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Automotive Manufacturing — Global

Automakers look to electrification to avoid billions in emission-related fines

» **Europe, China and US emission rules boost EVs, require big spending**. The three main auto markets have developed emissions and fuel-economy regulations that reward expansion of electric-vehicle fleets as a mechanism for reaching lower emission targets. This global trend creates a risk of material penalties for noncompliance and will require significant investment by companies seeking to maintain market share.

» **European producers have billions of euros in penalties as compliance incentive**. Europe's deadline for emission cuts is fast approaching in 2020/1, with half of large manufacturers needing to take drastic action over the next two years of production. The middle of our three scenarios puts total emission improvement below target, but even in our rapid-transition scenario, half the manufacturers could share €2.4 billion of potential penalties for failing to comply. Sales of high-emission models may have to be foregone in order to avoid penalties, resulting in lost market share. Penalties could also be incurred in 2020, due to less time to make progress and consumers switching away from diesel after the emissions scandal. These fines would be credit negative for the companies. Based on their current gap to 2020/1 targets, Volkswagen (A3 stable), Fiat Chrysler (Ba2 positive), Ford (Baa3 negative) and Hyundai (Baa1 negative) - Kia (Baa1 negative) are most exposed relative to EBITDA.

» **China aiming for new energy vehicle leadership.** The Chinese system strongly rewards new energy vehicles (NEVs) production, including battery electric and plug-in hybrid passenger vehicles. Passenger vehicles made in China are generally more efficient than imported passenger vehicles, according to the latest available data. This investment reflects the Chinese government's ambition to dominate the NEV market and battery production. Ford, Nissan (A2 review for downgrade) and Fiat Chrysler are furthest behind on 2020 targets, according to the latest fleet data. NEV credits and the flexibility to bank or trade credits limits the potential compliance costs.

» **California still dreaming of an electric future**. California and the other US states aligned with it on vehicle standards are committed to electrification and reducing emissions. The auto industry has already prepared for performance improvements, despite a federal decision to freeze emission standards in 2020. Fiat Chrysler, Daimler (A2 stable), and Jaguar Land Rover (Ba3 negative) have the most work to do to achieve the previously agreed upon fuel-economy targets.

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» **Continued investment in electrification required**. China, Europe and the US provide incentives for electrification with their policies. Together these markets account for about three-quarters of light vehicle sales. Any manufacturer wanting to maintain a global market share cannot delay investing in electrification. This will require significant investment in new model development, battery technology and supply, and marketing of electric vehicles to consumers.

European manufacturers have billions of euros in penalties as compliance incentive

2020/1 European CO_2 passenger car target is rapidly approaching

In terms of progress on the EU fleet CO_2 emissions performance, 2017 was a lost year, (base on the most recent official dataset available). Average CO_2 emissions for passenger cars remained around 118g CO_2/km in 2017, or 23g above the overall 2020/1 target of 95g CO_2/km.[1] The low numbers of new models or versions launched reflected manufacturers' strategy of holding back releases until they can deliver the CO_2 reductions required. The limited activity refreshing fleets in recent years signals greater potential advancements in the remaining window before the deadline.

Fleet CO_2 targets are adjusted to the weight of each manufacturer's fleet. Hence the makers of larger (and typically less-efficient) cars have less-demanding targets. In 2017, the gap to the 2020/1 target ranges from 9g - 30g CO_2/km, with the targets ranging from 91g - 107g CO_2/km for high volume producers. Smaller producers can seek niche exemptions, for example, Jaguar Land Rover produces less than 300,000 vehicles per year, so it agreed to a target of around 131g CO_2/km for 2020/1.

Delays in rolling out low-carbon vehicles could hamper manufacturers' ability to avoid penalties. In 2020, only the 95% of vehicles with the lowest CO_2 of a manufacturer's fleet will be assessed, rising to the full 100% in 2021. Omitting the worst-performing 5% could result in an improvement of several grams of CO_2/km in 2020, depending on the range of performance across a fleet. Analysis of the 2017 fleets indicates that eliminating the worst performing 5% of each manufacturers production only improves average performance by roughly 0.4g-4.7g CO_2/km. [see Appendix 1] This suggests that the benefit afforded by this phased introduction could be more than offset by having one less year to roll out electrified models. As a result manufacturers could also be subject to fines in 2020.

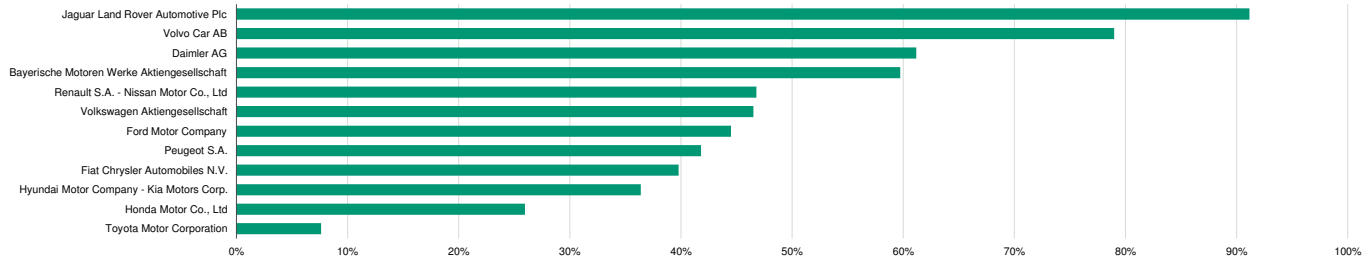
The 2020 95% phased implementation benefits will be offset by lower gains in CO_2 efficiency of Internal Combustion Engines (ICEs) and lower deployment of electric vehicles (EVs) in 2020, compared with 2021. In this scenario, 2020 will see similar penalties imposed to those estimated for 2021, given the fine margins for achieving the targets.

Consumers deserting diesels exacerbates CO_2 challenge in Europe

Consumers are switching away from diesel cars in Europe after the "dieselgate" scandal, making achieving emission targets more difficult. We expect performance in 2018 to be worse than 2017 for many manufacturers as a result. Diesel cars made a significant contribution to achieving CO_2 targets, as they typically have lower CO_2 emissions than their petrol equivalents. In 2018, diesel-powered vehicles fell to 36% of new passenger cars registered in Europe, down from 44% in 2017[2] and a peak of 56% in 2011. Jaguar Land Rover (Ba3 negative), Volvo Car (Ba1 stable), Daimler (A2 stable) and Bayerische Motoren Werke (A1 stable) own the brands that previously recorded higher-than-average diesel new passenger registrations, while Toyota Motor (Aa3 stable) has a very low proportion (see Exhibit 1.) It is not clear yet, whether the trend away from diesels will continue, or if larger vehicle segments or particular markets will maintain higher proportions of diesels.

Exhibit 1

Percentage of diesel vehicles in European new registrations, 2017



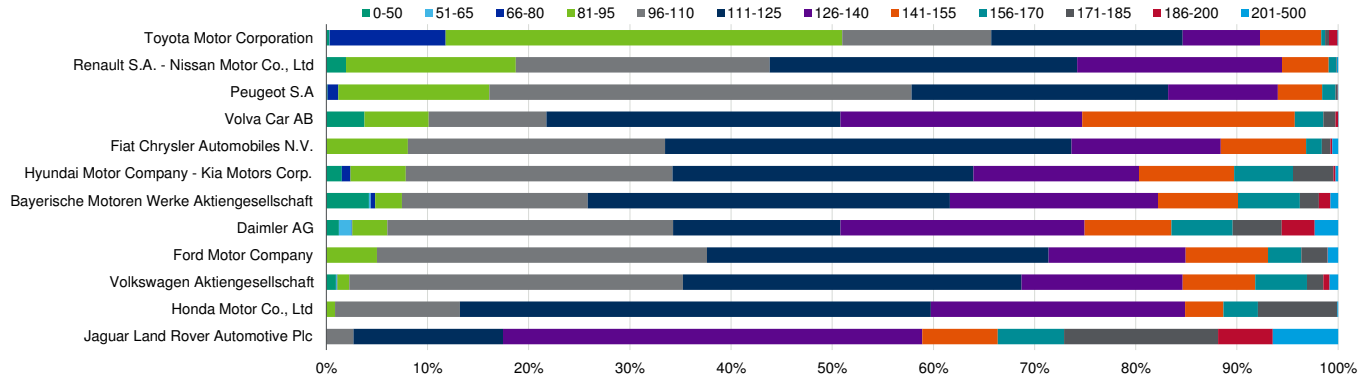
Note: Peugeot S.A. includes acquired Opel-Vauxhall brands
Source: European Environment Agency

Major fleet updates required for compliance

The 2017 distribution of CO_2 emissions for each manufacturer shows how large a proportion of each fleet needs to be eliminated or replaced with models emitting lower than the company's target (see Exhibit 2). The first four categories to the left of the grey band are below the EU overall target level of 95gCO_2/km. These categories should make up about half of the fleet, depending on the spread of performance and the precise company-specific target. This could result in manufacturers having to refresh half of their fleet in order to get the average CO_2 emissions down.

Exhibit 2

Proportion of European fleet in different bands of CO_2 emissions (gCO_2/km)



Note: Peugeot S.A. includes acquired Opel-Vauxhall brands
Source: European Environment Agency

The task will be made harder by the switch away from diesels, which will remove some of the better performing volume displayed in the chart. Eliminating some of the volume shown on the right end of the chart will also improve the average. This may mean some model ranges are discontinued or limited to the better performing engine variants.

Companies employing different strategies to achieve emission targets

Some companies are focused on mild hybrids, which will contribute to the ICE fleet efficiency, while others have already invested significantly in battery electric vehicles (BEV) and plug-in hybrids (PHEV) that should deliver the maximum level of so-called "EV supercredits" for a number of companies. BEV and PHEV vehicles are particularly valuable as they contribute to bringing the overall fleet average down, as well as bringing supercredits. A few companies already have eco-efficiency technologies approved, including auto-parts suppliers such as Valeo (Baa3 stable) and Bosch (unrated). We expect a flurry of further measures and deployments as the deadline approaches.

Fleet emission cuts required to reach the 2020/1 targets can be achieved 3 ways:

1) Improve the CO_2 efficiency of the internal combustion engines being produced. Increasing production of mild hybrids can contribute to this for example. Or incentivising consumer demand for certain more CO_2 efficient models, such as diesel instead of petrol, or smaller engines.

2) Increase the production of low-carbon vehicles that qualify for supercredits. BEVs and most PHEVs count toward this, with the threshold being <50g CO_2/km on the New European Driving Cycle (NEDC) test. These are weighted double in the 2020 calculations and x1.67 in 2021, up to a maximum overall reduction of 7.5g CO_2/km for the fleet.

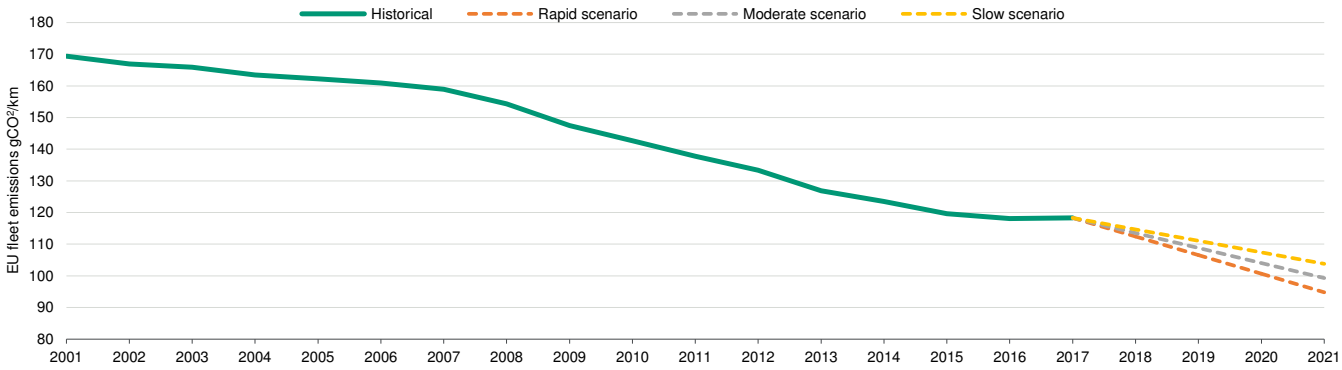
3) Integrate efficiency measures that qualify for CO_2 reductions. These technologies must contribute to vehicle safety or performance, rather than "comfort." Examples include efficient alternators, LED lights, or coasting functions. The maximum saving is 7g CO_2/km.

Manufacturers need to deliver faster cuts to achieve compliance

Since 2001, the EU-28 passenger vehicle fleet CO_2 performance has improved an average of 3.2g CO_2/km each year. Emissions fell fairly consistently between 2007 and 2013, due to tax incentives for diesel powertrains that had lower CO_2 emissions. After this, sales of SUVs increased in Europe, followed by the dieselgate scandal in 2015 that saw consumers switch away from diesel vehicles, which resulted in an upturn in emissions. In 2017, the last year for which the EU has published CO_2 figures, battery and plug-in hybrid electric vehicles were still a very small proportion of new vehicles.

Exhibit 3

Continued decline of CO_2 emissions for EU-28 new passenger vehicle



Note: Moody's Moderate scenario sees a total reduction of 19gCO_2/km over the next four years: CO_2 efficiency of 10gCO_2/km, EV supercredits of 6gCO_2/km and Eco-efficiency of 3gCO_2/km.

Source: ICCT, Moody's Investor Service

Over the next 4 years, the average annual improvement needed by the manufacturers ranges from 2.25g - 7.5g CO_2/km. The extra credits available will contribute to that goal, but this means half the companies must still consistently deliver levels of reductions that will prove challenging to reach over that period. Toyota is the only company that has already made significant progress, due to its more extensive deployment of mild hybrids (see Exhibit 4.)

Exhibit 4
Annual improvement required to meet 2021 target

Company	Fleet CO_2 emissions 2017 (gCO_2/km)	2021 target (gCO_2/km)	Gap in 2017 to 2021 target	Annual improvement (gCO_2/km)
Toyota Motor Corporation	103	94	9	-2.25
Volvo Car AB	124	107	17	-4.25
Peugeot S.A	111	93	18	-4.50
Renault S.A. - Nissan Motor Co., Ltd	111	93	18	-4.50
Jaguar Land Rover Automotive Plc	152	131	21	-5.25
Bayerische Motoren Werke Aktiengesellschaft	122	101	21	-5.25
Ford Motor Company	121	95	26	-6.50
Volkswagen Aktiengesellschaft	122	96	26	-6.50
Daimler AG	127	100	27	-6.75
Hyundai Motor Company - Kia Motors Corp.	122	94	28	-7.00
Fiat Chrysler Automobiles N.V.	120	91	29	-7.25
Honda Motor Co., Ltd	127	97	30	-7.50

Note: Peugeot S.A. includes acquired Opel-Vauxhall brands
Note: Estimated 2021 target shown is based on NEDC testing cycle. By 2021, this will be converted into a Worldwide Harmonised Light Vehicle Test Procedure (WLTP) equivalent.
Source: European Environment Agency provisional data

The ordering of manufacturers in the table is based on the size of the gap between provisional 2017 fleet performance and the 2021 target. The manufacturers in the bottom half of the table have left it late to close the gap. Some companies have reported provisional figures for 2018 that suggest performance is getting worse or staying the same, leaving even more to be done in the time remaining.[3]

PHEV/BEV vehicles made up around 2.0% of the EU-28 fleet in 2018. This would need to more than quadruple by 2021 and be evenly distributed across all manufacturers to allow the maximum number of supercredits to be achieved by all companies. If demand and/or supply falls short, that could reduce the credits available to some companies. Renault, Nissan and BMW already have a head start on BEV sales in Europe.

To date, eco-efficiency measures have delivered a maximum benefit of 4g CO_2/km per vehicle, and the leading company averaged only 0.4g CO_2/km across its fleet in 2017. Our three scenarios (see Exhibit 5) consider the current maximum being applied to half, three-quarters and all of a manufacturers' fleets in 2021.

All three scenarios we considered show automakers have work to do

We consider three scenarios representing rapid, moderate and slow transition by automakers. These scenarios are not designed to project penalties as it does not account for undisclosed company specific future production plans, or capture uncertainty around limitations or advantages privy to the different manufacturers. Rather, these scenarios offer a benchmark that can help inform judgments about a company's resilience to CO_2 emission targets. The rapid transition scenario should be feasible for most companies, however downside risks present headwinds to all companies achieving this.

Exhibit 5
Scenarios used to estimate potential manufacturer penalties

	Estimated gains by 2021 (gCO2/km)			
Scenario	ICE CO2 Efficiency	PHEV/BEV Supercredits	ECO-Efficiency	Total
Rapid transition	-12	-7.5	-4	-23.5
Moderate transition	-10	-6	-3	-19
Slow transition	-8	-4.5	-2	-14.5

Source: Moody's Investor Services

See Appendix 2 for further explanation of the assumptions used for Moody's scenario calculations.

Any company that fails to achieve its target will be subject to a penalty of €95 for each vehicle it registered in that year[4]. As a result, the potential cost per gram CO_2/km in excess of the target is a factor of the volume of cars sold by any given manufacturer. If a company has already invested across the range of options for ICE efficiency, EV production and eco-efficiency it should have no

problem in achieving its 2020/1 targets. Alternatively, manufacturers could decide to discontinue the worst performing models. This could leave a gap in model ranges, especially of less efficient large premium vehicles, if no alternative has been developed.

Automakers can also pool different companies in their corporate group — which may help or hinder achieving the targets. The acquisition of the Vauxhall/Opel brands by Peugeot (Baa3 stable) means the company has gone from being one of the leaders to having a compliance challenge because of the poor CO_2 performance of the Vauxhall/Opel fleet. As Peugeot moves to shared vehicle platforms across all its brands, it allows low-carbon drivetrains to be shared across the fleet.

As we enter the years when penalties could be incurred, 2020 and 2021, each manufacturer will have to take a view on whether to adjust production in an effort to avoid penalties. This would still be credit negative, as it would incur costs from foregone premium sales and idle manufacturing capacity. Aside from this, there may be further reputational impacts if the targets are missed, for an industry already attempting to recover from the recent emissions-testing scandal. This has already cost affected companies billions in compensation, fines, buybacks, and technical remedies. Expenditures are also expected for marketing and pricing strategies that could affect revenue, as companies try to increase sales of low emission or alternative fuel vehicles. Companies could, in some cases however, determine it is cheaper in the short term to pay the penalties than invest in compliance.

Penalties could total billions of euros across EU fleet if transition is too slow

The level of penalties provides a major incentive for manufacturers to meet the targets. The combined penalties across the rated group of companies range from an estimated €2.4 billion in the rapid transition scenario, to €5.9 billion in the moderate scenario and up to €11.2 billion if the transition is slow. This demonstrates the material incentives auto manufacturers have to comply. Given the high level of competition to sell electric vehicles during this period, it is possible manufacturers will end up achieving different results, with some only achieving slow or moderate progress, while others make a rapid transition to lower emissions.

Exhibit 6

Transition scenarios demonstrate the quantum of incentives to accelerate emissions reductions

		Scenario Penalties (mn)		
Company	EBITDA LTM (mn)	Slow	Moderate	Rapid
Toyota Motor Corporation	€28,337			
Volvo Car AB	€2,036	€57		
Peugeot S.A	€5,285	€773		
Renault S.A. - Nissan Motor Co., Ltd	€12,673	€728		
Jaguar Land Rover Automotive Plc	€822	€141	€44	
Bayerische Motoren Werke Aktiengesellschaft	€10,219	€608	€187	
Ford Motor Company	€6,753	€1,120	€682	€243
Volkswagen Aktiengesellschaft	€29,519	€3,869	€2,355	€841
Daimler AG	€14,045	€1,141	€730	€320
Hyundai Motor Company - Kia Motors Corp.	€5,443	€1,222	€815	€407
Fiat Chrysler Automobiles N.V.	€10,299	€1,344	€927	€510
Honda Motor Co., Ltd	€12,163	€194	€138	€82
Total	€137,594	€11,198	€5,877	€2,403

Note: Refer to Appendix 3 for full tables of penalty calculations for each scenario. LTM is based on available data, hence months may vary across manufacturers
Source: Moody's Investors Service

Volkswagen, Fiat Chrysler, Ford, and Hyundai-Kia are the companies with the highest potential levels of fines relative to EBITDA. While the penalties are proportional to the scale of the automakers, they are still significant and would be credit negative some companies under the moderate or slow scenarios. This is especially true for European-focused producers with poor margins, at a time when significant investment in technology is required.

Even under the rapid transition scenario, it is clear some tough choices may have to be made during 2020 and 2021 to deliver compliance. Companies in the bottom half of the table are still several g CO_2/km away from the fleet average target even under the rapid scenario. However, no manufacturer currently intends to miss their target, and its is possible companies will achieve greater improvements than indicated in the rapid transition scenario.

Given the aggressive assumptions of the rapid transition scenario, with high levels of credits for electric vehicles and eco-efficiency, companies will have to cease production of models with higher emissions, potentially losing market share. Companies will need to manage production and sales mixes closely during this period to come in on target.

The UK has outlined its intention to maintain equivalent standards to the EU targets upon leaving the EU. [5]. This would essentially result in the splitting of manufacturer fleets into EU and UK. The UK fleet has slightly higher CO_2 emissions than the EU average, which may make it harder to achieve compliance within the UK in isolation.

Proposed longer-term EU targets mean greater pressure to invest

On top of potential fines, companies active in the European market will need to keep investing in low-carbon technologies to align with the region's targets to maintain progress through 2030. The next phase of European Union passenger car CO_2 targets are currently being determined, but proposals are for a further 37.5% cut in CO_2 emissions from 2021 levels by 2030, with an interim target of a 15% reduction by 2025[6].

The next phase of targets are also based on a different testing regime, following the European emissions testing scandal. The EU's Worldwide Harmonised Light Vehicle Test Procedure (WLTP) and Real Driving Emissions (RDE) tests are now being phased in, replacing the NEDC tests. The performance of new vehicles under these new tests may also have a bearing on how easy it is for manufacturers to comply. The equivalent target levels under WLTP have not yet been determined.

China aiming for a leadership position on new energy vehicles

China's suite of policy incentives are aimed to promote New Energy Vehicle (NEV)[7] development over ICE efficiency. China's Corporate Average Fuel Consumption (CAFC) target is set at 5l/100 km for 2020 (see Exhibit 7 for a comparison of regional standards and metrics). The CAFC is a weight-based system, adjusting corporate fleet targets for the weight of passenger vehicles produced, similar to the European approach. [8] [9]

A NEV credit scheme sits alongside this to further stimulate development of these vehicles. Passenger vehicle manufacturers have been set a new energy passenger vehicle score equivalent to the number of conventional fuel passenger vehicles produced by the passenger vehicle maker multiplied by a new energy passenger vehicle target ratio of 12% for 2020. The two mechanisms allow some surplus credits to be carried forward into future years, and trading between producers to meet shortfalls. The linkages between the CAFC and NEV systems makes estimating future performance increasingly complex.

Domestically produced vehicles trump imported vehicles on fuel economy

Domestically produced passenger vehicles are typically more efficient than imported vehicles. Some passenger vehicle makers who produce in China are already achieving 2020 target levels and imports of inefficient vehicles looks unsustainable for overseas manufacturers. Comparing the fleet performance reported by the Chinese authorities for 2017 with the estimated target for each passenger vehicle manufacturer provides an indication of the gap that must be closed or offset by credits in 2020 (see Exhibit 7.)

For Chinese and foreign passenger vehicle makers, this is a combination of imported vehicles and those produced in China through joint ventures. This relationship with Chinese partners also provides an option to achieve compliance through trading credits between domestic producers and foreign joint venture partners. The figures presented here represent passenger vehicles made in China or imported into China by a given foreign[10] or Chinese automotive group[11].

Exhibit 7

Passenger vehicle manufacturers' latest performance relative to estimated 2020 China target

	2017 fleet performance (l/100km)	2020 adjusted target (l/100km)	Gap to 2020 target (l/100km)
Beijing Automotive Group Co., Ltd.	4.88	5.21	-0.32
Geely Automobile Holdings Limited	5.18	5.15	0.03
Bayerische Motoren Werke Aktiengesellschaft	6.46	5.66	0.80
Dongfeng Motor Group Company Limited	6.24	5.39	0.85
Volvo Car AB	6.82	5.88	0.94
Toyota Motor Corporation	6.37	5.26	1.11
Volkswagen Aktiengesellschaft	6.40	5.17	1.23
Honda Motor Co., Ltd.	6.39	5.12	1.27
General Motors Company	6.42	5.14	1.28
Peugeot S.A.	6.40	5.08	1.32
Daimler AG	7.18	5.81	1.37
Kia Motors Corporation	6.35	4.96	1.39
Hyundai Motor Company	6.47	5.07	1.40
Renault S.A.	7.04	5.42	1.62
Tata Motors Limited (Jaguar Land Rover Automotive Plc)	8.06	6.38	1.68
Ford Motor Company	7.28	5.39	1.89
Nissan Motor Co., Ltd.	7.73	5.55	2.18
Fiat Chrysler Automobiles N.V.	7.80	5.54	2.26

Note: Beijing Auto and Dongfeng calculations reflect passenger vehicle unit production from their own brand operations and do not include those from their joint ventures. Joint venture production is attributed to the foreign car brand, e.g. Beijing-Benz is attributed to Daimler AG.
Source: Ministry of Industry & Information Technology, China

There is significant potential for manufacturers to attain credits by producing NEVs, which will be a key variable in determining future compliance. Companies with a large gap to close will have to make substantial progress on the passenger vehicles they are offering, or incur the cost of buying credits if they want to maintain market share. Another option is to cease importing/producing the most-inefficient passenger vehicles to improve fleet performance. Overall there is plenty of flexibility in the system to facilitate compliance.

Electric vehicle supercredits ease compliance in China

The passenger vehicle fleet in China is on track to meet 2020 targets. In 2016, the average CAFC target across the Chinese fleet was at 134% of the 2020 fuel consumption target. The 2016 fleet achieved 132%, even before adding supercredits, which contributed a further 8% improvement, resulting in an overall level of 124%.[12] The supercredits for NEVs are weighted higher than, for example, in California. As a result we do not expect compliance to be an issue in China.

Manufacturers of over 30,000 vehicles per year are required to reach new energy passenger vehicle score targets. The new energy passenger vehicle score target is the number of conventional fuel passenger vehicles produced by the passenger vehicle maker multiplied by a new energy passenger vehicle target ratio of 10% for 2019 and 12% for 2020, respectively. Passenger vehicle makers can meet their targets by producing new energy passenger vehicles, with higher points being awarded for vehicles that have a longer travel range in general.

China currently dominates existing and planned lithium ion battery manufacturing capacity [13]. This strategy reflects the government's commitment to seizing this opportunity to become a world leader in battery and NEV technologies. Overseas producers are also seeking to establish battery capacity in China, with Tesla Inc. (B3 negative) planning to begin operation of a new gigafactory in China in 2019. Apart from China's commitment to reduce greenhouse gas emissions, the growing commitment to NEVs is driven by a desire to develop a strong global position in the NEV market, improve air quality and reduce oil imports.

Progress set to continue in China

Future targets make it clear that passenger vehicle manufacturers without an aggressive NEV strategy will struggle to meet Chinese expectations beyond 2020. Discussions for a 2025 target in China have centered around a 4l/100 km level, but are not yet approved. This demonstrates that China is expecting continued progress from those wanting access to its passenger vehicle market. The government expects NEVs to constitute over 20% of auto sales by 2025, indicating a continued ramp-up in production.

California still dreaming of an electric future

2025 US emission, fuel economy standards in limbo

Alignment between Californian and US federal regulations was interrupted when the current administration directed federal agencies to freeze fuel-economy requirements at 2020 levels indefinitely. Twelve other US states follow Californian standards, resulting

in a potential division of US requirements. California and the states that adopted its regulations indicated they want to keep the national standards consistent with Californian Low Emissions Vehicle (LEV) III standards, which were already adopted for 2015-25. Manufacturers have worked under the assumption that this would be the requirement for them to meet over this decade, and voiced support for continuing with standards that require year-on-year improvement in response to the proposal to freeze standards in 2020.

The US fleet is shifting further toward light trucks, raising the adjusted fleet targets. The US targets require a 35% improvement in fleet emission intensity from a 2016 baseline to an average of 175g CO_2/mile in 2025 for light vehicles[14], publised 2012. This is a combination of separate targets of 143g CO_2/mile for cars and 203g CO_2/mile for trucks. As the proportion of trucks being sold has increased, the combined light vehicle target rose. The US LEV standards differ slightly from Europe in that they are adjusted based on the footprint area of a vehicle rather than running mass. This means light-weighting techniques are rewarded under this system. (See Exhibit 15 for historic performance, enacted targets, and proposed targets across countries based on CO_2 emissions and fuel consumption.)

Extra credits can be gained to contribute to achieving emissions targets. The industry expects a 20g - 30g CO_2/mile benefit from implementing technologies in ICE vehicles that improve air-conditioning, or off-cycle energy, in 2025. Credits for achieving beyond the annual targets can also be banked to use in subsequent years or traded with other companies. Tesla has booked revenue in recent years from selling credits to other auto producers. The US also applies a multiplier incentive for electric and fuel-cell vehicles until 2021.

EVs are important for achieving the multiple vehicle standards in the US, where there is also a separate Zero Emissions Vehicles mandate in 10 states, which requires 22% credits by 2022. The credits are awarded based on the type of alternative fuel vehicle and its range. A California government review estimated the increases in EV range means the 22% level of credits would now equate to less than 8% EV sales in 2025. The US has Corporate Average Fuel Economy (CAFE) standards too, of 46.7 mpg in 2025, which focus solely on fuel economy, and do not allow for other methods of reducing emissions.[15]

US manufacturers range in fuel economy performance

A number of major US car manufacturers have a sizable gap to close if they are to achieve the CAFE targets. The company-specific targets are derived using data on the vehicle fleet of each manufacturer, and the proportion of cars and light trucks in each fleet. For 2016, fleet levels have a wide range of performance from 26.5 mpg – 38.5 mpg (see Exhibit 8). The adjusted manufacturer-specific targets for 2025 range from 42.6 mpg – 53.1 mpg.

Exhibit 8

US manufacturers performance and adjusted target

	2016 Fuel economy (mpg)	Target 2025 (mpg)	Relative improvement
Honda Motor Co., Ltd.	38.5	50.3	31%
Nissan Motor Co., Ltd.	35.1	49.3	40%
Volvo Car AB	32.5	45.7	41%
Hyundai Motor Company	37.1	53.1	43%
Toyota Motor Corporation	32.6	48.3	48%
Bayerische Motoren Werke Aktiengesellschaft	32.8	49.4	51%
Ford Motor Company	28.5	43.4	52%
Kia Motors Corporation	34.4	52.4	52%
General Motors Company	28.2	43.1	53%
Volkswagen Aktiengesellschaft	33.8	51.8	53%
Jaguar Land Rover Automotive Plc	27.2	43.6	60%
Daimler AG	30.1	48.4	61%
Fiat Chrysler Automobiles N.V.	26.5	42.6	61%

Source: Wards Auto, US Environmental Protection Agency

The relative difference gives an indication of the level of improvement a producer will have to deliver by 2025 under these targets. It is also important to consider the momentum companies have from investment in developing technological improvements in the last few years. Those manufacturers that are behind the curve will have to increase investment to catch up. This is likely to place further pressure on cash flow alongside uncertainty around the margins they can earn on low/zero emissions vehicles during this period.

By creating standards out to 2025, the US sent a long-term signal to vehicle manufacturers, and they are planning to continue to improve emissions performance. For global manufacturers in particular, there are efficiencies to be gained by deploying technology across multiple continents. China and Europe are driving deployment of alternative fuel vehicles (AFVs) via various mechanisms, and this is an opportunity for manufacturers to gain market share, or otherwise risk getting left behind.

Continued investment in electrification needed to reach targets

Electric vehicles essential for achieving emission, fuel-economy standards in major markets

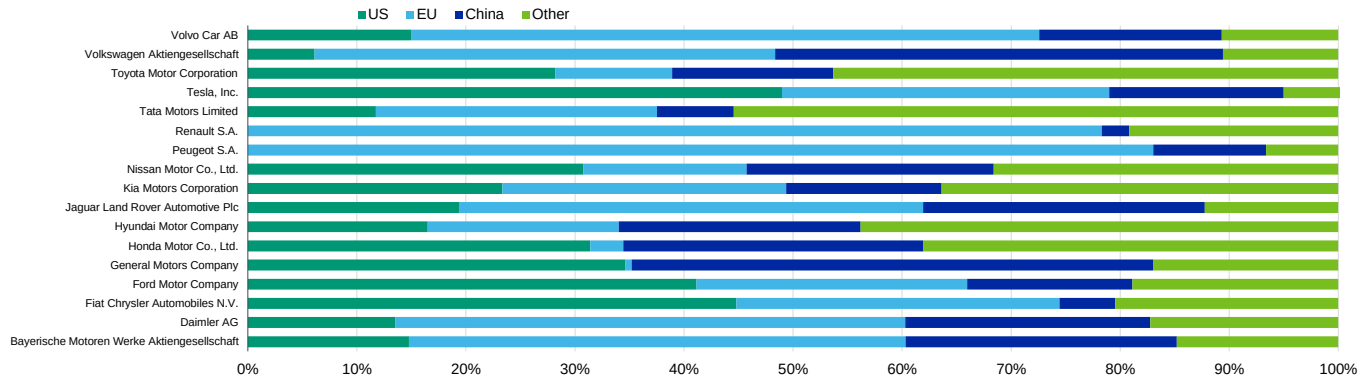
Auto manufacturers will not meet the emissions standards being set in Europe, China and the US without a growing pipeline of AFVs, incremental improvements in ICE efficiency will be insufficient for most large car producers.

Time is running out to deliver electrification of production, especially in Europe where targets are set for 2020-21, with significant penalties for noncompliance. China allows significant flexibility to achieve its 2020 fuel-efficiency targets, particularly through EV sales. California and other US states aligned with its vehicle standards are still committed to 2025 targets, and carmakers need to maximize sales to recoup the costs of developing new models and technologies.

The regulatory requirements in the US, China and Europe — which combined account for around three-quarters of light vehicle sales — essentially drive the global auto market. In addition to Chinese automakers which generate most of their unit sales in China, large western manufacturers such as Volkswagen (A3 stable), and General Motors (Baa3 stable) are already dependent on Chinese joint ventures for a major proportion of sales. The importance of China for global auto manufacturers means ignoring the shift to EVs will compromise their standing in the Chinese market. Companies will need to invest in new model design, battery technology or supply, as well as persuading consumers to buy the mandated models.

Exhibit 9

China, EU, US remain dominant in light vehicle markets



Source: Wards auto

Limited options as electrification accelerates

Auto manufacturers aiming to benefit from global growth can no longer hedge their bets with the rapid direction of policy travel. Japan is the next-largest market, but the fleet has already achieved its 2020 targets, which are similar to European levels, showing what is already possible. Some manufacturers have decided to focus on particular markets or vehicle segments, with GM's withdrawal from Europe and small cars an obvious example. This strategy limits long-term options, but reduces short-term investment requirements. At the other end of the spectrum, new entrants such as Tesla that only produce EVs have no compliance concerns, and indeed will earn credits they can sell to other manufacturers in some markets.

Appendix 1

Exhibit 10

Gap in CO_2 emissions by removing 5% of the worst performing CO_2 emission vehicles in new passenger registrations, 2017

	Difference in gCO2/km excluding 5% of most polluting vehicles
Honda Motor Co., Ltd	0.4
Peugeot S.A	0.6
Renault S.A. - Nissan Motor Co., Ltd	1.4
Hyundai Motor Company - Kia Motors Corp.	2.0
Volkswagen Aktiengesellschaft	2.2
Volvo Car AB	2.2
Fiat Chrysler Automobiles N.V.	2.3
Toyota Motor Corporation	3.1
Bayerische Motoren Werke Aktiengesellschaft	3.2
Ford Motor Company	3.7
Daimler AG	4.0
Jaguar Land Rover Automotive Plc	4.7

Note: Larger gap indicates the manufacturer benefits more from the 2020 exclusion of 5% of the worst performing CO_2 emission vehicles

Source: European Environment Agency, Moody's Investor Service

Vehicles with a more concentrated distribution of the CO_2 emissions across the fleet of new passenger registered vehicles see less difference from removing the worst performing five percent.

Appendix 2

Approach to creating the Rapid, Moderate and Slow transition scenarios

The 2021 target is adjusted for the average weight of the vehicle fleet. For the purposes of the calculation we have assumed each manufacturer's average weight does not change from the most recent 2017 data, unless the manufacturer has provided a revised target.

Rapid transition scenario:

On CO_2 efficiency, we assume a manufacturer can achieve 12g CO_2/km improvements over 4 years. This equates to the average improvement of 3g CO_2/km each year from 2001 to 2017. This a step up from the 1-2g CO_2/km some have achieved in recent years.

For EV supercredits we assume that a manufacturer will achieve the maximum credits of 7.5g CO_2/km. To put the maximum level of 7.5g CO_2/km in context, a production mix of 3.1% BEVs and 5.3% PHEVs in 2021 would deliver the maximum credits of 7.5g CO_2/km. The EU fleet mix in 2017 was 0.7% PHEVs and 0.4% BEVs.

For eco-efficiency we assume a manufacturer achieves the current best performance to date of around 4g CO_2/km across their entire fleet.

Moderate transition scenario:

On CO_2 efficiency, we assume a manufacturer can achieve 10g CO_2/km improvements over 4 years. This equates to an average improvement of 2.5g CO_2/km each year, a step down from the 2001 to 2017 annual average which could reflect the impact of declining diesel demand.

For EV supercredits we assume that a manufacturer will fall short of the maximum credits available as they cannot deliver or sell sufficient PHEVs/BEVs, but achieve 6g CO_2/km.

For eco-efficiency we assume a manufacturer achieves the maximum performance on three-quarters of their fleet, gaining 3 CO_2/km.

Slow transition scenario:

On CO_2 efficiency, we assume most manufacturers can achieve 8g CO_2/km improvements over 4 years. This equates to an average improvement of 2.0g CO_2/km each year, at the higher end of the 1-2g CO_2/km some have achieved in recent years.

For EV supercredits we assume that a manufacturer will fall short of the maximum credits available, as they cannot deliver or sell sufficient PHEVs/BEVs, but achieve 4.5g CO_2/km.

For eco-efficiency we assume a manufacturer achieves the current best performance on half of it's fleet, gaining 2g CO_2/km over the four years.

Appendix 3

Exhibit 11

Rapid transition scenario

Euro 2.4 billion in penalties

		Scenario gains by 2021 (gCO2/km)									
Company	Fleet CO2 emissions 2017 (gCO2/km)	ICE CO2 Efficiency	PHEV/BEV Supercredits	ECO-Efficiency	2021 scenario	2021 target (gCO2/km)	Gap to target in 2021 (gCO2/km)	European sales (2017) 1000's cars	Penalty per vehicle sold per gCO2/km over target	Estimated 2021 penalty (millions)
Toyota Motor Corporation	103	-12	-7.5	-4	79.5	94	-14.5	693	€95	--
Volvo Car AB	124	-12	-7.5	-4	100.5	107	-6.5	238	€95	--
Peugeot S.A	111	-12	-7.5	-4	87.5	93	-5.5	2,325	€95	--
Renault S.A. - Nissan Motor Co., Ltd	111	-12	-7.5	-4	87.5	93	-5.5	2,189	€95	--
Jaguar Land Rover Automotive Plc	152	-12	-7.5	-4	128.5	131	-2.5	229	€95	--
Bayerische Motoren Werke Aktiengesellschaft	122	-12	-7.5	-4	98.5	101	-2.5	985	€95	--
Ford Motor Company	121	-12	-7.5	-4	97.5	95	2.5	1,025	€95	€243
Volkswagen Aktiengesellschaft	122	-12	-7.5	-4	98.5	96	2.5	3,541	€95	€841
Daimler AG	127	-12	-7.5	-4	103.5	100	3.5	961	€95	€320
Hyundai Motor Company - Kia Motors Corp.	122	-12	-7.5	-4	98.5	94	4.5	953	€95	€407
Fiat Chrysler Automobiles N.V.	120	-12	-7.5	-4	96.5	91	5.5	976	€95	€510
Honda Motor Co., Ltd	127	-12	-7.5	-4	103.5	97	6.5	132	€95	€82
									Total	**€2,403**

Source: European Environment Agency, Moody's Investors Service

Exhibit 12

Moderate transition scenario

Euro 5.9 billion in penalties

		Scenario gains by 2021 (gCO2/km)								
	Fleet CO2 emissions 2017 (gCO2/km)	ICE CO2 Efficiency	PHEV/BEV Supercredits	ECO-Efficiency	2021 scenario	2021 target (gCO2/km)	Gap to target in 2021 (gCO2/km)	European sales (2017) 1000's cars	Penalty per vehicle sold per gCO2/km over target	Estimated 2021 penalty (millions)
Toyota Motor Corporation	103	-10	-6	-3	84	94	-10	693	€95	
Volvo Car AB	124	-10	-6	-3	105	107	-2	238	€95	
Peugeot S.A	111	-10	-6	-3	92	93	-1	2,325	€95	
Renault S.A. - Nissan Motor Co., Ltd	111	-10	-6	-3	92	93	-1	2,189	€95	
Jaguar Land Rover Automotive Plc	152	-10	-6	-3	133	131	2	229	€95	€44
Bayerische Motoren Werke Aktiengesellschaft	122	-10	-6	-3	103	101	2	985	€95	€187
Ford Motor Company	121	-10	-6	-3	102	95	7	1,025	€95	€682
Volkswagen Aktiengesellschaft	122	-10	-6	-3	103	96	7	3,541	€95	€2,355
Daimler AG	127	-10	-6	-3	108	100	8	961	€95	€730
Hyundai Motor Company - Kia Motors Corp.	122	-10	-6	-3	103	94	9	953	€95	€815
Fiat Chrysler Automobiles N.V.	120	-10	-6	-3	101	91	10	976	€95	€927
Honda Motor Co., Ltd	127	-10	-6	-3	108	97	11	132	€95	€138
									Total	**€5,877**

Source: European Environment Agency, Moody's Investors Service

Exhibit 13

Slow transition scenario

Euro 11.2 billion in penalties

		Scenario gains by 2021 (gCO2/km)								
	Fleet CO2 emissions 2017 (gCO2/km)	ICE CO2 Efficiency	PHEV/BEV Supercredits	ECO-Efficiency	2021 scenario	2021 target (gCO2/km)	Gap to target in 2021 (gCO2/km)	European sales (2017) 1000's cars	Penalty per vehicle sold per gCO2/km over target	Estimated 2021 penalty (millions)
Toyota Motor Corporation	103	-8	-4.5	-2	88.5	94	-5.5	693	€95	
Volvo Car AB	124	-8	-4.5	-2	109.5	107	2.5	238	€95	€57
Peugeot S.A	111	-8	-4.5	-2	96.5	93	3.5	2,325	€95	€773
Renault S.A. - Nissan Motor Co., Ltd	111	-8	-4.5	-2	96.5	93	3.5	2,189	€95	€728
Jaguar Land Rover Automotive Plc	152	-8	-4.5	-2	137.5	131	6.5	229	€95	€141
Bayerische Motoren Werke Aktiengesellschaft	122	-8	-4.5	-2	107.5	101	6.5	985	€95	€608
Ford Motor Company	121	-8	-4.5	-2	106.5	95	11.5	1,025	€95	€1,120
Volkswagen Aktiengesellschaft	122	-8	-4.5	-2	107.5	96	11.5	3,541	€95	€3,869
Daimler AG	127	-8	-4.5	-2	112.5	100	12.5	961	€95	€1,141
Hyundai Motor Company - Kia Motors Corp.	122	-8	-4.5	-2	107.5	94	13.5	953	€95	€1,222
Fiat Chrysler Automobiles N.V.	120	-8	-4.5	-2	105.5	91	14.5	976	€95	€1,344
Honda Motor Co., Ltd	127	-8	-4.5	-2	112.5	97	15.5	132	€95	€194
									Total	**€11,198**

Source: European Environment Agency, Moody's Investors Service

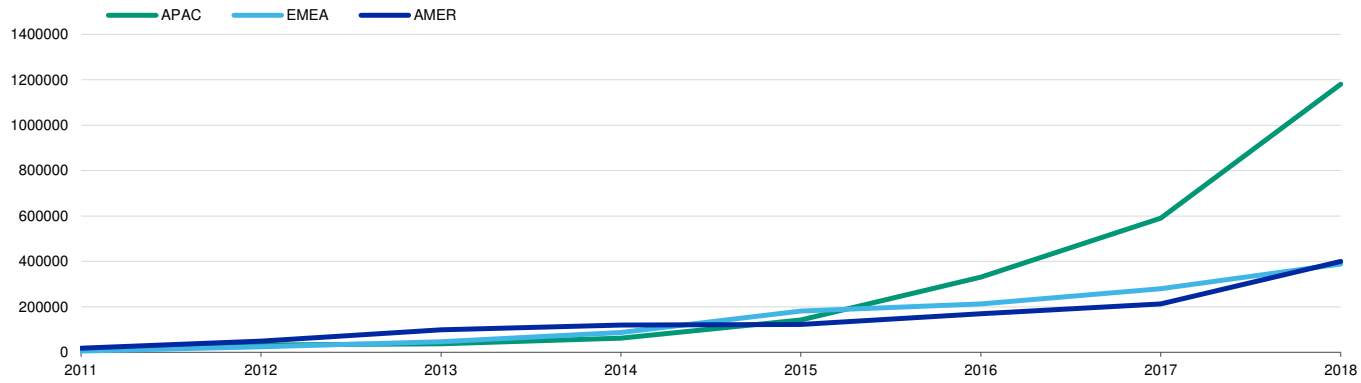
Appendix 4

Regional breakdown of AFV sales

Sales of AFVs have continued to increase, with the APAC region gaining significant momentum. Manufacturers relying on the APAC region should be particularly conscious of the changing demand in this market, where AFVs sales have grown against the overall trend.

Exhibit 14

Sales of AFVs continues to rise



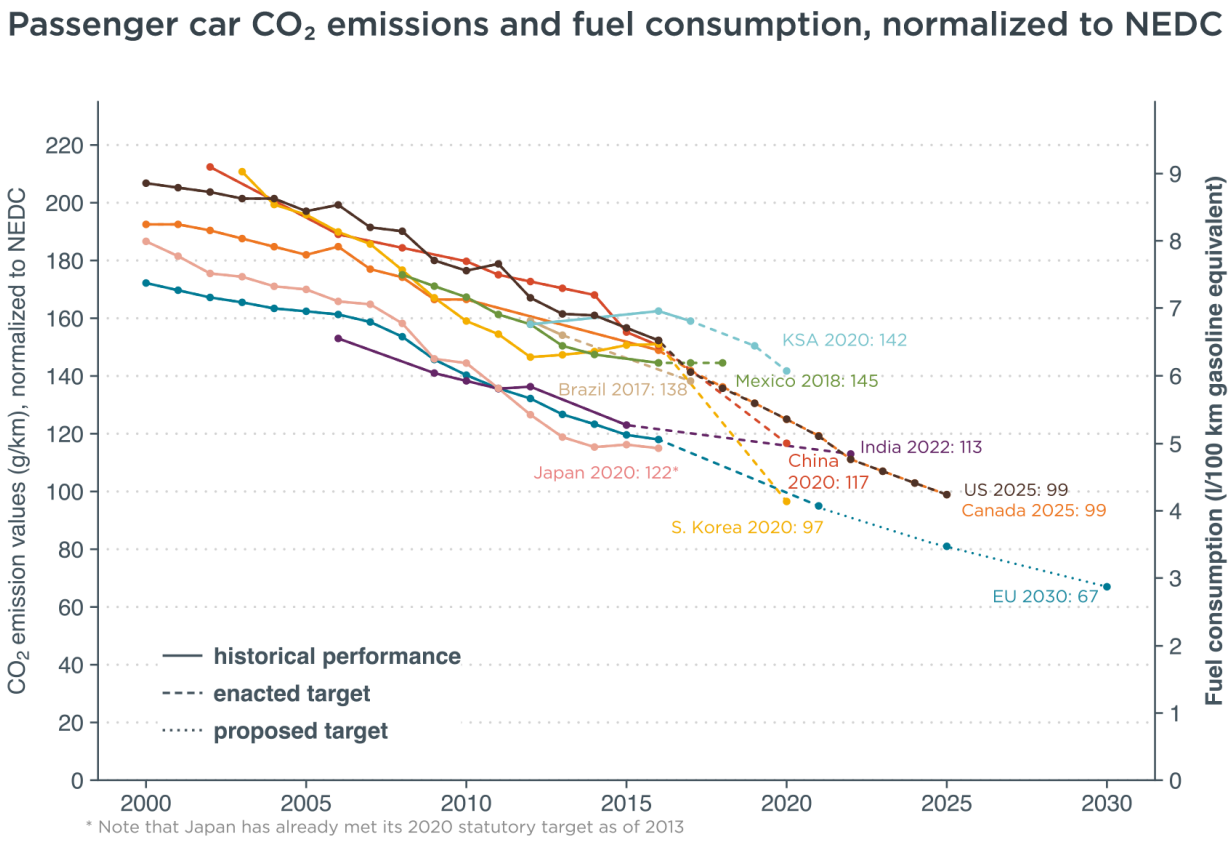
Source: Bloomberg NEF

Appendix 5

Global passenger car standards:

Exhibit 15

Comparison of global passenger car standards



Source: International Council on Clean Transportation[16]

Moody's related publications

Cross-Sector Rating Methodology

» General Principles for Assessing Environmental, Social and Governance Risks (January 2019)

Sector In-Depth

» Automakers face multiple challenges from carbon transition (February 2019)

» Auto sector transformation will drive global multi-sector credit trends (July 2018)

» Automakers fully engaged on Battery Electric Vehicles, but the transition will pressure returns (January 2018)

Endnotes

1 See, European vehicle market statistics Pocketbook 2018/19.

2 See, Fuel types of new cars, published by European Automobile Manufacturers Association, 7 February 2019

3 For example see Daimler FY18 Corporate Presention p39

4 See, European Commission; reducing CO_2 emissions from passenger cars

5 See, UK Government position on emissions standards related to Brexit, 2017

6 See, The international Council on Clean Transportation, ICCT Policy update

7 Plug-in hybrid vehicles, fuel cell electric vehicles, pure electric vehicles (also known as battery electric vehicles, BEVs)

8 See, Annual Report of China's Passenger Vehicle Fuel Economy, by Innovation Centre for Energy and Transportation (ICET),published 2017 Credits of up to 0.5l/100 km are available for off-cycle efficiency gains.

9 Examples of off-cycle technologies include: idle start-stop devices, shift reminders, efficient air conditioning, brake energy recovery, etc.

10 For example, BMW, Toyota, GM

11 Dongfeng, Beijing Auto and Geely

12 See, Annual Report of China's Passenger Vehicle Fuel Economy, by Innovation Centre for Energy and Transportation (ICET)

13 According to Bloomberg New Energy Finance New Energy Outlook 2018, battery manufacturing capacity is set to triple by 2021, with 73% expected to be controlled by Chinese companies by that date.

14 See, Environmental Protection Agency and National Highway Traffic Safety Administration, EPA and NHTSA, Regulatory Announcement

15 If it is assumed that light trucks represent 45% of the light vehicle sales, as they did in 2017.

16 See, ICCT Chart library, Passenger vehicle fuel economy

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