

Electric Vehicles in 2013: a Progress Report



Electric Vehicles in 2013: A Progress Report

Project lead

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Contributions & Special thanks

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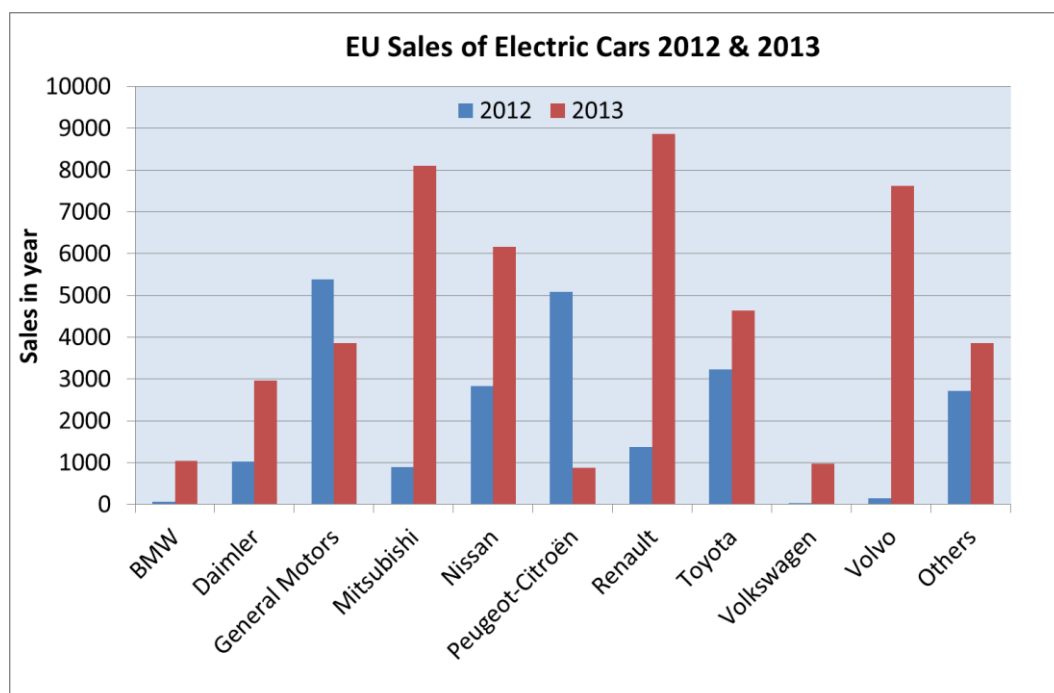
Executive Summary

This is the second part of T&E's annual Cars and CO2 report¹ that examines developments in new car CO2 emissions. This part is focused on electric cars.

Analysis of provisional cars sales data in 2013 supplied by the European Environment Agency² shows the market for electric vehicles (EVs) continues to grow strongly from a low base. Sales have approximately doubled annually since production vehicles were first marketed in 2010. In 2013, nearly 50,000 plug-in vehicles were sold in the EU representing around 0.4% of all cars. The top three selling models in 2013 in the EU were all new entrants (Renault Zoe, Mitsubishi Outlander and Volvo V60 Plug-in).

Manufacturer	Model	Type	Segment	Sales 2012 (approx)	Sales 2013 (approx)	New Entrant
Renault	Zoe	BEV	Supermini	-	8500	✓
Mitsubishi	Outlander	PHEV	SUV	-	8200	✓
Volvo	V60 Plug-in	PHEV	Large hatch	40	7580	✓
Nissan	Leaf	BEV	Compact	2800	6160	
Toyota	Prius Plug-in	PHEV	Midsize hatch	3200	4620	
General Motors	Volt/Ampera	PHEV	Midsize hatch	5300	3860	

In contrast, sales of the best-selling models in 2012 (Opel Ampera and Peugeot Citroen iOn / C-zero) both fell significantly. This suggests models and offerings with stronger consumer appeal are now being introduced. Another example of this is the BMW i3 which was only launched at the end of 2013 and therefore achieved only modest sales in-year.



¹ <http://www.transportenvironment.org/publications/how-clean-are-europe%E2%80%99s-cars-2014-%E2%80%93-part-1>

² <http://www.eea.europa.eu/data-and-maps/data/co2-cars-emission-6>

The EU accounts for about a quarter of global sales, which are also following a similar growth trajectory to the European market.³ The USA and Japan represent the largest national markets, with California in particular having achieved a 4% market share, largely driven by a mandate requiring manufacturers to sell EVs. In contrast, sales are still less than 1% in Japan and the rest of the US and are split evenly between battery electric and plug-in hybrid models. In coming years growth in China is expected to be particularly strong.

There is a wide variation in sales of EVs between European countries with Norway and the Netherlands achieving over 5% sales, compared to less than 1% elsewhere. In these two countries generous fiscal incentives drove the market in 2013; in the Netherlands some of the incentives ended on 31 December spurring last-minute purchases late 2013.

In 2013, as part of the Cars and CO₂ Regulation, sales of ultralow carbon vehicles were given an additional incentive as counting 3.5 times towards the manufacturer's fleet average emissions through a supercredit mechanism.⁴ Mitsubishi earned 19g/km of supercredits, artificially lowering its fleet average emissions from 123.9g/km down to 104.9g/km. Volvo reduced its emissions using supercredits by 7.1g/km. These excessively generous credits effectively reduce the need for companies to improve the efficiency of conventional vehicles and have fortunately been capped for the 2020/1, 95g/km target.⁵ It is essential that future policy to encourage ultralow carbon vehicles post 2020 does not introduce hot air by allowing far less efficient conventional vehicles.

The future trajectory of EVs sales is highly uncertain but seems likely to continue on at least the trajectory achieved since 2010. On this basis European sales would exceed 100,000 by 2015, 500,000 by 2021 and 1 million by 2025. This steady growth is more likely in the medium term than a sudden transformation of car sales to electric powertrains.

For the foreseeable future there is likely to be a diversity of fuels and powertrains including small efficient internal combustion engines for micro or city vehicles, hybrids and plug-in hybrids, electric and hydrogen vehicles which compete in different market segments. Regulations need to support this competition beyond 2020, as the way passenger cars and vans are decarbonised will progressively shift from improving the efficiency of conventional vehicles to increasing sales of ultralow carbon vehicles (ULCVs) with alternative powertrains. To achieve both of these objectives, establishing fleet average car CO₂ standards for 2025 and 2030 based upon tailpipe emissions is an effective approach. Whilst zero-rating battery electric and hydrogen vehicles does not reflect their full environmental impact, a complementary policy to incentivise supply of low carbon fuels, such as a Fuel Quality Regulation will encourage energy companies to decarbonise transport fuels.

Conversely, including transport in the Emissions Trading Scheme, as proposed by German Carmakers,⁶ would not provide the right market signal to require a shift to alternative powertrains. The significant economic opportunities created by the shift to ultralow carbon vehicles, such as is currently being achieved in the UK,⁷ will not therefore be realized were

³ http://www.theicct.org/sites/default/files/publications/ICCT_EV-fiscal-incentives_20140506.pdf

⁴ <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02009R0443-20130508&from=EN>

⁵ <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0333&from=EN>

⁶ Intervention by the German Association of the Automotive Industry (VDA) to a European Commission stakeholder event, Brussels, 27th March 2014

⁷ http://www.lowcvp.org.uk/news,lowcvp-news-uk-auto-sector-renaissance-driven-by-low-carbon-policy-focus-new_3026.htm

transport included in the ETS. Such a move would also eliminate wider benefits of more fuel efficient cars to the EU economy, drivers and energy security.

To incentivise ultralow carbon vehicle sales a flexible mandate, similar to that successfully used in California, is the most effective approach. This would encourage all carmakers to ensure a minimum percentage of sales are ultralow carbon vehicles but provide flexibility on how the target is met. A 2025 mandate of around 10% sales is likely to be both achievable and on a pathway to fully decarbonise vehicles by 2050. Including a trading element, like in California, further increases compliance flexibility without weakening incentives or the regulation as a whole.

Electric vehicles can perform an important role in a shift to more sustainable mobility but are not a panacea. Specifically, *how* and not *whether* a shift to emobility happens will determine how sustainable the eventual outcome becomes. For example: unless vehicles are powered by renewable energy, CO₂ benefits will be limited or even negative in some countries. Unless EVs are used appropriately in combination with other sustainable transport models, excessive car use will continue to impose huge costs through congestion and reduce urban quality of life. The focus of future policy must not therefore be only to increase sales but to encourage emobility where it makes the most economic and environmental sense. This includes encouraging electric bikes, micro-urban passenger and delivery vehicles, shared use cars and taxis and fleets in addition to growing the market share amongst private buyers.

Introduction

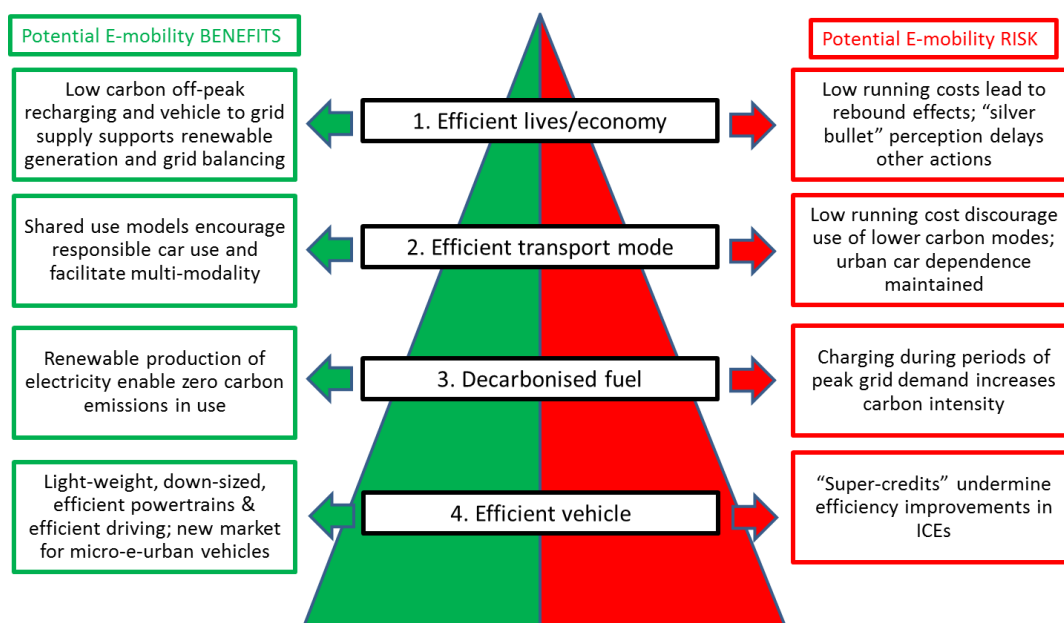
This is the second part of T&E’s annual Cars and CO2 report⁸ that examines developments in new car CO2 emissions. This part is focused on electric cars.

Sustainable e-mobility

A shift to ultralow carbon cars is needed to achieve the required emission reductions from road transport to achieve climate goals. It is therefore essential to begin to develop the market for a range of ultralow carbon alternatives. Currently BEVs, PHEVs and FCEVs are the main contenders, but it is immaterial which alternatives emerge from the technology race, so long as they deliver a genuinely sustainable outcome.

The question of whether a shift to e-mobility (electric or hydrogen cars) can deliver a sustainable solution stimulates fierce discussion between those that view e-mobility as a panacea for sustainability and those who argue that it perpetuates a car-dominated society with inadequate environmental benefits. Both arguments are tenable, as it is the way a shift to e-mobility happens that will determine how sustainable the eventual outcome will be. The figure below illustrates the challenge.

E-mobility could make a major contribution to sustainable mobility-
but its impacts will depend upon **how** the market develops



Where and how ultralow carbon vehicles are driven; how the “fuel” is produced or generated; and when the vehicle is charged will all profoundly affect whether e-mobility is a sustainable transport solution. E-mobility could make a sizable contribution towards more sustainable mobility and for these reasons it is one of the approaches we support. However policy should be redirected to focus on the way electric vehicles are used rather than simply

⁸ <http://www.transportenvironment.org/publications/how-clean-are-europe%E2%80%99s-cars-2014-%E2%80%93-part-1>

stimulating the substitution of vehicles with an internal combustion engine for ones with a battery or fuel cell. T&E will shortly be issuing a briefing paper to explain how policy should be redesigned to support a genuinely sustainable shift to emobility.

A note on data

The analysis in this report is derived primarily from data collated by the European Environment Agency's provisional 2013 CO₂ registration data, supplemented by recent ICCT analysis⁹ and other sources. The provisional car sales data for 2013 has been collated by the European Environment Agency from data supplied by national administrations responsible for car registrations in each of the 28 Member States. These data are currently under review by carmakers. The preliminary data are of high quality, but there can be errors or omissions in specific batches of data. Whilst for the total car data figures this rarely has much impact, for EVs there are many fewer data points and sales vary enormously from one Member State to another, so a single error or omission is more likely to influence the results significantly. Hence some numbers may change for individual models or manufacturers as a result of the ongoing review being undertaken by carmakers and the EEA. The overall conclusions and key findings of this report are not anticipated to change.

What is an Electric Vehicle?

This report focuses on two categories of electric vehicles:

- **Battery Electric Vehicles (BEVs)** are 'pure' electric vehicles in that all of their power is derived from mains electricity, supplied to an on-board battery which then drives an electric motor (or possibly more than one) within the vehicle. These vehicles produce zero emissions at the point of use, although they will still give rise to emissions elsewhere if the power that they use comes all or in part from fossil-fuelled power plants.
- **Plug-in Hybrids (PHEVs)** are also powered primarily by electricity and can operate in an 'all-electric' mode similar to a BEV, but in addition they have a small conventional internal combustion engine (ICE) which is used to enhance their performance or extend the available range of the vehicle between charges, or both. These vehicles do produce emissions of CO₂ and other pollutants while the ICE is in operation, but generally at a low level (with CO₂ emissions typically of less than 50g/km). This category of vehicles includes so-called range-extended electric vehicles such as the Opel Ampera, where the internal combustion engine is used purely to top up the battery to give greater range between charges, and does not drive the wheels directly.

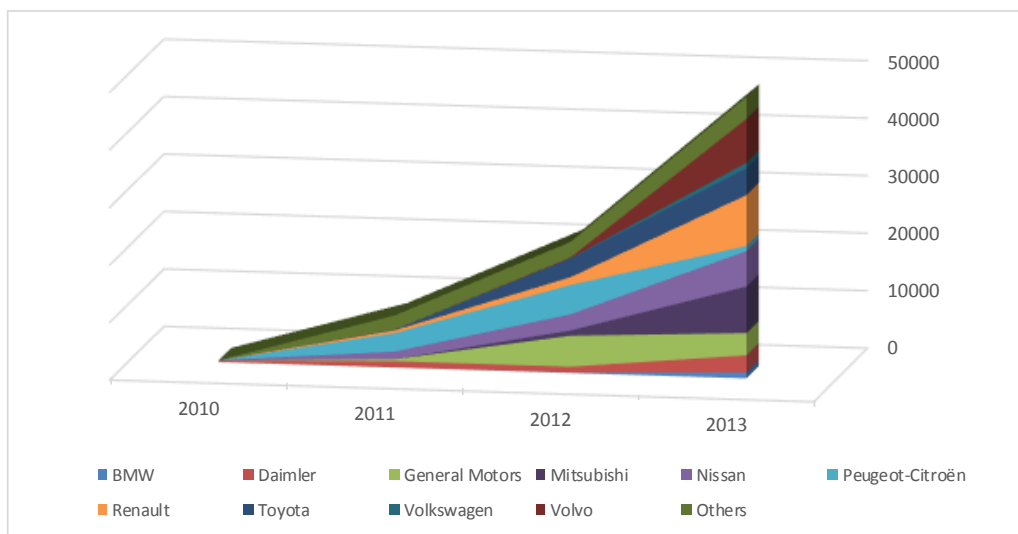
A hydrogen fuel cell electric vehicle (FCEV) is also a form of EV as it is powered by an electric motor, although it does not derive its power from mains electricity. However in 2013 sales of FCEVs were negligible so they are not considered in detail in this report. As noted below, sales are expected to grow significantly in the future. Other types of hybrid, which derive their motive power from petrol or diesel fuel but use an auxiliary electric motor to enhance efficiency or performance, are not considered as EVs for the purpose of this report.

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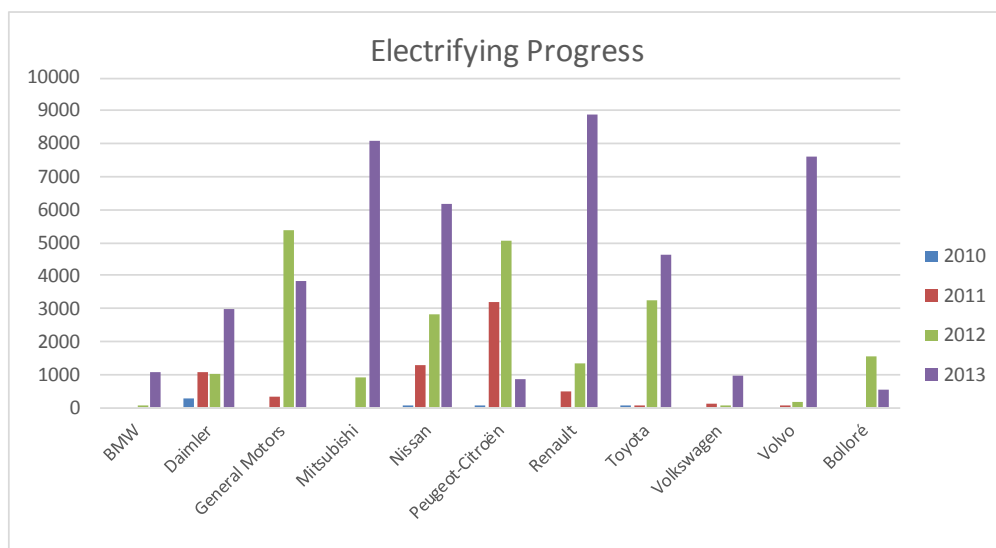
Electric Vehicles in 2013

Overview of Electric Vehicle sales in Europe in 2013

2013 recorded another year of growth in EV sales across Europe – they more than doubled to just short of 50,000 in the EU, or well above that figure with Norway’s 8,700 sales added. This is the third consecutive year in which sales have more than doubled from the previous one, with sales growing exponentially from just 700 in 2010. As against this, sales of around 50,000 EVs still made up only around 0.4% of all the new cars sold – one car in every 250 sold and a tiny proportion of the total market.



This growth is partly the result of more major car companies offering EV models in the market in 2013, although not all have prospered as illustrated in the following chart:



Daimler, Nissan and Toyota have all made steady progress, primarily on the basis of established and popular models (the ForTwo Electric, Leaf and Plug-in Prius respectively). Daimler tripled its sales to nearly 3,000 and Nissan more than doubled its sales to above 6,000 in 2013. Even more striking however is that these three have been rapidly overtaken in 2013 by new entrants to the EV market –Volvo and Mitsubishi and Renault, which have all launched new and immediately-successful models. Each has sold more than 7,500 vehicles. BMW and VW are other new entrants in 2013 with striking and innovative new products, although both were still relatively small players in 2013 due to vehicles being launched late in the year.

In contrast General Motors has faltered as sales of its Volt/Ampera models have suffered from growing competition in the plug-in hybrid market. It is reported¹⁰ that Opel/Vauxhall may now withdraw the Ampera from sale in Europe after poor sales; but the original Chevrolet Volt is currently still slated for a revamp in 2016. PSA’s sales have also fallen away significantly from more than 5,000 in 2012 to less than 1,000 in 2013, reportedly because its CZero has been eclipsed by the new Renault Zoe. For Renault, the success of the latter has more than made up for declining sales of the Fluence since the Better Place initiative filed for bankruptcy in May 2013.

Top-selling EV models in 2013

Looking at sales of individual models, a number of important new features can be seen.




Manufacturer	Model	Type	Segment	Sales 2012 (approx)	Sales 2013 (approx)	New Entrant
Renault	Zoe	BEV	Supermini	-	8500	✓
Mitsubishi	Outlander	PHEV	SUV	-	8200	✓
Volvo	V60 Plug-in	PHEV	Large hatch	40	7580	✓
Nissan	Leaf	BEV	Compact	2800	6160	
Toyota	Prius Plug-in	PHEV	Midsize hatch	3200	4620	
General Motors	Volt/Ampera	PHEV	Midsize hatch	5300	3860	
Daimler	ForTwo Electric Drive	BEV	Citycar	1000	2960	
Tesla	Model S	BEV	Sports	35	1660	✓
BMW	i3	BEV/PHEV	Compact	-	1050	✓
Volkswagen	eUP	BEV	Citycar	-	950	✓
PSA	C Zero/iOn	BEV	Small hatch	5100	880	
CeComp (Bolloré)	Bluecar	BEV	Small hatch	1540	570	
Mia	Mia Electric	BEV	Citycar	510	260	




In 2013, the top four models all sold way above the level of the 2012 top seller (the Volt/Ampera, with sales of 5,300, now relegated to only sixth place). The popular Nissan Leaf made progress from 2,800 sold in 2012 to over 6,000 in 2013, but can still only manage fourth place in the increasingly competitive new market.

¹⁰ <http://europe.autonews.com/article/20140721/ANE/307259991/opel-will-discontinue-weak-selling-ampera-sources-say>

2013 also witnessed the arrival of several significant new plug-in hybrids, notably the Mitsubishi Outlander, Volvo V60, Prius Plug-in and BMW i3 (as available as a BEV). As described below, the new entrants also include several large or 'high end' models that take the range of EVs significantly beyond a 'small car' niche.

Meet the new entrants

The Renault Zoe				
	Launch date:	December 2012	Type:	BEV
	2013 Sales:	8,500	Segment:	Supermini
<p>The Zoe went from new entrant to top seller in Europe in a matter of months. It is a 5-door supermini with a 22 kWh lithium-ion battery pack driving a 65 kW synchronous motor. Top speed is 135 km/h with an official range of 210 km. It has a 5-star Euro NCAP rating. France has been by far the largest market so far, but global sales reached 10,000 in January 2014. Batteries are leased for a monthly fee.</p>				
The Mitsubishi Outlander				
	Launch date:	July 2013	Type:	PHEV (44g/km)
	2013 Sales:	8,200	Segment:	SUV
<p>The Outlander is the first mainstream SUV developed with built-in provisions for either ICE or PHEV powertrains. In the PHEV configuration, the two powertrains work either serially or in parallel as conditions dictate. The 12 kWh lithium-ion battery pack delivers an all-electric range of 60 km with a top speed of 120 km/h.</p>				
The Volvo V60				
	Launch date:	September 2012	Type:	PHEV (49g/km)
	2013 Sales:	7,580	Segment:	Large hatchback
<p>The V60 is a large hatchback, and the world's first diesel plug-in hybrid with a 5-cylinder 2.4-litre turbo diesel engine. The electric motor is powered from a 12 kWh lithium-ion battery pack, giving an all-electric range of up to 50 km. On a full charge and full tank, the car's total range is estimated at up to 1,200km.</p>				

The Tesla Model S				
Launch date:	August 2013	Type:	BEV	
2013 Sales:	1,660	Segment:	Sports hatchback	
<p>Developed in California, the Tesla Model S is the world's first all-electric production model luxury sports hatchback. Its huge 85kWh battery can deliver over 300kW of power, giving it an acceleration of 0-97km/h in 4.2 seconds, and a top speed of 210 km/h. It also has a range estimated at 510 km at a constant speed of 89 km/h. The battery accounts for much of its 2 tonnes weight, and requires a special charger.</p>				
The BMW i3				
	Launch date:	Jul 2013	Type:	BEV (0g/km) & PHEV (13g/km)
	2013 Sales:	1,050	Segment:	Urban supermini
<p>The i3 is a compact car with a design 'language' developed specifically for urban electric driving. It is sold as a pure electric car, or in a range extender version with a very small petrol engine and fuel tank. Extended range is 260-290km in normal driving. The i3's many innovations include use of lightweight aluminium and carbon-fibre reinforced plastics. Unlike Europe's other top-selling EVs, it has only 4 Euro-NCAP stars.</p>				
The Volkswagen eUp				
Launch date:	November 2013	Type:	BEV	
2013 Sales:	950	Segment:	City Car	
<p>The eUP is the fully electric version of the VW Up! It has an 18.7 kWh lithium-ion battery, which is integrated into the floor of the car. It has an official range of 160 km and a top speed of 130 km/h. It has a novel energy regeneration system, allowing the driver to balance driveability against energy recovery.</p>				

Danger – High Voltage

It is striking that several of the new models described above for 2013 are of high power and performance characteristics and not energy efficient. Sustainable low-carbon electricity is at a premium and will remain so for a long time to come, and needs to be used efficiently. However, these new models arguably can make an important contribution to the development of a vibrant electric vehicle market in a number of ways:

- They challenge the persistent urban myth that EVs are small and underpowered cars with limited range and performance;
- People who can afford to drive luxury cars such as these are probably not the sort who would choose to drive a more conventional EV, so they have the potential to extend electric cars into further market segments;
- Potential buyers are often the sort of influential people who might be able to help change attitudes and policies towards EVs;
- Luxury models such as these incorporate advanced features that are as yet too expensive to include in a standard EV, but experience suggests that these innovations will in time fall in price and ‘trickle down’ to less expensive models, thereby improving their performance and making them potentially more attractive, efficient, etc.

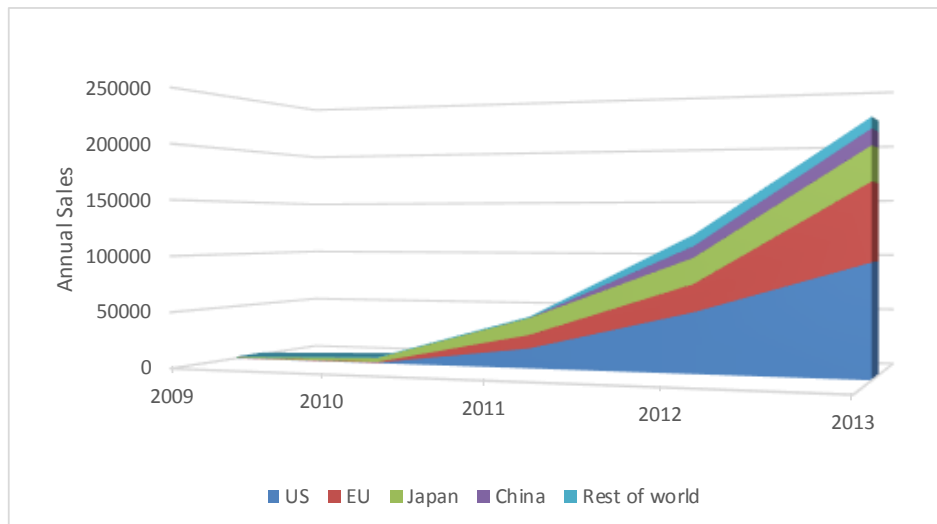
A small number of high performance vehicles do not make a significant environmental impact, but policy should not incentivise their supply. In the future, incentives for electric vehicles may need to include energy-efficiency criteria.

European EV sales in the global context

The small range of available EVs means that they are sold around the world with little or no adaptation to local tastes or regulations. Total global sales therefore will ultimately determine the success or otherwise of the technology.

The International Council for Clean Transportation (ICCT) has recently published a report on the global trend in EV sales and the incentives in place to encourage them in a range of countries¹¹. This confirms that the strong upward trend in sales reflected above for Europe is also seen in both the US and Japan, with the US (and principally California) representing the largest source of demand to date, at nearly twice the EU level. The EU accounts for about 1 in 4 of the EVs sold globally in 2013. Both the US and EU exhibit a similar pattern of rapid and exponential growth since the early days of EV commercialisation in 2009/10. Globally, sales have roughly doubled in each of the past two years, from about 45,000 vehicles sold in 2011 to more than 200,000 in 2013, a similar pattern to that highlighted above for Europe.

¹¹ http://www.theicct.org/sites/default/files/publications/ICCT_EV-fiscal-incentives_20140506.pdf



Source: ICCT

Highly significant for the future is the strong growth now seen in China. This reflects government-led encouragement for the take up of electric vehicles to address the twin challenges of mass motorisation and acute air quality problems. Reflecting this large and growing market, BMW Group, for example, predicts that China will become the world's largest market for electric vehicles in at most five years, as more charging stations are built and the government continues to promote low-emission cars very aggressively. However, the carbon intensity of the Chinese grid electricity is likely to make the CO2 benefits modest. "We expect that the Chinese car market for electromobility will become the largest for those cars in a few years," commented Karsten Engel, BMW's CEO in China, recently. "Because you have supply now, there are cars coming on the market. We are coming with ours, others are coming as well". Volkswagen Group is also betting on vehicles with alternative powertrains to spark future growth in the world's largest auto market, and has announced plans to unveil at least 15 electric vehicle models in China by 2018.

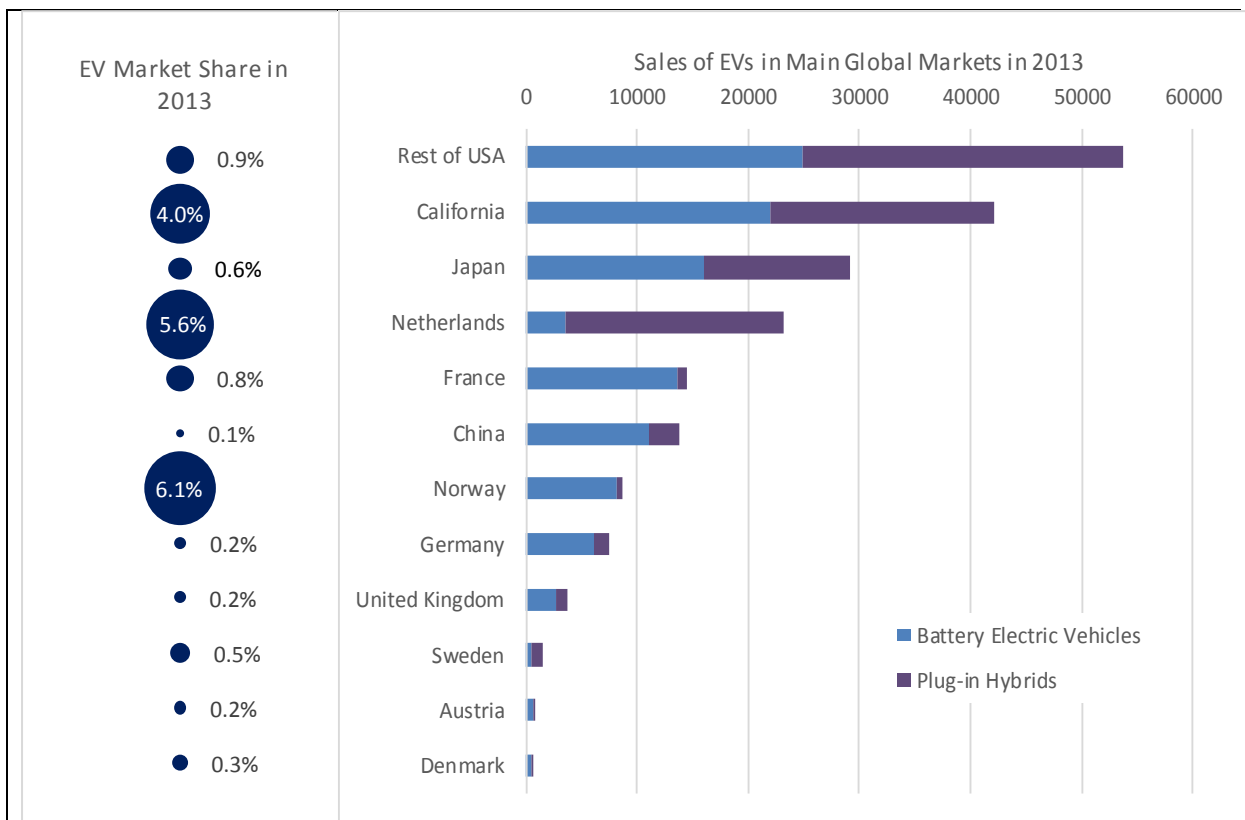
It is extremely difficult for alternatively-fuelled vehicles to break into the long-established and highly sophisticated market for ICEs because of the numerous barriers to entry that they face. These include consumer conservatism and unfamiliarity with a new technology; risk-aversion; misinformation; and the 'chicken and egg' problem whereby people will not buy an EV because of the lack of charging infrastructure, while infrastructure providers will hold back if there is not enough demand for recharging. Whilst it is important that EVs are used sustainably, it is also important to grow the current niche market in order to:

- Stimulate manufacturers to bring forward plans for new models or variants, thereby widening the range of products available to a wider pool of potential buyers;
- Stimulates innovation and competition amongst manufacturers to accelerates the technical improvement of the models on offer;
- Bring down prices (which remain substantially above those of conventional equivalents), through both innovation and some economies of scale;
- Increase the frequency of routinely seeing EVs on the road, or having a friend or colleague who uses one, which may bring more motorists to consider the possibility of switching to an EV;

- Increase the use and installation of more and better public recharging infrastructure, and this in turn will encourage more motorists to feel able to use an EV on a wider range of journeys.

Sales across Europe and beyond

The recent analysis by ICCT has underscored that the scale of EV sales, expressed either as the absolute number of vehicles sold or of the market share of new car sales that are EVs, varies widely from one country to another. Even amongst the large developed countries, the contrasts are striking, as the figure below illustrates.



Source: Based on ICCT data

Outside Europe, the USA and Japan represent the largest national markets as indicated earlier. California also has by far and away the largest market share at 4%, driven by a mandate requiring manufacturers to sell EVs. In contrast sales are still less than 1% in Japan and the rest of the US. In these markets, sales are about evenly split between BEVs and PHEVs.

As the figure illustrates, Norway and the Netherlands had by far the largest market share for EVs in Europe in 2013, with both well above 5%. In these countries the split between BEVs and PHEVs is very different, with the Netherlands standing out for its very high share of PHEVs, while Norway has almost exclusively BEVs. This is mainly driven by the targeting of national incentives.

Both the sudden leap in their market shares and the distinct contrast in the types of vehicles bought strongly suggest that their large fiscal incentives for EVs were highly instrumental in bringing about these increases.

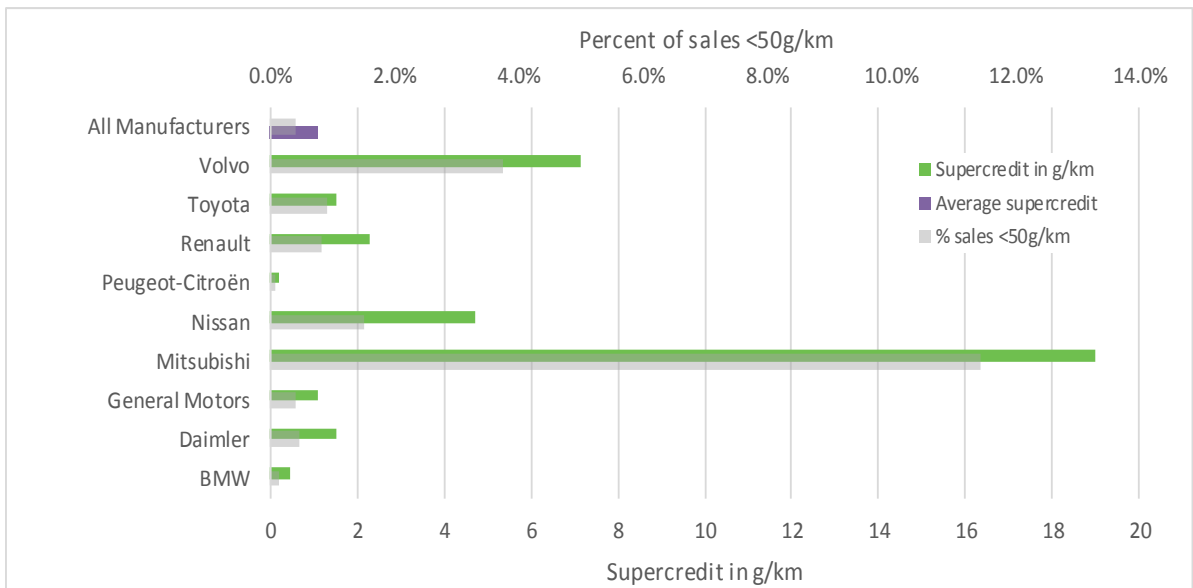
For example, Norway's fiscal incentive of approximately €11,500 per BEV (equivalent to about 55% of a typical vehicle's base price) helped deliver a 6% market share for BEVs in 2013, and a 90% market share increase from 2012 to 2013. Similarly, the fiscal incentive in the Netherlands of about €38,000 for each PHEV (equivalent to about 75% of the vehicle base price) in 2013 helped deliver a 5% market share for PHEVs in 2013, and a huge 1,900% leap in market share from 2012 to 2013. This level and form of subsidy has clearly been effective but is not sustainable, even in the medium term. Whilst tax incentives for sales of low carbon vehicles are justified and an important tool to stimulate the early market, these should be proportionate and subsidising car purchase through grants is not an appropriate or long-term solution.

Elsewhere in Europe, the market shares of EVs remain much lower at below 1%, but there are still marked contrasts between them. For example despite incentives sales in France the UK and Germany are currently low.

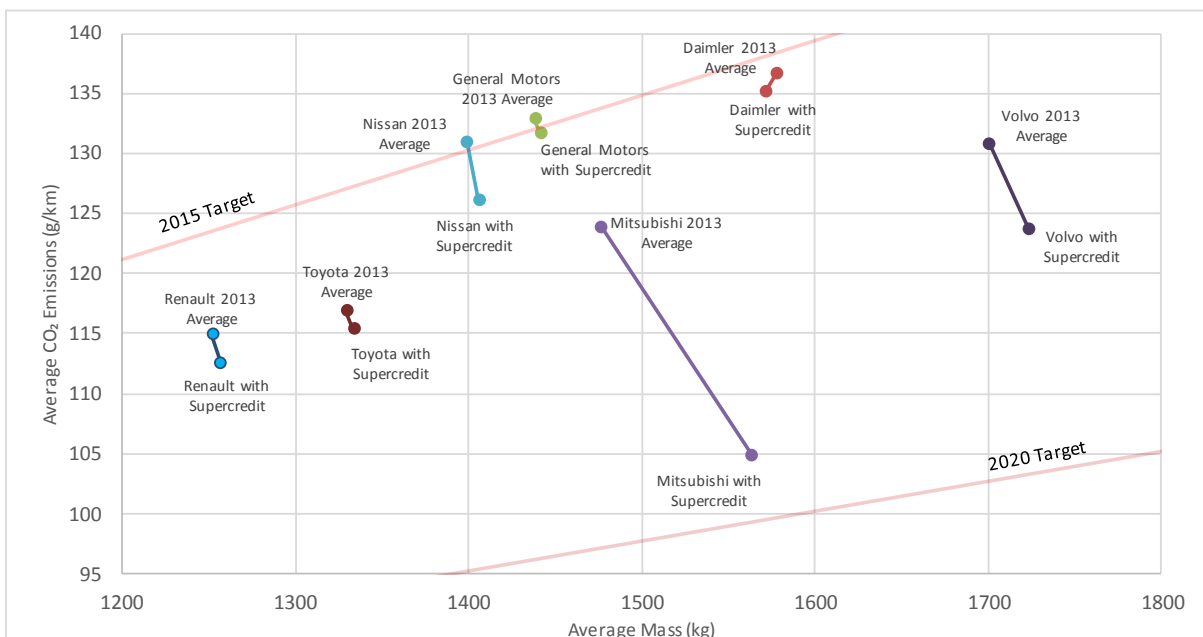
Supercredits in the EU market

Under the Cars and CO₂ Regulation, 2013 is the second year in which supercredits are available for low carbon cars. Under this provision, each new car sold with tested CO₂ emissions of 50g/km or below is now counted 3.5 times towards the manufacturer's average for that year. That is, 2.5 'imaginary' EVs are added to the company total for each EV sold. Supercredits are designed to incentivise sales of cars with the lowest carbon emissions, but in doing so they effectively weaken the targets for companies that sell EVs.

In 2012, this provision had only quite limited impact on company performances; only for GM, Nissan and Toyota did EVs represent more than 0.5% of sales, and only for Nissan did the credit generated exceed 2g/km of improvement in its total sales weighted average CO₂ emissions. However, as the figure below illustrates, the new entrants to the market have drastically transformed this picture.



The most striking new feature is the huge supercredit benefit now attributed to Mitsubishi, reflecting the very high proportion of its total sales now accounted for by the Outlander. As a result it receives a supercredit of 19g/km, bringing its fleet average from 123.9g/km down to 104.9g/km, one of the best corporate performances overall and way ahead of all the main players. The same is true to a lesser extent for Volvo, whose EV sales in 2013 accounted for nearly 4% of its total and resulted in 7.1g/km of supercredit to add to an already good overall performance in 2013.



The chart above illustrates the impact of supercredits on the largest beneficiaries' distances to target. From this, several key conclusions emerge:

- For Nissan and GM, supercredits were sufficient to take them beyond the 2015 target in 2013.
- All the other major beneficiaries are already well within the 2015 target, so have no need for such generous rewards from supercredits.

- Only for Daimler do supercredits move its average towards the bottom left of the graph, reflecting the fact that the ForTwo is substantially smaller and lighter than the typical Daimler sold.
- For all others, the average moves towards the bottom right, reflecting the fact that the EVs sold are above the average weight of each company's sales.
- In these cases, the shift in the average is more or less at right angles to the 2020 target line, such that the benefit from supercredits in terms of meeting future targets is even greater than the CO₂ averages alone would suggest.

Company	Contribution of weight to supercredit
Daimler	-57.5%
General Motors	20.2%
Mitsubishi	24.6%
Nissan	11.2%
Renault	16.9%
Toyota	18.2%
Volvo	19.0%

Indeed, for these companies, typically around one-fifth of the supercredit benefit of EVs derives from their heavy weight rather than their ultralow CO₂. This in turn suggests that a very high rate of supercredit (such as the 3.5 level for 2013) may actually incentivise the manufacture of heavier EVs. This provides a further reason that within the Car CO₂ regulation that company targets should be based upon the footprint of the vehicle being sold not mass.

Future Prospects for Electric Vehicles

New EVs in the pipeline

The diversification of the EV market in 2013 is expected to continue in 2014 and probably beyond. Notably, both VW and Ford have taken a different approach to the other major manufacturers, preferring to base their EVs on their existing range of models. The benefits, they argue, come from the ability to drive costs down through shared parts, and to have the flexibility to build as many or as few cars as the market demands, as they are made on the same production lines.

The Ford Focus Electric, for example, will be the first electric version of Ford's most popular mid-range hatchback. It has a 23kWh liquid-cooled battery that gives a range of 160km and a top speed of over 135km/h. Acceleration is 0-100km/h in 11.4 seconds. Early reports suggest that it looks extremely similar to its conventional cousins. It is expected to be particularly popular in the vehicle fleet market.

The Volkswagen eGolf is also a BEV, sending 113bhp to the front wheels and giving it good acceleration in spite of its weight. It can accelerate from zero to 60km/h in 4.2 seconds and to 100km/h around six seconds later, with a top speed of 140km/h. It has a 24.2kW capacity lithium-ion battery weighing 318kg, installed in the floor of the car to keep the centre of gravity low. Many other components (including the drag coefficient) have been optimised for the electric version. As with the eUP, the degree of regenerative braking applied is user-adjustable, as is the level of power available in 'Eco' and 'Eco+' driving modes. VW claims that the eGolf is around 30 per cent more energy efficient than competitors such as the Nissan Leaf, and quotes a typical range of 190km.

Also upcoming from VW is reported to be the **TwinUp**, a diesel-electric PHEV version of the Up! and rumoured to better the performance of its all-electric cousin featured above. A

PHEV version of the **Passat** is also expected to be launched at the Paris Motor Show this October.

The Electric Mercedes B-Class will be a high-end BEV, utilising the drive train of the Tesla Model S. The top speed is limited to 160km/h to conserve battery life, which provides a typical range of 185km. This will be an expensive, high-end car, and it remains to be seen whether buyers will prefer this classic Mercedes design to the radical new approach adopted by BMW.

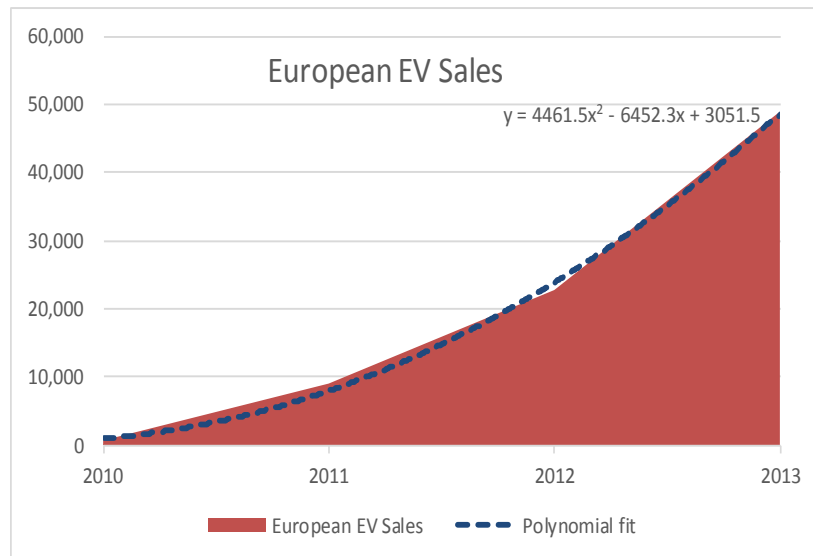
Meanwhile **BMW** is seeking to build on the early success of the i3 with the launch in mid-year of the **i8**, a luxury sports car PHEV. It has a 7.1kWh lithium-ion battery pack with intelligent energy management that delivers an all-electric range of 37 km on the official cycle. It has a low vehicle weight for its size — 1,485kg thanks to numerous lightweight components — and a low drag coefficient. In all-electric mode the i8 has a top speed of 120km/h, or in 'sport' mode it can deliver a mid-range acceleration from 80 to 120km/h in 2.6 seconds.

Nissan is capitalising on its success with the popular Leaf and has started production in Barcelona of its second all-electric vehicle, the **e-NV200**, which is the all-electric version of its NV200 van. It is now available across Europe as a five-seat 'combi' passenger car, a light commercial vehicle for urban deliveries, and an electric taxi. It uses the same drivetrain technology as the smaller Leaf, but its larger format is intended to make it accessible in new market segments. Top speed is capped at 122km/h, giving a range of around 170km, which is comfortably above a typical daily van usage. Nissan claims that its low maintenance and cheap fuel make it 40% cheaper to run than its diesel equivalent. Some major brands (including Coca-Cola, FedEx, and British Gas) are already reported to have trialled the new van, with BG already convinced enough to order 100 production vehicles.

The Electric Kia Soul will be the first globally-sold, mass-produced all-electric vehicle from a Korean manufacturer. It is based on Kia's popular urban mini-MPV crossover, the Soul, and has recently been launched in Europe. This electric model is fitted with a 192-cell 27kWh lithium-ion polymer battery delivering an official range of 210km on a single charge. The 81.4kW electric motor produces a high torque of 285Nm and an acceleration of 0-100km/h in 11.2 seconds. Top speed is 145km/h. Kia has achieved a high energy density for its new EV at 200Wh/kg, and uses novel equipment including a heat pump, smart air intake control and an individually-tailored ventilation system to minimise ancillary demands on the battery.

The future trajectory of EV sales

Production model EVs only began to appear on Europe's roads in 2010, and in that year only a few hundred were sold. Sales have however at least doubled in each year since, with sales reaching around 50,000 in 2013. The figure below illustrates the strong growth.



However, as noted above, sales of around 50,000 EVs in 2013 still made up only a tiny proportion of the total market. In this early stage of market development it is premature to make predictions of future take-up. However, *if* this pace of growth was to continue, sales would reach over 100,000 by 2015; almost 500,000 by 2020; over 1 million by 2025 and over 2 million by 2030. This would represent around 15% of all new car sales by 2030, and is broadly consistent with national EV targets recently published by the International Energy Agency.

T&E believes that, in order for the EU to meet challenging CO₂ reduction targets for 2050, cars and vans will need to be virtually carbon-free by that date. In order to achieve this, all new passenger cars sold will need to be essentially carbon-free (ie EVs or equivalent) from 2035 at the latest. This will allow 15 years for a complete turnover of the car fleet. The early trajectory will therefore need to be accelerated at some point in order to achieve climate goals.

There are a number of reasons to be optimistic about high future rates of growth in the short term:

- Further new models are planned for launch;
- The range of plug-in hybrid models available is increasing and these are more attractive to some buyers;
- Battery costs are falling and forecast to fall further, with new batteries chemistries (such as lithium air) expected to become available in automotive applications within a decade;
- The market share in most countries is still extremely low, but two European countries (Norway and the Netherlands) have achieved more than ten times the EU average EV sales share – albeit with a level of incentives that cannot be sustained for long;
- A number of manufacturers have indicated they will commercialise fuel cell technology from 2015, creating further competition and choice.

Battery Electric or Fuel Cells in the future?

The future trajectory of EVs is further clouded by the fact that global automakers are taking different views whether battery electric technology or the hydrogen fuel cell provides the best long term investment.

Toyota, for example, is ending its battery deal with US electric carmaker Tesla, and is concentrating instead on mass-producing a fuel-cell vehicle, alongside its smaller rival Honda. Nissan, by contrast, continues to bet on all-electric cars, unveiling its second model this year despite relatively limited global sales to date of its flagship Leaf. It is pushing the technology particularly hard in China.

Daimler, Toyota and General Motors are currently the frontrunners in developing fuel cells. Toyota hopes to achieve a 500-kilometre range for its first fuel-cell car — more than twice that of a typical battery EV — and to offer much faster refuelling in just a few minutes. If realised, these performance parameters will eventually give fuel cell vehicles a clear edge over EVs, but the technology is still under development and is very expensive. The necessary infrastructure for hydrogen refuelling also presents even greater challenges than those of installing EV recharging points. Hydrogen uses energy less efficiently and also needs to be generated in a low carbon way.

Fuel-cell vehicles are expected to get a new push with the state of California launching a new network of hydrogen refuelling stations. Fuel cells tend to be seen as the preferred solution by US pundits on account of their better range and refuelling characteristics, to the extent of sometimes understating the huge technical obstacles still to be overcome before they can be widely marketed. Meanwhile EVs continue to consolidate their head start in Europe in particular, where range limitations are arguably less of an obstacle than in the US, and where an electric recharging infrastructure looks less problematic than a hydrogen one would.

Overall, this scramble for ultra-low carbon technology is sparking massive investment, with Japan's seven major car manufacturers expected to spend a record \$24 billion on green car research and development this year, according to the Nikkei Business Daily. Hence further and rapid technical developments are more or less guaranteed; but it remains to be seen which of the two favourites will win out in the end.

How Future Policy can Support the Future Market

Policy priorities

T&E continues to take the view that for the foreseeable future there will be a diversity of fuels and powertrains. This will include small efficient internal combustion engines for micro or city vehicles, hybrids and plug-in hybrids, electric and hydrogen vehicles. These will compete to a greater or lesser extent in different market segments. We anticipate this multi-powertrain environment is likely to continue until beyond 2030, at which point some technologies are likely to obtain a competitive advantage and begin to predominate. Which ultralow carbon solutions dominate will depend upon how future technologies develop, and particularly their cost.

However, the focus of policy to simply drive sales of EVs the early development of the market needs to be complemented by actions that encourage early niche markets where EVs make both economic and environmental sense. These might include electric bikes, micro-urban vehicles (such as the Renault Twizy), urban delivery vehicles, shared use cars and taxis, and fleet vehicles. Such vehicles would be immediately attractive to local authorities in urban areas, which could also support their deployment. This is not to suggest there is no early market for private car sales but rather that this market will take time to develop and should not be the exclusive focus of national policies particularly in countries where there are no CO₂ savings due to the high carbon electricity supply.

Post 2020, the way passenger cars and vans are decarbonised will progressively shift from improving the efficiency of conventional vehicles to increasing sales of ultralow carbon vehicles with alternative powertrains. The role of policy will therefore be twofold:

1. To continue to drive an improvement in the efficiency of conventional powertrains, such as through hybridisation;
2. To support emerging alternative powertrains and enable these to establish an initial market position and progressively compete against traditional engines and hybrids.

The shape of future regulation

T&E supports establishing vehicle fleet average CO₂ regulations based upon tailpipe emissions for 2025, and probably 2030, as the best way to achieve the dual objectives of improving vehicle efficiency and encourage the market for ultralow carbon vehicles. This is because a tailpipe metric will zero-rate battery electric and hydrogen vehicles and provide a significant incentive for their supply. Whilst zero-rating battery electric and hydrogen vehicles does not reflect their full environmental impact, a complementary policy to incentivise supply of low carbon fuels, such as a Fuel Quality Regulation to replace the current Directive, should be used to encourage energy companies to decarbonise transport fuels.

T&E does not favour supercredits to further incentivise supply of ultralow carbon vehicles. This is because double counting of these vehicles effectively creates 'hot air' in the regulation by weakening the target as illustrated in the report. The success of a Zero

Emission Vehicle (ZEV) mandate in encouraging sales of BEVs in California illustrates that this is a better approach, but T&E believes it could be improved and advocates a flexible mandate. With a flexible mandate, all carmakers are encouraged to ensure a minimum percentage of sales are ultralow carbon vehicles. Companies achieving more than the mandated level of vehicles could then either:

1. Sell surplus credits to manufacturers not meeting their targets. Specialist carmakers such as Tesla can thereby benefit directly from selling electric cars and earning credits in the EU in a similar way that they do selling ZEV mandate credits in California;
2. Use surplus credits to raise their own fleet average tailpipe target. This would provide a link between policies to drive ultralow carbon vehicles and improving the efficiency of conventional vehicles.

The percentage of ULCVs a company is required to sell would depend in part upon the definition of what constitutes a ULCV. The current system of supercredits uses a threshold of 50g/km but this approach incentivises vehicles with large batteries that can be energy inefficient. This can be avoided by including an energy efficiency criterion for vehicles to qualify towards the mandate. T&E is currently examining options for the definition of an ULCV and the level of an appropriate mandate. As part of this work we are considering whether the definition should be extended beyond cars (M1 class) to large quadricycle (L7 class) to stimulate the supply of small electric vehicles. To avoid electric cars receiving extra incentives, by raising the company target by increasing the average mass to vehicles supplied the target should be based upon the footprint not mass of the vehicle.

Heading on the wrong direction – including transport in the Emissions Trading Scheme

As part of the discussions on the 2030 climate and energy package, the German Car industry¹² is advocating that road transport emissions should be included in the EU Emissions Trading Scheme (ETS). The ETS covers around half of the EU's CO₂ and is based on the 'cap and trade' principle. Within the cap, companies receive or buy emission allowances which they can trade with one another. If transport were included in the scheme it is anticipated that drivers would be required to pay for the carbon emissions associated with the fuel burnt in their cars. The cost at the current low market price would be less than €0.02 rising to €0.07 if the carbon price rose to the level of €25-30 that is needed to incentivise many policies to lower emissions; e.g. fuel switching from coal to gas.

If transport was included in the ETS there would be no incentive or requirement for carmakers to improve the efficiency or lower the emissions of vehicles if the complementary system of vehicle standards could be considered double regulation. The effects of this would be universally detrimental as it would:

- Undermine investment in low carbon automotive technologies for suppliers
- Worsen energy security

¹² Intervention by the German Association of the Automotive Industry (VDA) to a European Commission stakeholder event, Brussels, 27th March 2014

- Shift the burden of carbon saving from transport to industry and from sheltered sector to potentially exposed ones damaging the EU economy
- Delay and decelerate the rate of emissions reductions in transport putting at risk achievement of climate goals
- Introduce politically difficult increases in fuel prices that some Government' may be unwilling to pass on thereby eliminating any environmental benefit
- Increase, not reduce, the costs of motoring and therefore detrimental impact on job creation in the wider economy.

Notably the significant economic opportunities created by the shift to ultralow carbon vehicles, such as is currently being achieved in the UK,¹³ will not be realized were transport included in the ETS. Standards rather than including transport in the ETS deliver the wider benefits for the economy¹⁴ and will drive the necessary shift to ultralow carbon vehicles.

¹³ http://www.lowcvp.org.uk/news,lowcvp-news-uk-auto-sector-renaissance-driven-by-low-carbon-policy-focus-new_3026.htm

¹⁴ <http://www.transportenvironment.org/what-we-do/cars-and-co2/publications>