



THE SPARK IGNITES
EV & HYBRID
GLOBAL MARKET RESULTS

Analysis completed: November 2016



OUR KNOWLEDGE IS YOUR **POWER**

DEFINITIONS

VEHICLE TYPE



ALTERNATIVE FUEL VEHICLES (AFV)

HEV (Hybrid Electric Vehicle)

- Active Hybrid: this type of hybrid can run purely on the electric motor (for a limited distance), or on a combination of combustion engine and electric motor or combustion engine only. It may have a switch to enable full electric mode. The battery is usually charged by the engine and/or regenerative energy from deceleration and braking and/or by plug-in. The electric motor and combustion engine are separately connected to the transmission, so each power source can work independently.
- Mild Hybrid: the combustion engine is the main source of power to drive the car. The electric motor assists the engine when appropriate and at times might even power the car on its own (for very short periods). The system may stop the engine firing at idle or when driving in certain situations such as cruising on flat ground or going down hill. The electric motor is used to boost (assist) the combustion engine and the battery is charged by the engine directly and by regenerative energy from deceleration/braking.

PHEV (Plug-in Hybrid Electric Vehicle)

- JATO codes an electric/hybrid vehicle with batteries that can be recharged by connecting a plug to an electric power source.

BEV (Battery Electric Vehicle)

- The vehicle is powered by electric motors.

EREV (Extended Range Electric Vehicle)

- In this type of hybrid the vehicle is driven solely by an electric motor. The combustion engine is used to generate electricity to power the motor. The combustion engine is not connected to the transmission.

FCEV (Fuel Cell Electric Vehicle)

- In a Fuel cell, hydrogen is reacted with oxygen to produce water and electricity, the latter being used to power the electric motor.

INTRODUCTION

With sales of Alternative Fuel Vehicles (AFVs) predicted to top 11 million units across China, India, Japan, the USA and Europe by 2023, according to LMC Automotive (JATO's vehicle forecast data partner), this relatively young vehicle type is set to be one of the most important sources of growth for the automotive industry in the next decade.

Despite starting from a low base, new technologies, a growing sense of consumer responsibility for the environment and diesel's reputational problems are giving a welcome boost to sales of Electric Vehicles (EVs) and Hybrids. Indeed our latest data indicates that global demand has grown by 22.8% during the first eight months of this year alone – the highest percentage increase of all fuel types available in the market.

Even the global drop in oil prices hasn't dampened demand, and the encouraging targets set by both manufacturers and governments suggest that this growth will only accelerate over the next 10 years. Volkswagen Group alone is expecting to sell between 2 and 3 million electric vehicles by 2025 through 30 new models.

This White Paper examines recent changes in the EV and Hybrid passenger car market; the different categories that are emerging; and how the industry will respond to the increasing demand. We have used historic JATO Dynamics global volume data, split by region, make and model, to look at the specifications of today's most popular EV and Hybrid cars, and LMC Automotive forecast data to predict what the future holds for this dynamic category.

GLOBAL OUTLOOK

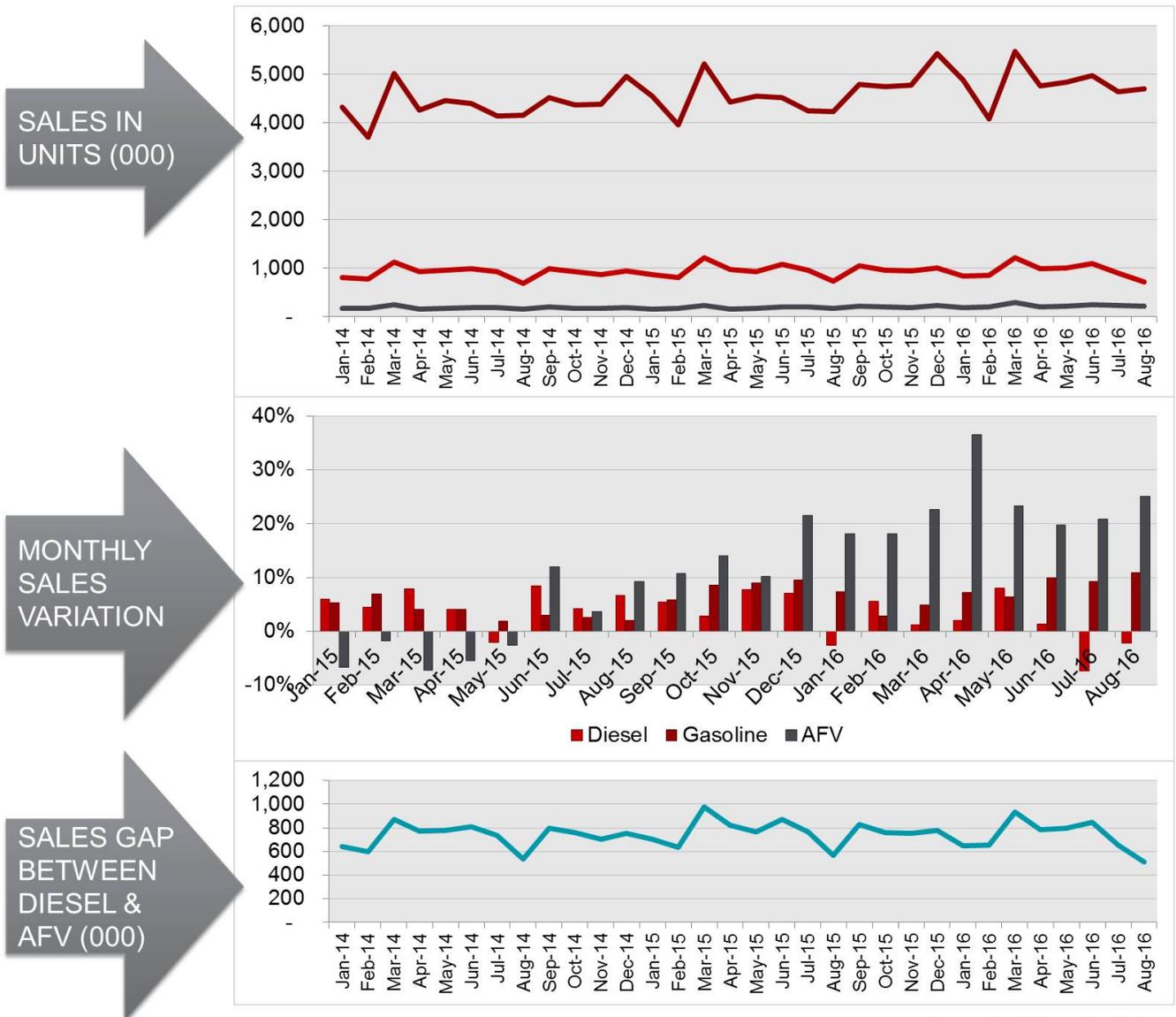
JAPAN PROVIDES THE VOLUME AND CHINA THE GROWTH

EV and Hybrid cars still have a relatively small market share globally, but sales are growing fast, driven by China in particular. Although the low cost of oil remains a challenge to sales, particularly in the USA, global figures still forecast that the category is heading towards another year of record growth.

Three quarters of the 74.7 million passenger cars sold in the world during the first eight months of 2016 were fuelled by gasoline engines, meaning that Alternative Fuel Vehicles (AFVs) still only make up a very



GLOBAL SALES OF DIESEL, GASOLINE & AFV AT A GLANCE

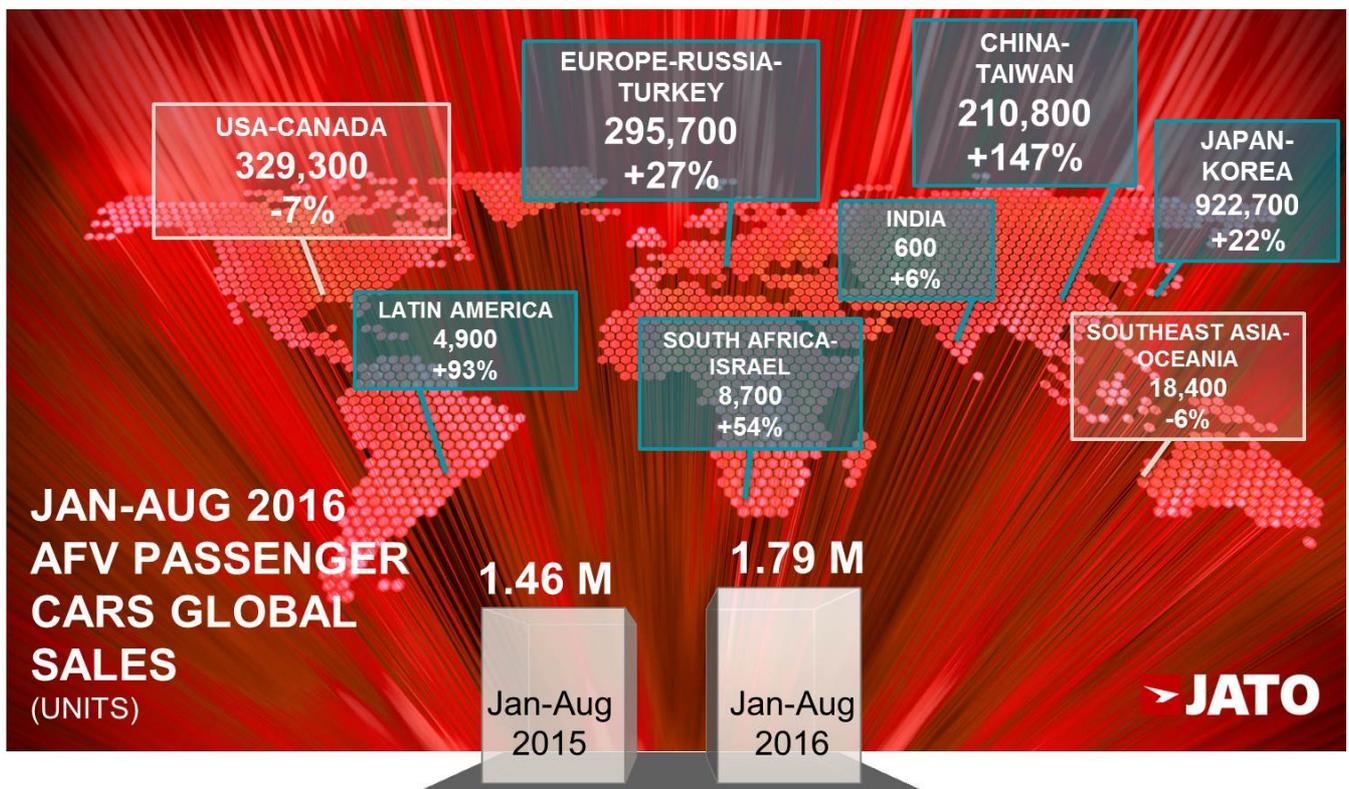


Source: JATO Dynamics Limited

small fraction (3.5%) of the total global market, which is dominated by gasoline passenger cars (75.5%) and diesel (14.8%). But EV and Hybrid passenger cars are gaining ground fast, having recorded the highest percentage of year-on-year growth, with sales jumping from 1.46 million units in January - August 2015 to 1.79 million units in the corresponding first eight months of 2016.

Their rapid growth is even more impressive in the five largest markets for EVs and Hybrids - China, India, Japan, USA and Europe – where their sales totalled 1.69 million units in the first eight months of 2016, up by 22.3% year-on-year, and accounting for 3.9% of the total market. LMC Automotive predicts that by the end of 2016 their market share could reach 4.1% - the highest share ever achieved.

Japan is the world leader in terms of volume of AFVs sold, perhaps helped by its strong position as the world's biggest Hybrid (HEV) manufacturer. AFV sales in Japan accounted for 52% of the total sold across these five largest markets in the first eight months of 2016, and 49% of the global sales total.



Yet it is China – where demand soared by 160% between January - August 2016, taking its total volume to 206,000 units – that is currently the biggest source of growth in the category. This is in part due to the government's goal of having 5 million units of pure EVs and plug-in Hybrids on the roads by 2020.

These ambitious electrification plans still face big challenges. So far government subsidies – including exemption from China's licence plate lotteries, to get EV cars to buyers quicker – haven't been enough to counter perceived problems such as infrastructure weakness, and demand still lags behind the country's targets.

The popularity of SUVs amongst Chinese consumers, and low oil prices, are also big challenges to the growth of the AFV category. SUVs, mostly powered by gasoline engines, sold 5.2 million units in the first eight months of 2016, representing 34% of China's total market, compared to AFVs' 1.3% share of total passenger car sales. Like their American and European counterparts, Chinese consumers want SUVs and, as long as there are no competitively priced electric or hybrid SUV models, and oil prices remain low, that is unlikely to change.

**TOP 20 AFV MARKETS
SALES YTD AUG/16**

		Units (000)	% YTD Aug 15-16
1	Japan	879.8	+20.7%
2	USA	306.9	-9.4%
3	China	205.6	+159.5%
4	UK	53.9	+22.0%
5	France	47.4	+24.4%
6	South Korea	42.9	+63.0%
7	Norway	38.2	+31.4%
8	Germany	32.5	+29.3%
9	Italy	25.1	+45.6%
10	Canada	22.4	+31.9%
11	Spain	18.3	+53.2%
12	Sweden	16.1	+65.9%
13	Belgium	11.9	+60.2%
14	Netherlands	11.8	-47.4%
15	Australia	8.7	-2.2%
16	Switzerland	8.5	+8.9%
17	Israel	8.2	+59.4%
18	Poland	6.0	+78.3%
19	Thailand	5.3	-25.6%
20	Taiwan	5.3	-17.0%



Source: JATO Dynamics Limited

Challenges to AFV sales in China mirror what has happened in USA. With almost 307,000 units sold, the USA remains second in the global rankings despite a fall of 9.4% in volumes in the first eight months of 2016 compared to the same period last year

This decrease can be attributed to the stagnation of the overall market (which only grew by 0.5% from January to August 2016) and the ongoing popularity of SUVs which made up only 14 of the 67 alternative fuel models available in the USA in this period. This makes gasoline models the easier choice for consumers in the market for an SUV and removes AFVs from their consideration set.

Elsewhere, Europe is closing its gap on the USA after a 26.5% year-on-year increase in sales volumes of AFVs for January – August 2016. Total registrations during this same period were 295,700 units – or 2.6% of total market.

The UK, France and Norway were the largest markets in Europe during this period, and part of the 21 European countries that posted positive growth. Only The Netherlands, Turkey, Croatia and Russia registered a decline.

It appears that despite various government incentives, including tax exemptions, European consumers are still opting for traditional fuels over Electric and Hybrid passenger cars due to a lack of choice and competitive pricing.

Other key markets include Canada, posting a 32% increase – and South Korea which beat its 2015 full-year sales figure in the first eight months of 2016 with growth of 63%. Israel has also already surpassed its 2015 full-year sales figure, with more than 8,200 units sold from January – August 2016, up by 59%, and exceeding the 7,200 cars sold during 2015. EV and Hybrid sales in Mexico had reached 4,200 units by August 2016, far outstripping the 1,800 sold during the same period in 2015.

HYBRIDS LEAD A MATTER OF PRICE

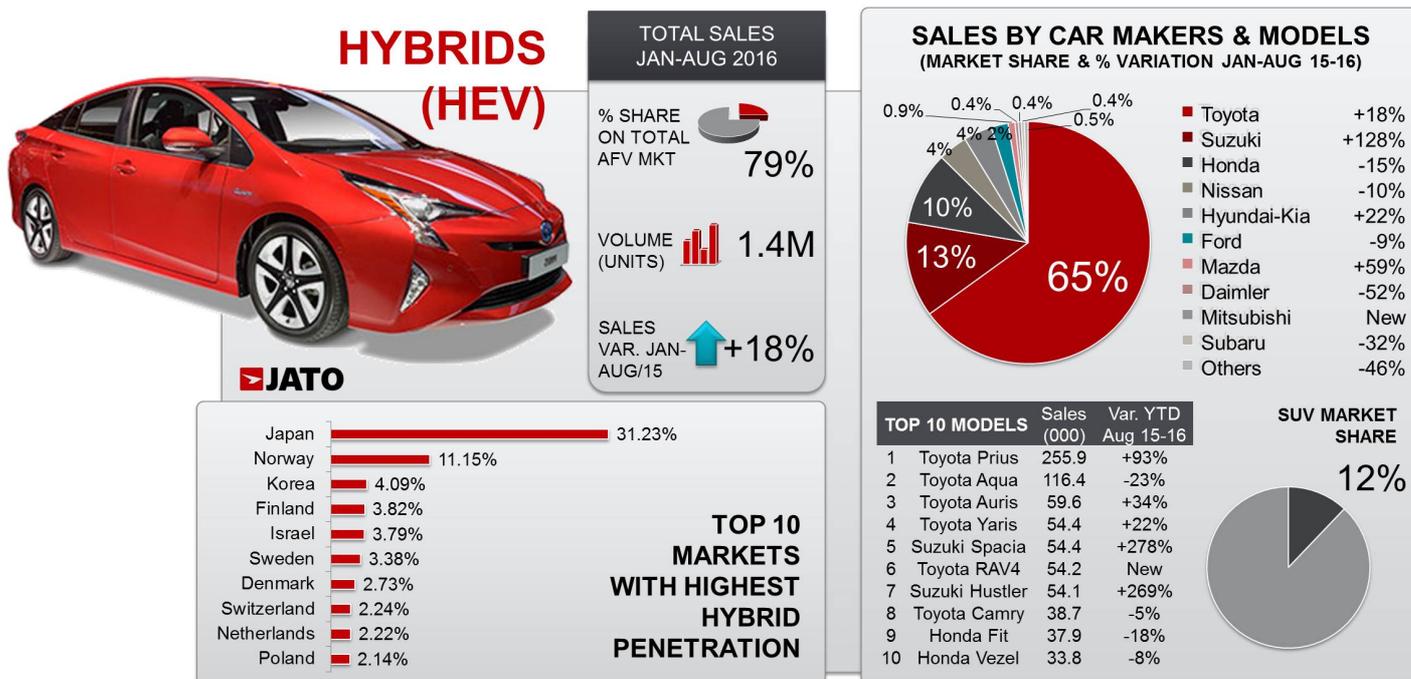
Hybrids (HEV) continue to be the most popular choice for consumers looking for an AFV. Seen as a safer bet because they were one of the first types of EVs to market, and because they fill the middle ground between regular combustion and pure electric cars, they are the only member of the AFV family to have gained a solid share of global markets. Although still far from the sales volumes posted by regular combustion cars, HEV have consolidated their position with a 17.7% increase during the first eight months of 2016.

Global demand for hybrid passenger cars totalled 1.41 million units between January – August 2016. This is 212,000 units greater than during the same period in 2015, demonstrating that investments in the category and revamped vehicle ranges are having a positive impact. This is despite economic conditions continuing to favour gasoline cars and SUVs.

In fact, the reported, year-on-year growth in HEV in the first eight months of 2016 comes despite a significant year-on-year surge in global demand for SUVs, which are primarily powered by gasoline engines, over the same period, from 12.5 million units from January - August 2015, up to 15 million during the first eight months of 2016¹.

All of this suggests a significant HEV sales opportunity for models that better meet the needs of the global consumer – particularly those increasingly looking for an SUV.

Hybrid SUVs accounted for 12% of the Hybrid category total in the eight months to August 2016. This is a significant jump compared to the 8% market share that they enjoyed over the same period in 2015. At a country level this could be higher but the global average is skewed by the Japanese market, which despite being the largest hybrid market in the world is one of the few where SUVs are not popular. In fact



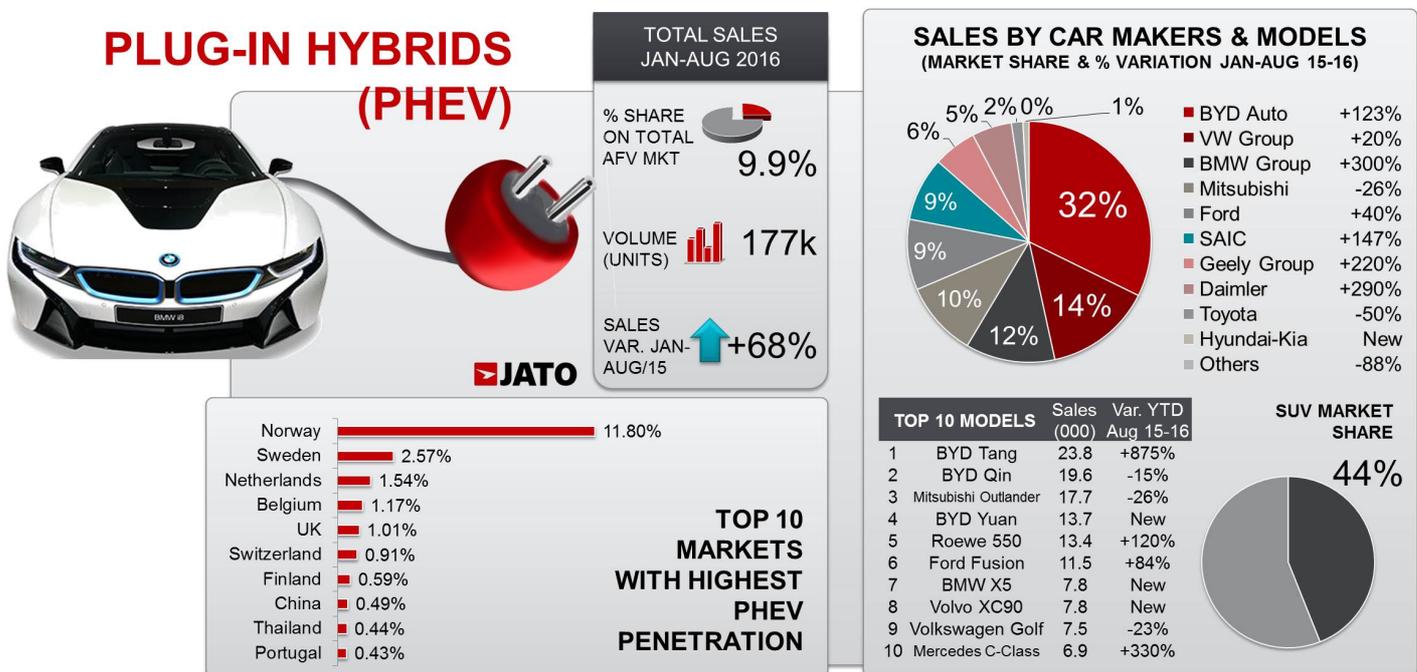
¹ Estimated figures for sales/registrations of SUVs in 53 markets covered by JATO

SUVs account for only 10% of market share because the government has historically encouraged smaller cars, and penalized imports.

Incentives introduced by the Japanese government in 2009, included subsidies and tax breaks which helped to fuel the initial growth of the category, and today HEVs are commonplace on the country's roads. Although the subsidy programme ended in 2012, Japan's HEV market continues to grow, counting for 61% of total global sales in the first eight months of 2016 – an impressive 20.9% increase over the same period of 2015 – indicating that the Japanese market has reached a point where incentives are no longer needed to drive consumer demand.

Japan also boasts the world's largest HEV market share with the category accounting for 31% of the passenger cars sold in market from January – August 2016, far outstripping the government target of 18% by the 2020. Norway came second with 11% of the passenger cars registered during this period being powered by hybrid engines. South Korea reported 40,800 hybrid passenger cars sold over the period, representing a 4.1% market share. Hybrid penetration in the USA and China stood at 1.9% and 0.4% respectively, and in Europe, Hybrids represented 1.6% of total registrations from January - August 2016.

This positive trend has had an impact on how car manufacturers' HEV sales are performing globally – with Japanese car makers unsurprisingly taking the top four sales spots over the eight months to August 2016. This Japanese brand dominance is led by Toyota, which held a 65% market share of global HEV sales, thanks to the buoyant domestic market in Japan, accounting for over half (52%) of its global HEV sales. Toyota was followed by Suzuki, which outsold Honda thanks to a 128% increase during the first eight months of the year, thanks to the success of its popular kei-cars, which posted strong increases in Japan. Honda fell a place in the rankings due to lower sales volumes of its Fit and Accord Hybrid versions, whilst Hyundai was the best-selling non-Japanese car maker during the period. Daimler was the European leader.



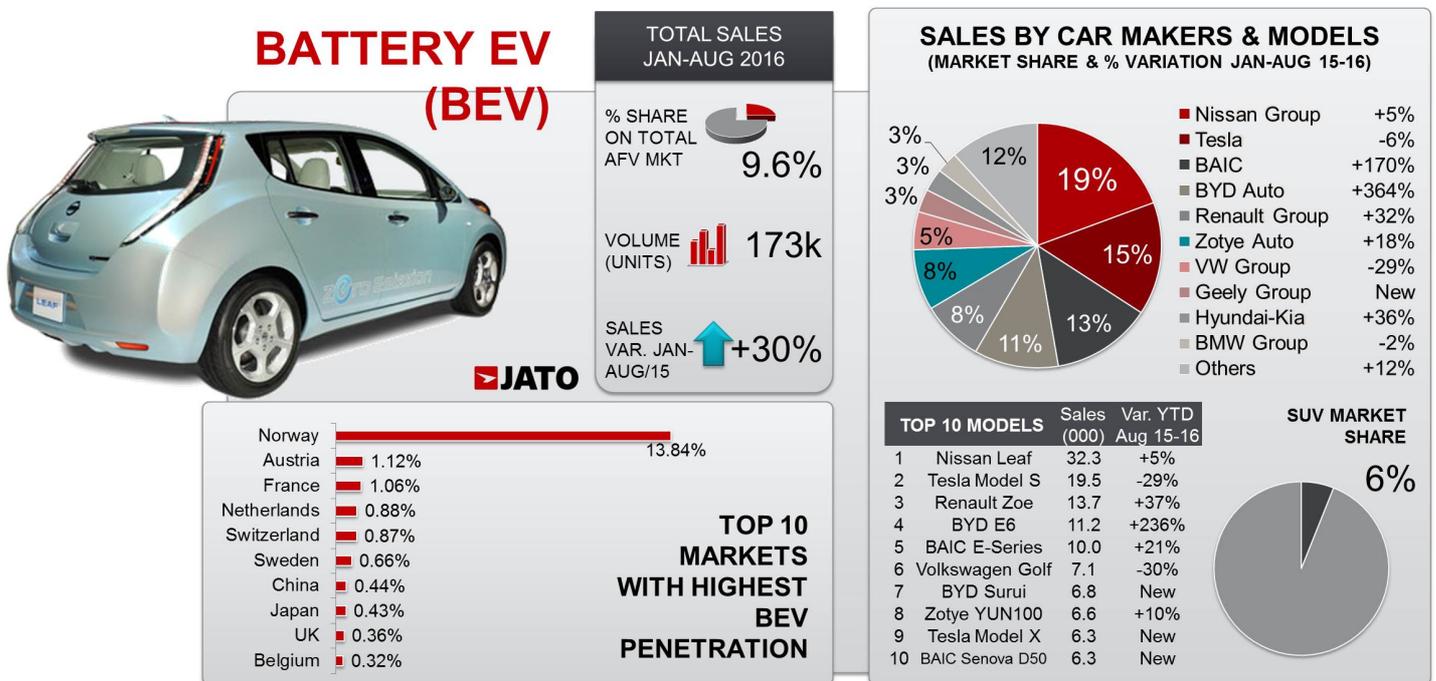
In comparison to HEVs, sales volumes for **Plug-in Hybrids (PHEV)** have been significantly lower globally due to the inconvenience of recharging their batteries which requires access to an external power source and their comparatively higher price. After reaching almost 200,000 units worldwide in FY 2015, sales grew by 68% in the eight months to August 2016, with 176,600 units sold, of which 43% were in China, 35% in Europe and 16% in the USA.

The Chinese car manufacturer BYD Auto leads the way on PHEV sales from January – August 2016, with 57,100 units (32% of total global sales), followed by Volkswagen Group (14% market share) and BMW Group (12% share).

BYD's has an ambition to sell 150,000 units (pure electric and plug-in hybrid cars) and this year launched the plug-in hybrid SUV Tang, which hit the Chinese market in June 2015. It has enjoyed popularity ever since, with sales totalling 23,800 units making the Chinese SUV the world's best-selling plug-in hybrid passenger car.

The Tang is not the only plug-in hybrid SUV. Other models such as the Mitsubishi Outlander, the BMW X5 and the Volvo XC90 make up the 44% share that SUVs have on total plug-in hybrid sales. By comparison, SUVs counted for just 12% of the global sales volumes of regular hybrids (HEV).

The global popularity of SUVs could, in part, explain the recent growth in PHEV sales, but their high price point is likely to limit mainstream adoption for now, with the cheapest model in the ranking starting at an average price of US \$31,553/unit.

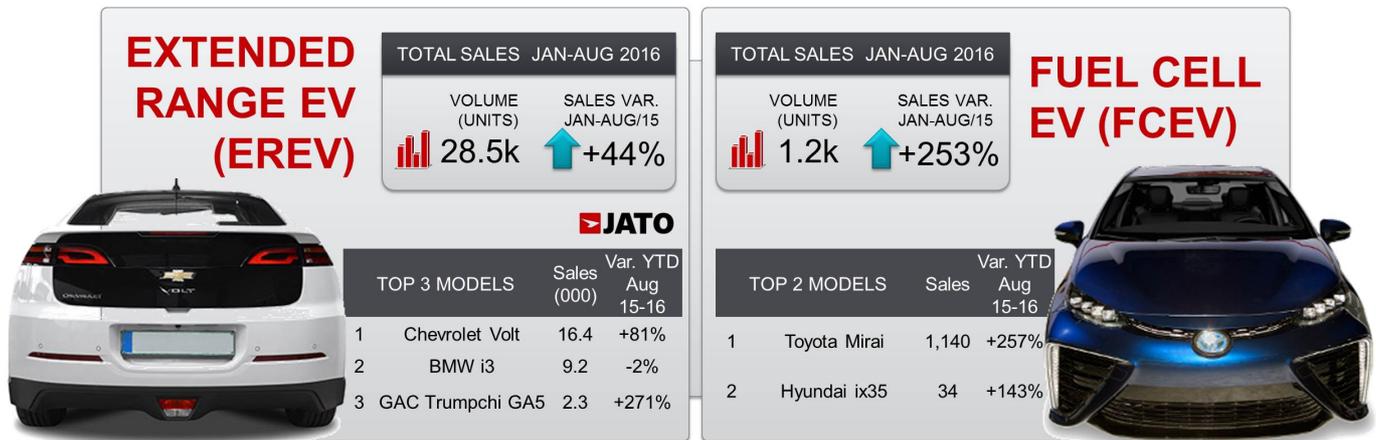


In third place behind the PHEV category are the **Pure Electric Passenger Cars (BEV)**. Even though BEV sales grew by 30% during the first eight months of this year, it was not enough to outstrip the stronger growth posted by PHEV. Global BEV sales totalled 172,700 units in the eight months to August 2016, led by China which accounted for 40% of global demand - double the USA's total, and ahead of Europe (31%). While China and Japan recorded strong year-on-year growth for BEV, Europe only saw a small uplift on the same period in 2015 (+2.4%) and the USA reported a drop (-19.4%).

These latest results indicate that there are opposite trends in China and USA. The latter dropping down one place in the global ranking, with US consumer demand weakened by low fuel prices, the challenge of limited battery life, and the overall slowdown in the American market which has hit all segments apart from SUVs and Trucks.

By August there were only two solely electric SUVs available in the US car market and no electric pickups. Despite this, Silicon Valley's Tesla Motors is forging ahead with plans that include improving batteries, attracting customers from cheaper segments with its Model 3 and, according to the company's latest industrial plan - "Master Plan, Part Deux" - the launch of an electric pickup.

The **Extended Range EV (EREV)** and **Fuel-Cell EV (FCEV)** are still rare sightings on the world's roads. In the eight months to August 2016, 28,500 EREV and almost 1,200 units of FCEV were sold, both posting strong growth compared to January - August 2015. Sales of EREV (+43.6%) were boosted mainly by the Chevrolet Volt and GAC Trumpchi GA5, whereas sales of the BMW i3 Rex plateaued and the rest of the models did not sell in significant volumes. As for FCEV, Toyota has sold 1,140 units of its Mirai Midsize Sedan model during this period - a solid performance considering its average price of US \$63,053/unit.



PRICES

Our analysis shows that Hybrids are still being positioned as the half-way house between traditional fuel and fully electric cars. They are not only seen as cheaper and more convenient than purely electric vehicles, many also feature the traditional designs that customers see on the petrol or diesel versions, adding to their mainstream appeal.

Our global price data for all EV and Hybrid models shows that HEV (Hybrid Electric Vehicles) are the most affordable. These cars, which include both the FHEV (Full Hybrid Electric Vehicle) and the MHEV (Mild Hybrid Electric Vehicle), record the lowest average price per unit sold between January - August 2016 at USD \$27,875². This is lower than all other EVs and perhaps one of the main reasons that they enjoy a 79% market share of the total EV & Hybrid global market.

It is no secret that the batteries and technology used by fully electric cars (BEV) require big investments by the car manufacturers. Unsurprisingly this impacts the final price for consumers, with fully electric cars having an average price of US \$42,588 per unit sold - 53% more than their Hybrid counterparts. Despite subsidies in many countries, the BEV still struggles with high battery costs despite significant reductions since 2010.

WHERE ARE THE CHEAPEST AND MOST EXPENSIVE AFV? LOWEST AND HIGHEST AV. PRICE/UNIT SOLD AMONG TOP 10 MARKETS

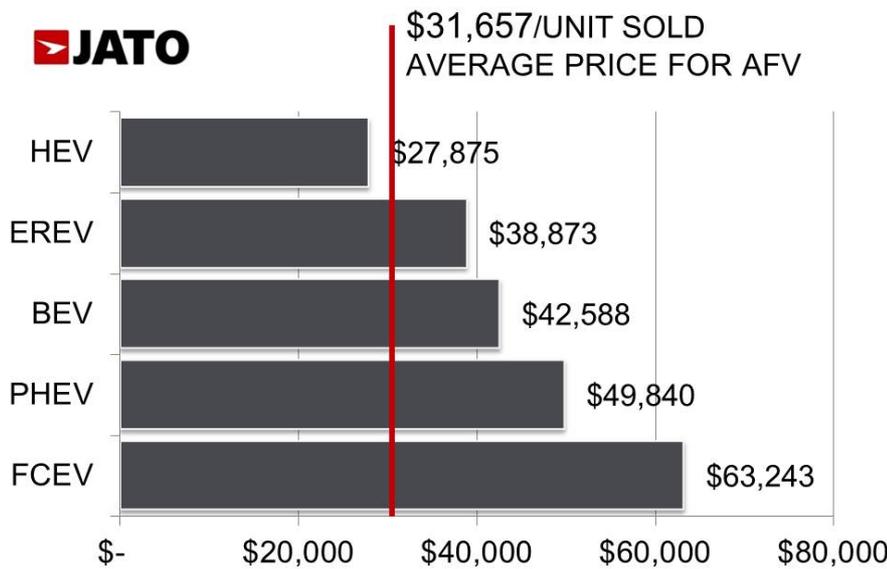


² At 1-November 2016 USD Exchange rates. The values correspond to retail prices before any discount offered.

Plug-in Hybrid EVs (PHEV) have a larger battery and other components, which makes the vehicle more expensive. PHEVs sold in the first eight months of this year had an average price of US \$49,840/unit globally - 17% higher than the BEV and 79% higher than the regular Hybrids. However, the concept is that the driver has the ability to use electricity instead of the gasoline engine to recharge the battery. In essence, it is a BEV without the “range anxiety.”

Even more expensive than the PHEV are the Fuel Cell EVs (FCEV), which are severely affected by a limited hydrogen infrastructure. In fact there were only two models that reported sales during the period analysed: the Hyundai ix35 (Tucson in USA) and the Toyota Mirai. Their average price per unit sold was US \$63,243. In contrast the EREV’s average price, known as range-extended battery-electric vehicle (BEVx) by the California Air Resources Board (CARB), was US \$38,873/unit sold.

AVERAGE PRICE* (USD**) PER UNIT SOLD JAN-AUG 2016



AV. PRICE IN TOP 10 AFV MARKETS BY VOLUME	
	AV. PRICE /UNIT SOLD JAN-AUG/16
Japan \$	25,040
Korea \$	30,434
Italy \$	31,378
Canada \$	31,607
USA \$	35,421
France \$	36,259
China \$	38,587
Great Britain \$	40,553
Germany \$	42,986
Norway \$	43,923

* Excluding all types of incentives. ** 3/11/16 exchange rates. Source: JATO Dynamics Limited

THE FUTURE

A RACE TO BE MAINSTREAM

The future looks bright for all Alternative Fuel Vehicles (AFVs), with continued sales growth forecasted, and manufacturers investing in their pipelines.

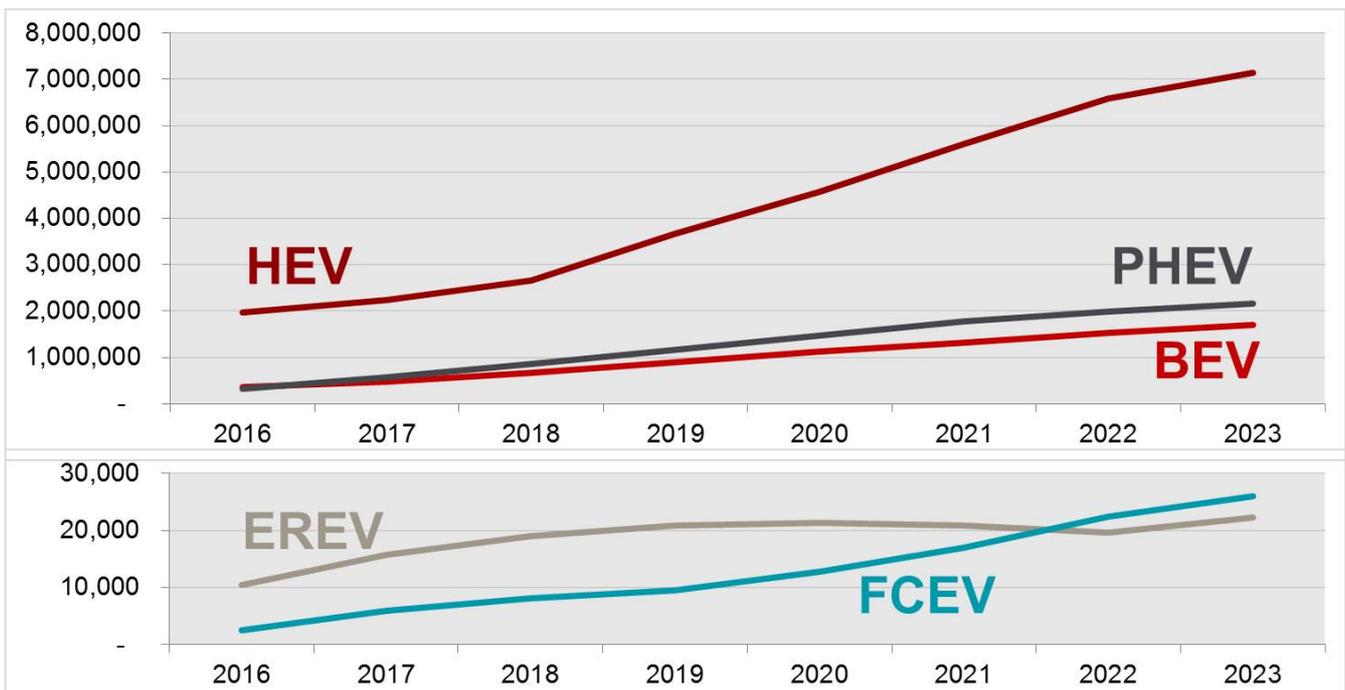
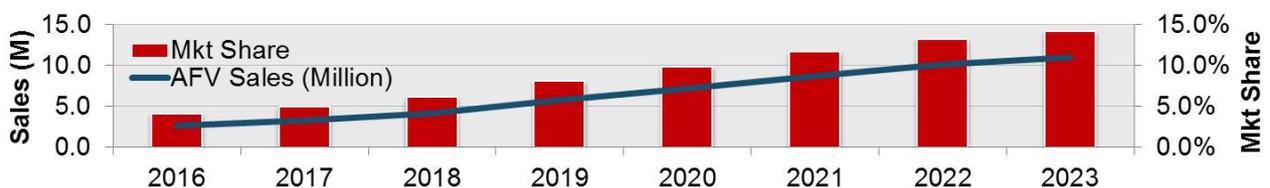
According to JATO's forecast partner LMC Automotive, sales of all AFV combined in China, India, Japan, USA and Europe will exceed 11 million units by the year 2023 – accounting for 14.2% of global passenger car sales in those markets, a rise of more than 10 percentage points compared to the share these cars had in the first eight months of 2016. The accelerated growth is expected to come mostly from Europe and China, leaving the US market lagging behind, Japan stalled and India expected to post only moderate increases.

By 2023 Japan will continue to lead AFV market penetration globally, with 29.9% of all of its passenger car sales forecast to be EVs and Hybrids, whilst in the same period AFV sales in Europe are expected to



AFV SALES FORECAST 2016 – 2023 CHINA, EUROPE, INDIA, JAPAN, USA

JATO

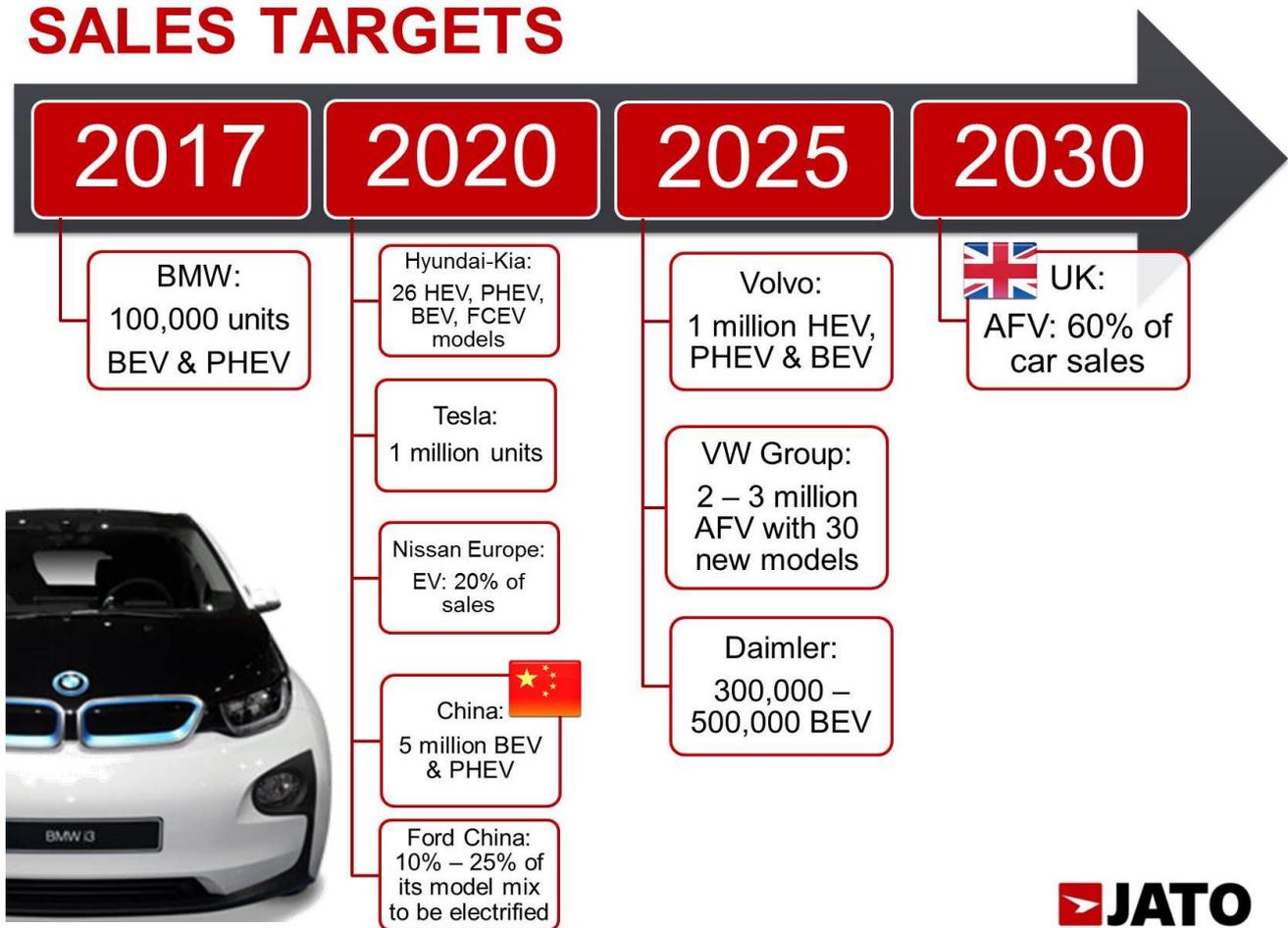


grow to account for 19.4% of the total, or 3.91 million units, becoming the largest market. Uptake is expected to be much more restrained in the USA however, where AFV market share is forecast to grow comparatively modestly from 2.9% in FY 2016 to reach 11.2% by the end of 2023. Demand in China is predicted to follow a similar trend with EVs and Hybrids forecast to represent 12.1% of total passenger car sales by 2023. Sales in India are predicted to rise to 5.6% over the same period.

According to LMCA, Hybrids will continue to dominate the AFV market even if they lose some of their market share. Demand for these cars in the five markets analysed will total 7.14 million units by 2023, up from the 1.97 million cars expected to hit the roads by the end of this year. In seven years' time Hybrids will count for two of every three AFVs sold. But in contrast to the current situation, Japan will no longer be the main market, as growth is expected from Europe and China, representing 31% and 30% of 2023 sales respectively.

Plug-in Hybrids will outsell the pure electric cars (BEV) from 2017 and by the end of 2023 they will account for 20% of AFV total sales in these five markets. The biggest market for plug-in Hybrids will continue to be Europe with almost half of the sales coming from the region. Europe will be followed by China (36% of sales) and the USA (with only 14% of market share). China will become the largest market for BEV, but Europe will grow faster and will more than double the sales volume of the US market over this period.

SALES TARGETS



All of these forecasts closely align with the official targets announced by some of the main players in the industry. By 2020 Hyundai-Kia plans to have 26 new models featuring hybrid, plug-in, electric or fuel-cell

powertrains in its range, whilst Nissan expects 20% of its vehicle sales in Europe to be EV by this point. In the same year Tesla aims to sell around one million units, partly boosted by growing demand in China.

Many manufacturers are looking to capitalise on the Chinese government's ambitious goal of selling five million BEV and PHEV by 2020 – a target that includes one million pure electric vehicles (BEV). In addition to Tesla, Ford has announced that by the same year between 10% and 25% of its Chinese model mix will be electrified.

2025 targets are even more ambitious. Volkswagen Group expects to sell between two and three million electric vehicles (BEV) by 2025 with 30 new models. That would account for around 25% of its global sales, compared to the 14% that all AFV sales will generate by 2023. Its German competitor Daimler believes that under current volumes it will be able to sell between 300,000 and 500,000 electric vehicles by the same year.

Another premium manufacturer that sees a bright future is Volvo, with an annual sales target of one million units of HEV, PHEV and BEV by the end of 2025. Meanwhile UK authorities believe that by 2030 60% of the new car sales will be EV.

CONCLUSION

Petrol engines have been in existence for 140 years. The resurgence of electric and hybrid drivetrains have taken only a fraction of this time to re-emerge and become viable alternatives offering a solution to existing and future mobility and pollution challenges.

But despite this early promise many customer concerns remain.

Price along with infrastructure weaknesses are still the main barriers to sales of AFVs. This is why most car makers are focusing their efforts on improving the range of their batteries in order to offer more efficient cars and dispel fears of range anxiety. But on its own this won't be enough. As we have seen as long as there are gaps in the AFV line-up – in particular around key segments such as SUVs – then customers will continue to consider traditional petrol and diesel variants.

Nonetheless, despite the low price of oil globally, the industry is clearly focused on increasing the number of AFVs in the market. We see how important they are to the world's largest car makers' plans for the next 10 to 15 years and their forecasts indicate their determination to succeed in transitioning away from traditional drivetrains.

The proliferation of these cars will happen at different rates according to each market and its regulatory policies. We predict that Europe and China will become the biggest markets thanks to the government backdrop whilst at the same time the USA and Japan will experience lower growth rates – albeit for different reasons.

The future of efficient travel now depends on how well governments, car makers and consumers agree on the importance of the next generation of AFVs. How practical, feasible and ultimately affordable they are to produce, own and drive is in large part down to the type of mass transport we want for ourselves. The technology is within reach, but will we choose to grasp it?



JATO DYNAMICS
LIMITED
HUNTON HOUSE
HIGHBRIDGE ESTATE
OXFORD ROAD
UXBRIDGE UB8 1LXUK
www.jato.com
enquiries@jato.com
T +44 (0) 20 8423 7100
F +44 (0) 20 8423 2233
