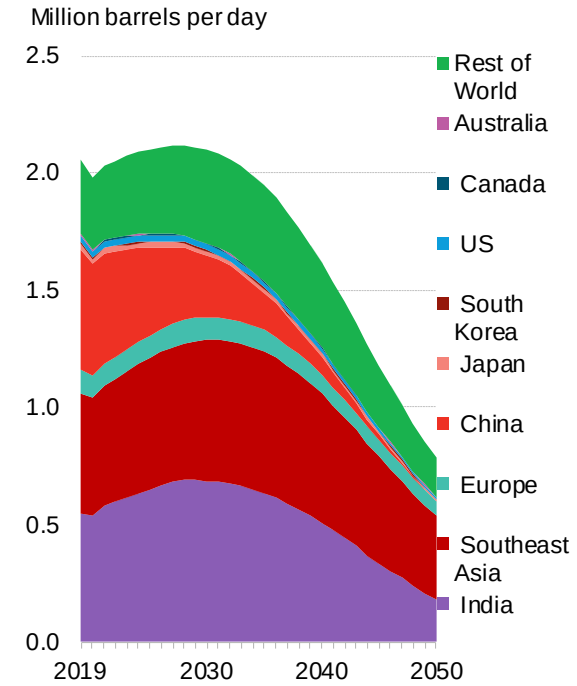
Source: BloombergNEF. Economic Transition Scenario

- We estimate that there are about 107 million three-wheelers on the road today, roughly 90% of which are in India and China. China's fleet is about 10 times larger than that of India. Due to policy and economics, the three-wheeler fleets in China and India have already achieved respective electrification rates of around 80% and 38% in 2021.
- Three-wheelers have electrified much more rapidly than two-wheelers because their primary owners are commercial entities such as delivery companies and shared mobility services. These operators respond more quickly to attractive total-cost-of-ownership savings than consumers.
- In the ETS, the fleet of electric three-wheelers globally rises from 74 million in 2021 to peak at over 140 million in 2047. ICE units continue to play a role in low-income, rural communities.
- The three-wheeler market consumes both gasoline and diesel. We estimate that roughly 30% and 15% of the India and China fleet respectively were CNG powered in 2019. This will likely grow over time and further displace oil-powered kilometers.

Two- and three-wheelers road fuel outlook

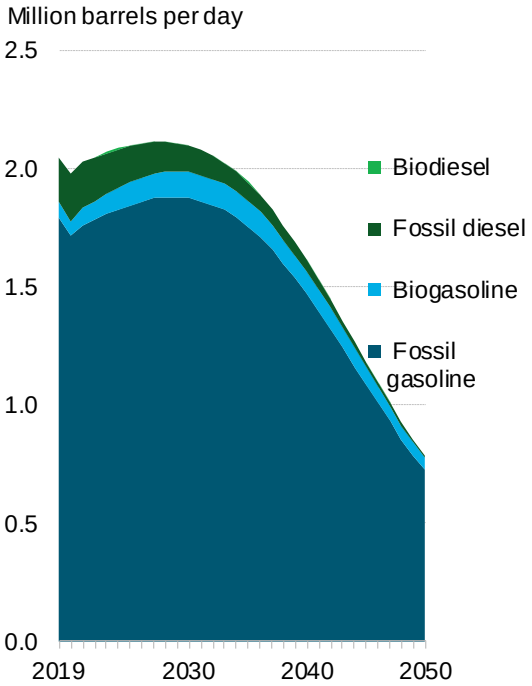
Rapid electrification leads to a speedy decline in fuel demand

Demand by region - Economic Transition Scenario



Source: BloombergNEF, IEA. Note: Includes biofuels.

Demand by fuel - Economic Transition Scenario



Source: BloombergNEF. Note: Includes biofuels.

- In the ETS, demand for road fuels from two- and three-wheelers declines rapidly after 2035 to reach roughly 1.69 million b/d by 2040, and 0.86 million b/d in 2050.
- China, India and Southeast Asia consumed over 76% of road-fuels in 2021.
- In India, two- and three-wheelers accounted for almost 70% of gasoline demand in 2021. This share declines quickly as commercial and passenger vehicle kilometers grow.

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Combined road-fuel outlook

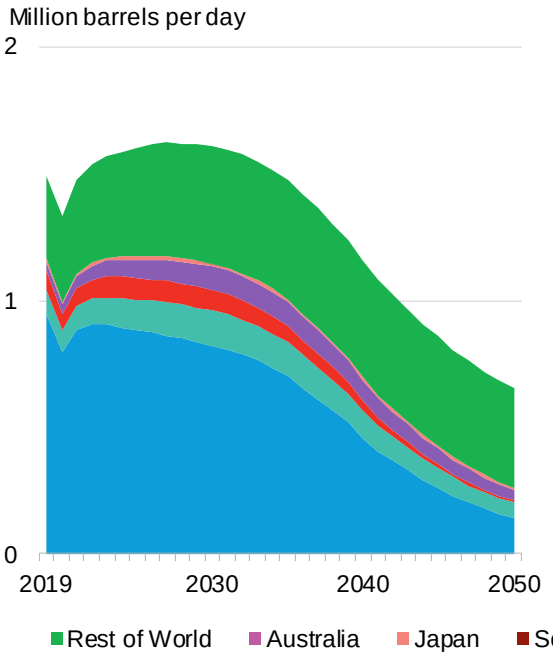
Biofuels boot out fossil-fuels, and diesel trumps gasoline

*For more of the data behind this report, see **BNEF's Transport Data Hub***

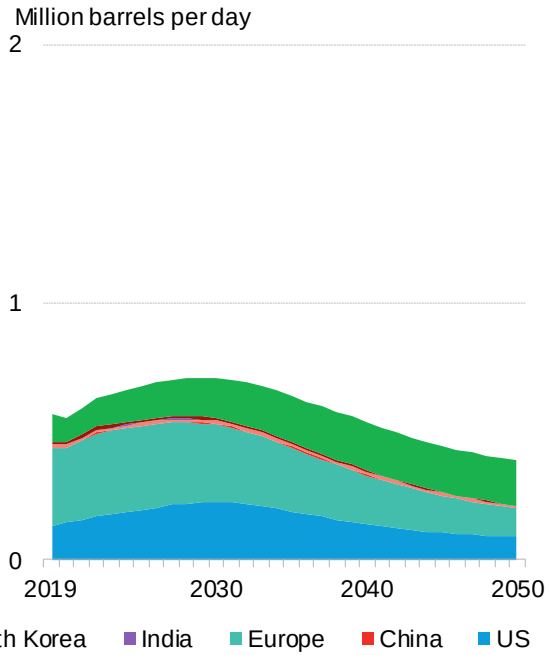
Renewable road fuel demand

Blends increase in many markets, but volume declines

Biogasoline demand



Biodiesel demand



Rest of World | Australia | Japan | South Korea | India | Europe | China | US

Source: BloombergNEF, IEA. Economic Transition Scenario

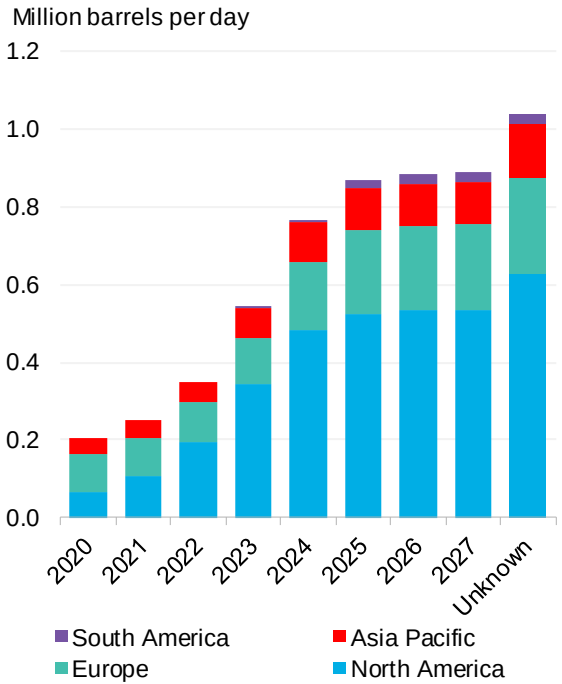
Source: BloombergNEF, IEA. Economic Transition Scenario

- In our ETS, the share of biofuels in road fuels increases from almost 4.87% in 2021 to 5.16% by 2031, before declining to 4.6% in 2050.
- While the blend increases in markets like the US and Europe, as growth in these regions is outpaced by markets with a lower blend rate, like Asia, the outright volume of biofuels consumed globally declines.
- Price sensitivity varies by market, and is particularly acute in countries where several grades of fuel are available at the pump, such as the US In Brazil. A high penetration of flex-fuel vehicles give consumers the ability to switch between bio- and oil-derived gasoline based on price.
- India and China help to drive growth in biogasoline demand despite China having suspended its national target. In our ETS, both continue to gradually rollout the blend in stages, steadily increasing the national average blend rate.
- Biodiesel (predominantly renewable diesel) sees steady growth, predominantly driven by improved policy support driving growth in the US, and several countries increasing blending mandates. Brazil is raising its biodiesel blending mandate in 1% increments each year, from 10% in 2018 to 15% in 2023. Malaysia and Indonesia are also targeting higher blends but the rollout is likely to be delayed, as has historically been the case.
- For more see *The Outlook for Biofuels* (web | terminal).

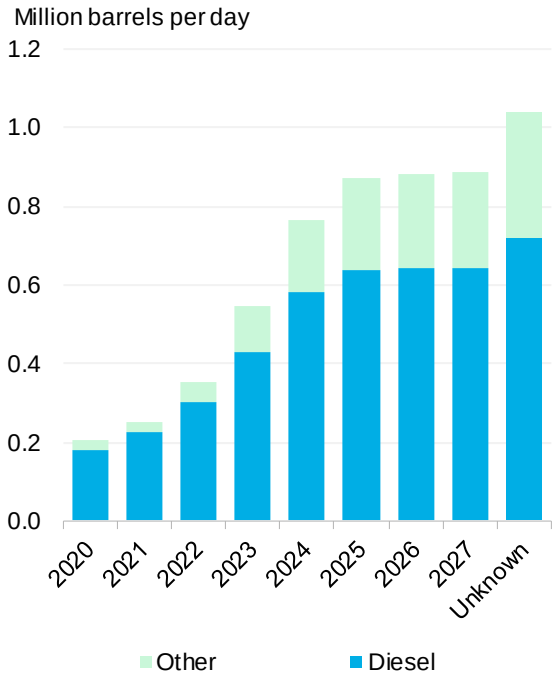
Renewable road fuel supply

Supply ramps up quickly by 2025

Renewable fuel supply by region



Renewable fuel supply by product



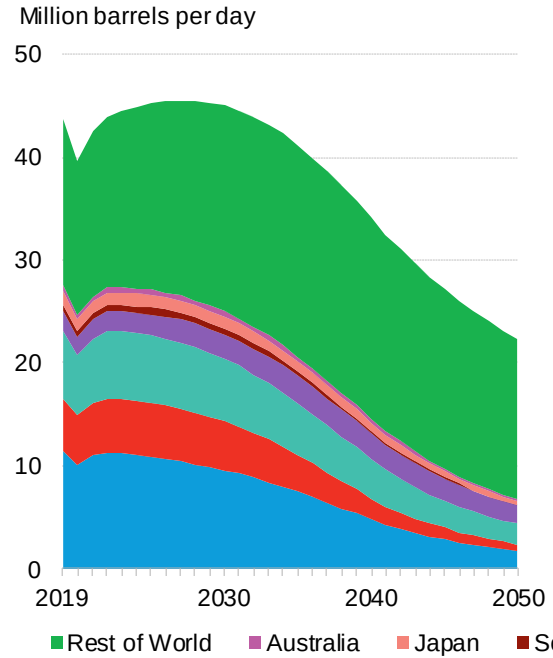
Source: BloombergNEF

- The market for drop-in renewable fuels is expanding rapidly thanks to their ability to replace fossil fuels like-for-like, without the need for blending. As such, they have the potential to decarbonize hard-to-abate sectors such as trucking and aviation. BloombergNEF is tracking more than 100 projects planning to produce renewable diesel-type fuel. We also estimate the potential split of capacity across the three main products --renewable diesel, jet fuel, and naphtha.
- By 2025, planned projects would bring total capacity to 800,000 b/d, from just over 200,000 in 2021.
- Most capacity is aimed at producing renewable diesel for on-road applications, but a growing number of projects are looking to prioritize the production of renewable jet fuel, or sustainable aviation fuel (SAF). Just 3% of current capacity is set up for aviation fuels. This could increase to 16% by 2025.
- Almost all current commercial-scale production is via hydroprocessing, in part due to the synergies with traditional oil refining. By 2025, hydroprocessing will still be the dominant technology, but the share of alternatives like Fischer-Tropsch, Alcohol-to-jet and Power-to-liquids (e-fuels) will have risen to 5%.
- With many projects announced facing uncertainty as feedstock costs rally, BloombergNEF assessed each individual project on a number of metrics, including disclosed feedstock procurement strategy, regulatory and permitting stages, construction status, financing and offtake agreements. For more see *Global Renewable Fuel Projects Tracker* (web | terminal).

Combined road-fuel outlook

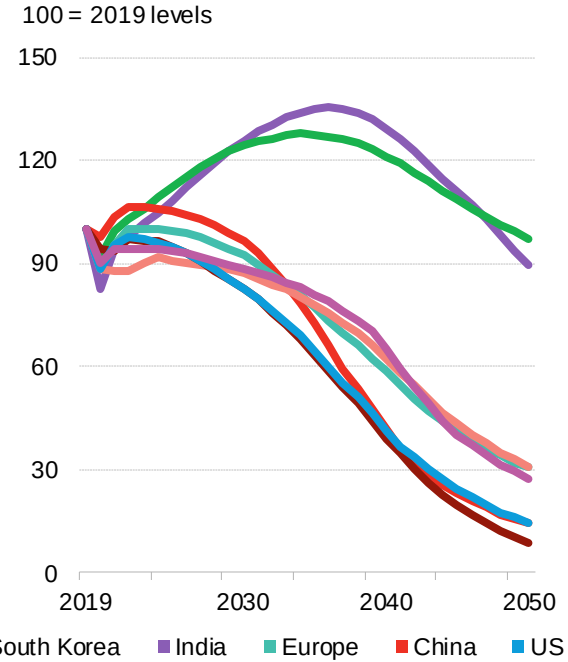
Demand peaks in 2027

Road fuel demand

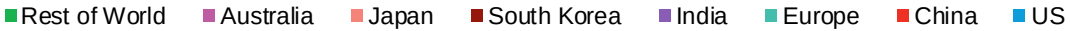


Source: BloombergNEF, IEA.

Road fuel demand rebased



Source: BloombergNEF.



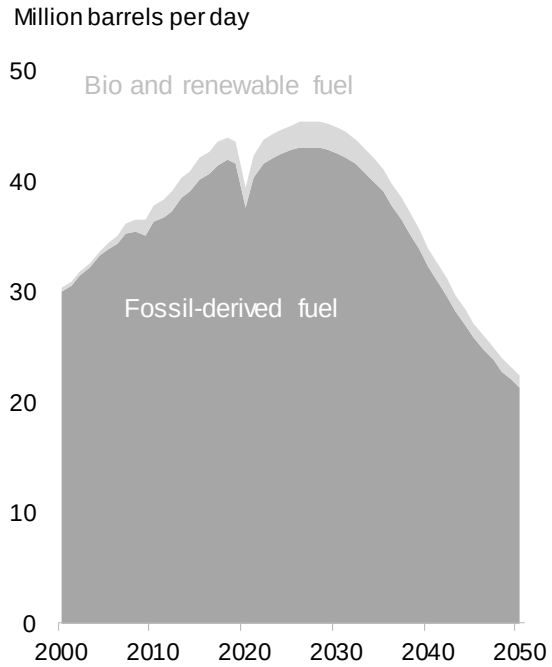
- In our ETS, total road-fuel demand grows by 3.1 million b/d to peak at 45.2 million b/d in 2027. From then on demand begins to decline structurally, reaching 34.1 million b/d by 2040 – similar levels to the early 2000s - and 22.4 million b/d by 2050.
- Over 1 million b/d of 2050 demand is bio-derived fuel, meaning fossil-derived road fuels fall below 22 million b/d by 2050, a level not seen since the early 1970s.
- The peak in demand masks regional and modal variations;
  - Demand in the US and Europe has already peaked. Demand in China is set to peak in 2023 in our ETS, at almost 5.29 million b/d.
  - Growth in India and Rest of World remains strong before slowing in the late 2030s.
  - Demand in the passenger car and two- and three-wheelers has likely peaked, or plateaued, in part due to Covid-19, but also as markets shift toward different modes of transport like autonomous vehicles.
  - Commercial truck road-fuel demand drives growth, and in turn supports diesel demand until the 2030s before declining.

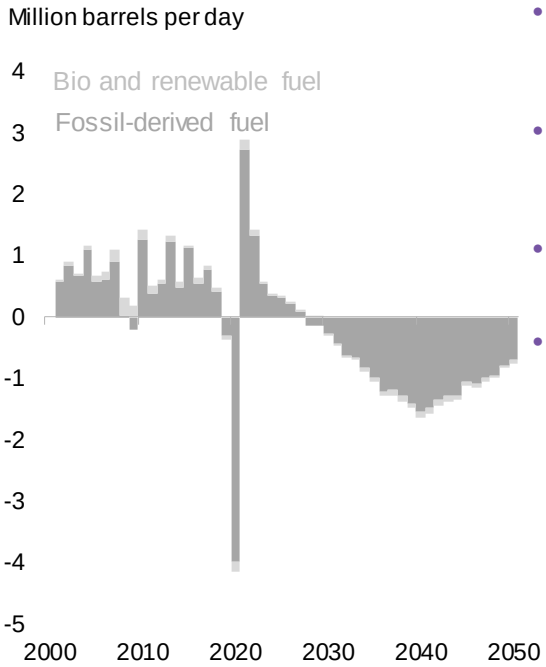
Note: Includes fossil and bio road fuels only, excludes emissions from alternative drivetrains. Economic Transition Scenario.

The BloombergNEF take

Economics do not get the world even close to net zero

Road fuel demand – Economic Transition Scenario





- Despite the rapid penetration of lower-carbon drivetrains, and even zero tailpipe emission drivetrains like electric and fuel cell vehicles, the road sector continues to rely heavily on fossil fuels long in to the future in our Economic Transition Scenario.
- Even as almost 2.4 billion electric or fuel cell passenger vehicles, commercial trucks, two and three wheeled vehicles drive on the world's roads in 2050, road fuel use is set to remain above 20 million b/d.
- While the ICE vehicle fleet declines, in 2037, fossil-derived road fuel demand will remain at levels registered in 2010. By 2041 demand equals levels seen in 2000.
- In the near-term renewable fuels -- like renewable diesel -- can help decarbonize hard-to-abate segments like commercial trucking. However, until policy incentivizes more renewable fuel use or a swifter penetration of alternative cleaner drivetrains in heavy trucks, fast growth in demand for mobility and freight movements in emerging markets will outweigh efforts to decarbonize road transport in regions like Europe, China and the US.

Source: BloombergNEF, IEA. Note: This research excludes buses.

BloombergNEF Oil Content Links

Weekly Publications

- Oil Price Indicators (web | terminal)
- Oil Tanker Time Charter Database (web | terminal)
- Aviation Indicators (web | terminal)
- Road Traffic Indicators (web | terminal)
- U.S. Oil and Gas Indicators (web | terminal)

Monthly Publications

- Oil and Product Markets Monthly (web | terminal)
- Oil Products Arbitrage and Flows Monthly (web | terminal)
- Petrochemical Markets Monthly (web | terminal)
- China Oil Markets Monthly (web | terminal)
- BNEF Oil: The Month in Short (web | terminal)

Quarterly Publications

- U.S. Shale Quarterly Outlook (web | terminal)
- North America Oil and Gas Hedging Quarterly (web | terminal)
- U.S. Biofuels Quarterly (web | terminal)
- China Quarterly Oil Brief (web | terminal)
- Global Oil Refinery Closures Tracker (web | terminal)

LiveSheets and Data

- U.S. Oil Plays Break-Even LiveSheet (terminal)
- U.S. Gas Plays Break-Even LiveSheet (terminal)
- Oil Market Price Data (web | terminal)
- OPEC Crude Flows LiveSheet (web | terminal)
- Oil and Product Stocks Data (web | terminal)
- Oil Products Arbitrage LiveSheet (web | terminal)
- Oil Refinery Margins LiveSheet (web | terminal)
- U.S. Oil Hedging Analysis (web | terminal)
- U.S. Oil Companies Unit Costs Database (web | terminal)
- U.S. Oil and Gas Companies' Well Costs Database (web | terminal)
- Oil and Gas Company Financials LiveSheet (web | terminal)
- Oil Floating Storage Economics (web | terminal)
- China Oil Markets Playbook (web | terminal)
- Petrochemical Markets Playbook (web | terminal)
- Biofuels Playbook (web | terminal)
- Jet Fuel Demand Forward Estimates (terminal)
- Oil and Gas Company Energy Transition Scores (web | terminal)
- Global Renewable Fuel Projects Tracker (web | terminal)

Long-term Outlooks

- Global Oil Demand Outlook to 2050 (web | terminal)
- Road Fuel Outlook (web | terminal)
- Aviation Fuels Outlook (web | terminal)
- Petrochemical Feedstocks Demand Outlook (web | terminal)
- Marine Fuels Outlook (web | terminal)
- Biofuels Outlook (web | terminal)
- Sustainable Aviation Fuel Outlook (web | terminal)
- Downstream Oil Investment Outlook (web | terminal)

Oil Company Low Carbon Strategy

- Oil and Gas Company Energy Transition Investment Trends (web | terminal)
- Is Big Oil Serious About Going Low Carbon? (web | terminal)
- How Oil and Gas Companies Are Addressing Climate Risk (web | terminal)
- Oil and Gas Climate Risk Strategy Best-Practice Reporting (web | terminal)
- Understanding Oil and Gas Emissions Intensity Targets (web | terminal)
- After the Price Shock: Oil Majors' Low-Carbon Strategies (web | terminal)
- National Oil Companies and the Energy Transition: China (web | terminal)
- National LNG Company Strategies: Go Big or Stay Home (web | terminal)

Appendix

Passenger car categorization and examples

BloombergNEF categorization	US	Europe	China
Small (Toyota Corolla, Fiat 500, VW Lavida)	Compact, subcompact	Mini, small	A, B, C
Medium (Audi A4, Honda CR-V, Toyota Camry, Hyundai Mistra)	Compact crossover, mid-size, mid-size crossover, mid-size SUV, entry luxury, entry sport, mid-range sport, premium sport, exotic	Lower medium, medium, upper medium, sport, others	D
Large (Honda Odyssey, Toyota Avalon, Mercedes S class)	Minivan, van, large, mid-range luxury, premium luxury	Luxury, van	E, MPV
SUV (Ford F150, Lincoln Navigator, Cadillac Escalade, Trumpchi GS4)	Full-size pickup, entry luxury SUV, mid-size pickup, large traditional SUV, mid-range luxury SUV, large crossover SUV, premium luxury SUV		SUV, SUV-B, SUV-C, SUV-D, SUV-E

Source: BloombergNEF.

Commercial truck categorization and examples

Region	LCV	MCV	HCV
US	<3.5T	>6.5 <15T	>15T
Europe	<3.5T	>3.5 <16T	>16T
China	<6T	>6 <14T	>14T
India	<3.5T	>3.5 <16T	>16T
Japan	<5T	>5 <9T	>9T
South Korea	<5T	>5 <12T	>12T

Source: BloombergNEF.

Two- and three-wheeler categorization and examples

Type	Class	Image	Description
Two-wheeler	Moped		**Engine size**: typically less than 50cc (cubic centimeters). Most are pedal assisted. **Example**: TVS XL super.
	Scooter*		**Engine size**: up to 150cc and typically above 75cc. Most are automatic (gearless) vehicles. **Examples**: Vespa, Honda Activa and Suzuki Access.
	Motorcycle		**Engine size**: typically between 90cc and 350cc. The engine capacity can also go beyond 1,000cc. Most are manual-geared vehicles. **Examples**: Yamaha R1, Kawasaki Ninja and Hero Splendor.
Three-wheeler	Auto rickshaw		**Engine size**: typically between 100cc and 400cc. **Examples**: Bajaj RE Auto Rickshaw and Piaggio Ape Auto Rickshaw.
	Motor tricycle		**Engine size**: typically between 100cc and 900cc. Fuel type is usually gasoline or diesel. **Example**: Shifen3 wheel truck.

Source: BloombergNEF.

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Our expert coverage assesses pathways for the power, transport, industry, buildings and agriculture sectors to adapt to the energy transition.

We help commodity trading, corporate strategy, finance and policy professionals navigate change and generate opportunities.

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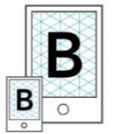

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