

Electric vehicles: Socket to me

Electric vehicles could add 25% to UK electricity demand

In the very long term, we estimate the total conversion from gasoline to electric vehicles (EVs) could increase UK electricity demand by 25%. However, National Grid has calculated that the extra demand from EVs could be almost offset by reduced demand stemming from more energy efficient lighting and appliances and the rollout of smart meters. EVs will have a notable impact on electricity consumption patterns and grid management, in our opinion.

A smoother load curve is positive for utilities

EV owners could help smooth intra day electricity loads by concentrating charging in the traditionally quieter (and cheaper) overnight hours. This would lead to a more constant level of electricity demand throughout the day, which improves the utilisation of peaking plants and probably enables higher achieved power prices for baseload capacity. EVs may also push utilities towards more dynamic residential tariffs to influence consumption patterns and behaviour.

15% carbon reduction depending on power source

The irony of EVs is that the power to charge the cars would most likely come from fossil fuels. Nevertheless, an EV charged from the typical UK power mix would emit about 60% less CO₂ than a conventional gasoline vehicle. Transport in turn is c.25% of a country's carbon emissions, so EVs could reduce total CO₂ emissions by about 15%. This would be a meaningful contribution towards the European Union's goal of an 80% carbon reduction by 2050.

A 7 year unsubsidised payback without subsidies

A handful of EV models are now beginning to hit the market but the economics are far from compelling at current price points. We estimate that buying the Nissan Leaf EV will cost £8,500 more upfront compared to a Ford Focus, but the annual fuel savings will be £1,200. This suggests a payback period of about 7 years, not very compelling given the short life of a car/battery. Some governments offer subsidies to help shorten the payback.

Nissan say 10% of car sales in 2020 to be electric

With current battery technology limiting maximum range to around 100 miles, depending on driving conditions, the practical constraints of charging may offset the economic argument for most drivers. Perhaps we are still a development cycle away from demand inflexion and in the car industry that means 5-6 years. The CEO of Nissan believes 10% of cars sold globally in 2020 will be EVs, although this is at the high end of industry forecasts.



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EVs create 25% more power demand

In the very long term, we calculate that a full conversion of the passenger car fleet from gasoline to electric could add approximately 25% to UK electricity demand. The charging of EV batteries could have a significant impact on electricity consumption patterns and grid management. EV owners could help smooth load curves which would improve the utilisation of peaking plants and enable higher achieved power prices for baseload capacity.

One charge goes around 100 miles

We understand the leading electric vehicle on the market today is the Nissan Leaf and the characteristics of this model are the basis for many of the calculations that follow in this report. The Leaf has a battery capacity of 24kw, that when fully charged can go about 70-100 miles. The exact range is debatable as it depends on driving conditions such as speed, air conditioning etc. The US Environmental Protection Agency conducted a test that suggested range could be anything between 47-138 miles. For our analysis, we have assumed conditions closest to City traffic as we believe urban dwellers will be the earliest adopters of EVs.

Table 1: Range of Nissan Leaf depending on driving conditions

Driving condition	Speed		Temperature	Drive Duration	Range		Air conditioner
	mph	km/h			mi	km	
Cruising (ideal condition)	38	61	68	3 hr 38 min	138	222	Off
City traffic	24	39	77	4 hr 23 min	105	169	Off
Highway	55	89	95	1 hr 16 min	70	110	In use
Winter, stop-and-go traffic	15	24	14	4 hr 08 min	62	100	Heater on
Heavy stop-and-go traffic	6	10	86	7 hr 50 min	47	76	In use

Source: EPA

The range limitation is arguably the biggest obstacle, rather than economics, to higher EV penetration in our view. A study by the US department of Transportation suggested that 80% of car owners travel less than 50 miles a day. So an EV with a range of 100 miles would still be suitable for a large proportion of the car park.

One charge takes 7 hours

At 3.5kw/h residential voltage, fully charging the 24kw Leaf battery at home will take almost 7 hours. However, with a commercialised direct current charging station, electricity can be transferred at up to 50kw/h which would bring charging time down to under 30 minutes.

Each vehicle consumes 2600kwh of electricity annually

If we assume a fully charged Leaf gets 140km in average driving conditions, then we can calculate that the vehicle does 5.8km per kwh. According to Direct Line Insurance, the average UK driver goes 9,628 miles or 15,405 km per year. We therefore estimate that each electric vehicle would consume 2,641kwh of electricity per year. Our autos team believe average mileage on the Continent is around 10,000 miles, similar to the UK, while the US is a little higher at 12,000.

Impact of rising EV penetration

There are just over 30m passenger cars in the UK, implying almost one in two people is a car owner (or about 60% of the eligible driving population). We show the comparable figures for France, Germany, Italy and Spain in Table 2 below. Italy stands out for its high car ownership rate. Our analysis does not include commercial vehicles where range anxiety is likely to be a bigger hurdle.

Table 2: The Car park

Country	No. of passenger cars	Population (mn)	Cars per capita	Power consumption	Power per capita
	2010 (mn)			2010 (TWh)	
UK	30.75	60.587	0.51	330	5.45
France	31.27	63.601	0.49	490	7.70
Germany	42.06	82.217	0.51	520	6.32
Italy	36.58	59.715	0.61	320	5.36
Spain	22.35	46.777	0.48	260	5.56

Source: JD Power, Transmission System Operators

While we offer some thoughts later in this report on how EV penetration may evolve, the primary purpose is to show the impact on electricity demand at various levels of penetration. For what its worth, the CEO of Renault/Nissan has suggested that 10% of cars sold in 2020 could be EVs, although this is at the high end of industry forecasts. About 2mn cars a year are sold in the UK, implying the car park is about 15 years old on average and suggesting EV penetration is only likely to be around 1% in 2020.

Table 3: Number of EVs on the road at different penetration rates

Penetration rate	UK	France	Germany	Italy	Spain
1%	0.3	0.3	0.4	0.4	0.2
5%	1.5	1.6	2.1	1.8	1.1
10%	3.1	3.1	4.2	3.7	2.2
20%	6.1	6.3	8.4	7.3	4.5
30%	9.2	9.4	12.6	11.0	6.7
40%	12.3	12.5	16.8	14.6	8.9
50%	15.4	15.6	21.0	18.3	11.2
60%	18.4	18.8	25.2	21.9	13.4
70%	21.5	21.9	29.4	25.6	15.6
80%	24.6	25.0	33.6	29.3	17.9
90%	27.7	28.1	37.9	32.9	20.1
100%	30.7	31.3	42.1	36.6	22.4

Source: BofA Merrill Lynch Global Research

If we fast forward a few years, to say 2030 and assume penetration by that point has reached 10% of the installed base, there would be 3.1mn EVs on the road in the UK (see Table 3). Assuming each vehicle uses c.2,600kwh of electricity per year, implies about 8TWh of extra electricity demand (see Table 4).

Table 4: Extra TWh from different EV penetration rates

Penetration rate	UK	France	Germany	Italy	Spain
1%	0.81	0.8	1.1	1.0	0.6
5%	4.1	4.1	5.6	4.8	3.0
10%	8.1	8.3	11.1	9.7	5.9
20%	16.2	16.5	22.2	19.3	11.8
30%	24.4	24.8	33.3	29.0	17.7
40%	32.5	33.0	44.4	38.6	23.6
50%	40.6	41.3	55.5	48.3	29.5
60%	48.7	49.5	66.6	58.0	35.4
70%	56.8	57.8	77.8	67.6	41.3
80%	65.0	66.1	88.9	77.3	47.2
90%	73.1	74.3	100.0	86.9	53.1
100%	81.2	82.6	111.1	96.6	59.0

Source: BofA Merrill Lynch Global Research

In 2010, the UK consumed 330TWh of electricity. An extra 8TWh from 10% of the cars being EVs, would increase electricity demand by 2.5% (see Table 5). Should penetration of EVs ultimately reach 100%, this would require an additional 81TWh of power and represent a 25% increase in electricity demand.

Table 5: Extra electricity demand as a percentage of current system consumption

Penetration rate	UK	France	Germany	Italy	Spain
1%	0.2%	0.2%	0.2%	0.3%	0.2%
5%	1.2%	0.8%	1.1%	1.5%	1.1%
10%	2.5%	1.7%	2.1%	3.0%	2.3%
20%	5%	3%	4%	6%	5%
30%	7%	5%	6%	9%	7%
40%	10%	7%	9%	12%	9%
50%	12%	8%	11%	15%	11%
60%	15%	10%	13%	18%	14%
70%	17%	12%	15%	21%	16%
80%	20%	13%	17%	24%	18%
90%	22%	15%	19%	27%	20%
100%	25%	17%	21%	30%	23%

Source: BofA Merrill Lynch Global Research

For simplicity, we have assumed constant underlying electricity demand at 2010 levels. We have also assumed no change in the km/kwh of the battery which is likely to improve with better technology over time.

Italy has a slightly higher car ownership rate and lower power consumption per capita which is why EVs could increase electricity demand by 30%. France on the other hand, is already a relatively intense consumer of power and has a low proportion of car ownership, which is why EVs create less incremental electricity demand of only 17%. Spain and Germany produce results of 21-23%, closer to the UK figure.

Subjective assumptions but conclusion in right ballpark

As a sense check, National Grid has recently published a report suggesting that 50% penetration of EV vehicles would add roughly 30TWh of electricity demand, slightly less than our 41TWh estimate, but in the general ballpark. RWE has stated in a presentation that 2.5mn EVs (6% penetration) would consume about 4TWh which would be slightly less energy intensive than our estimate of c.7TWh. EDP has estimated that full EV penetration in Portugal would increase electricity demand by 35%.

15% CO2 reduction depending on fuel mix

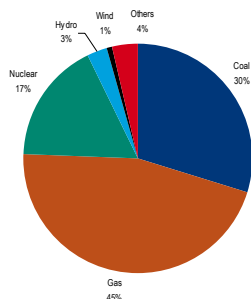
A conventional gasoline car emits roughly 200-400kg of CO2 per mile depending on the type of vehicle and its fuel efficiency. Based on some respective work by the US Department of Energy (DOE) and the Utility CEZ in the Czech Republic, we estimate that an electric vehicle would emit only 100g/mile of carbon depending on the electricity mix used to power the vehicle. Full EV penetration would therefore reduce transport emissions by around 60% at the mid point. Transport in turn is about 20-30% of a country's carbon emissions, so EVs could reduce total CO2 emissions by about 15% at the mid point. This is a meaningful contribution to the various national targets for greenhouse gas reduction.

The source of electricity for charging an EV will depend on the country (Germany for example has more coal in the mix) and the time of day (overnight will use more wind due to the weather). Our calculations were based on a mix similar to the UK, shown in Chart 1.

A flatter load curve

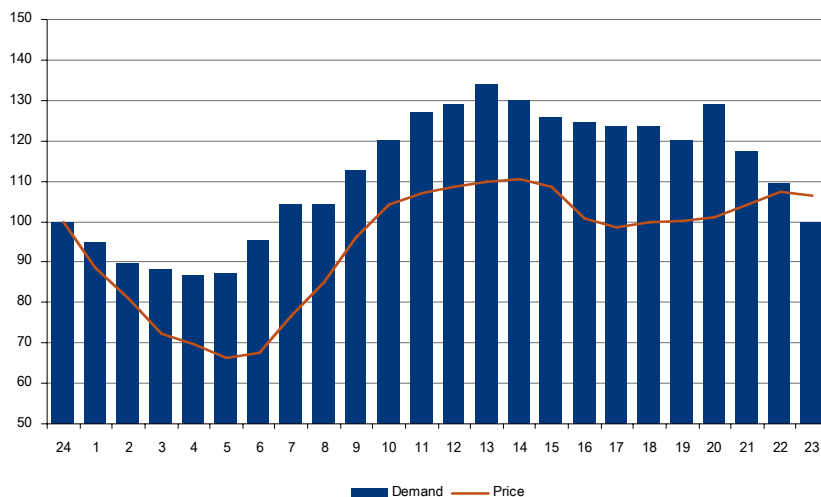
Power demand fluctuates during the course of the day, with sustained high demand between the midday working hours and low demand overnight while people are sleeping. The spread between peak (2pm) to trough (5am) demand was 42% on September 1st in Spain as illustrated in Chart 2. Power prices tend to follow the same intra day pattern as demand.

Chart 1: UK generation mix



Source: EuroStat

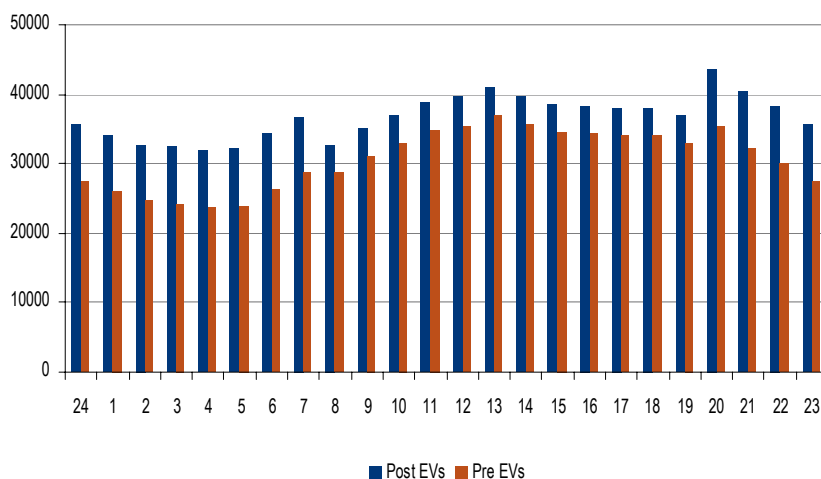
Chart 2: Spain energy demand (indexed) during Thursday 1st September 2011



Source: Red Electrica

We calculated in Table 5 that full EV penetration would add roughly 20% to daily power demand in Spain. If this extra demand was concentrated during the overnight hours when commuters arrive home from work, it would radically change the load curve. In Chart 3, we assume two thirds of EV electricity charging takes place overnight (8pm-7am) and one third during the day (8am-7pm). The peak to trough power demand in this scenario is only 32% compared to 44% previously. It is worth highlighting that the working day tends to finish later in Spain which is why there is a spike in demand at 8pm according to Red Electrica, compared to around 6pm in the UK according to National Grid.

Chart 3: Intra day energy demand (MWh) with and without EVs



Source: Red Electrica, BofA Merrill Lynch Global Research

Higher utilisation of peaking plants & baseload price

While full EV penetration is a long way off, from a utility perspective, this altered load curve would allow 'peaking' plants (typically gas) to be run for a longer period of time and generate extra revenue. Also, greater electricity demand from EVs could potentially raise power prices during the overnight hours which would be positive for the profitability of baseload power stations.

Little extra capacity needed to satisfy demand

With little extra power demand during existing midday peak hours, it is unlikely much extra generation capacity needs to be built, in our view. Reserve margins (a minimum of 10-15% but currently 20-30% due to weaker power demand from the recession) are already calculated relative to the peak point of demand (usually a day in January due to heating demand) which is unlikely to be materially surpassed by an overnight hour because of EVs in our opinion. Unfortunately, at this stage there is not enough user experience at this stage to really understand consumer behaviour.

Improved grid stability and less profitable pumped storage

EVs could have a small structural impact on reserve margins by using the cars as a network of batteries to store power in periods of weak demand and sell power back to the grid when demand is high (and prices are elevated in response). This would improve grid stability and maybe allow for a structurally lower level of reserve margin. We would also comment EVs could potentially reduce the value of existing storage capacity such as hydro pumped storage by compressing the spread between intra day power prices and the profitability of pumping overnight.

Push towards more dynamic residential pricing

To avoid stress on the network, utilities are likely to alter pricing structures in order to discourage charging during times when electricity demand is already high such as midday or the early evening. Most residential consumers (including prepay) in the UK pay a fixed rather than flexible tariff and in the long term this could structurally change because of EVs in our opinion. More sophisticated infrastructure will be required to communicate between the vehicle and the grid. E.ON already provides a home charging station that can be combined with a smart meter to minimise cost by charging the EV at cheaper times.

Unclear impact on maintenance capex

The impact on maintenance capex is not clear to us. Running the generation capacity harder could shorten its useful life in the absence of extra maintenance capex. On the other hand, by spending less time ramping up and cooling down capacity, more constant utilisation could actually put less strain on the capacity and reduce maintenance capex.

Utilities getting involved in charging networks

Utilities have begun to think about the impact EVs could have on electricity demand and their business models through changing consumption patterns. Table 6 details a number of pilot projects that European utilities are currently engaged in to help build out the necessary charging infrastructure.

Table 6: Examples of utility interest in electric vehicle infrastructure

Utility	Involvement
E.ON	In Aug 2011, E.ON opened a fast charging station on a Bavarian Autobahn. E.ON will charge a flat fee of €5 for up to 50kw. E.ON has done test projects with Volkswagen and Daimler and installed 100 charging stations around Munich as part of a pilot project.
RWE	RWE have partnered with Renault to establish 1000 charging stations across Germany and Daimler for 500 charge points in Berlin. RWE are also building 250 charging points in Amsterdam through its Essent subsidiary.
EDF	EDF, together with Vinci, Schneider and Nissan are aiming to build over 3,500 charging points in France in 2013. Boris Johnson, the Mayor of London, has announced an intention to increase the number of charging stations in the capital from 200 at present to 1,300 in time for the Olympics. These stations will use equipment from Siemens and electricity from EDF.
Vattenfall	BMW and Vattenfall have erected 50 charging stations in Berlin.
Nuon	The Dutch utility Nuon is helping to build 200 charging points in Amsterdam.
Enel	Enel has partnered with Daimler on an e-mobility project. In Spain, Telefonica, Endesa and Renault have converted 30 former telephone boxes into charging points.
Iberdrola	Has a Green Mobility program and has partnered with Mitsubishi to recommend each others services/products. Its UK arm, Scottish Power, has a public grant to develop 375 charging points in Scotland.
SSE	Has a trial with BMW for 40 vehicles in Oxford where SSE installed domestic charging points.

Table 6: Examples of utility interest in electric vehicle infrastructure

Utility	Involvement
Fortum	Small scale R&D trial in the city of Espoo, Finland and Stockholm to study charging patterns and payment methods and the suitability of taxis and public transport for electrification.
Verbund	Trial project between Vienna, Austria and Bratislava, Slovakia funded by public grants to link the two cities with charging infrastructure in 2013.
CEZ	Has a FutureMotion strategy to support electromobility in the Czech Republic.

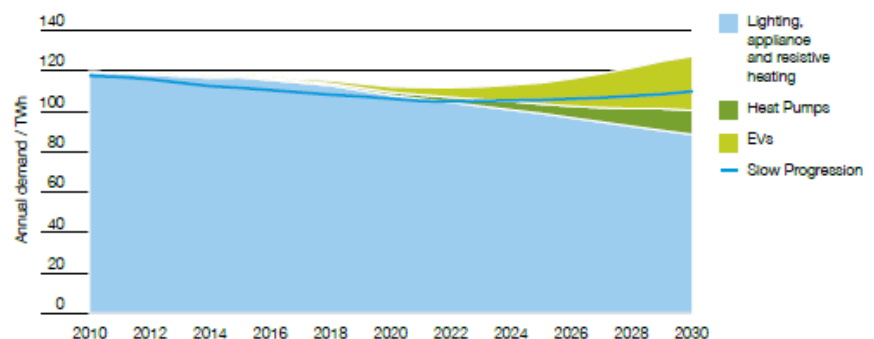
Source: Companies

EVs almost offset by energy efficiency measures

We estimated earlier that full EV penetration would lead to incremental electricity demand of 81TWh (or 25%) in the UK. National Grid has estimated that in 2030, the UK will consume roughly 30TWh less as a result of replacing incandescent bulbs with LEDs and upgrading appliances such as fridges and washing machines to higher efficiency standards. The EIA (Energy Information Administration) in the US has suggested that lighting accounts for 25% of electricity consumption. If LEDs are 50% more efficient, this would simplistically be a 12.5% saving on power demand.

Smart meters will also be rolled out across the Europe over the next decade. Based on the experience from pilot projects in the US, we believe that electricity consumption can fall an additional 10-15% due to changing behaviour when consumers are more aware of consumption/cost. The combination of lighting and smart meters could therefore roughly offset the impact of EVs on electricity demand in our opinion.

Chart 4: Energy efficiency almost offsets EVs



Source: National Grid

Payback period too long

While the Nissan Leaf is £8,500 more expensive to initially purchase than the Ford Focus, we estimate an average driver would save about £1,200 a year on fuel. This implies a payback period of about 7 years. This is not very compelling given the relatively short lifespan of a car, particularly a lithium battery with a finite number of charging cycles.

EV costs just £250 a year to charge

The cost of charging an EV will depend on a range of factors such as time of day (cheaper overnight when general electricity demand is lower) or whether the car is charged at home or at work (industrials tend to have lower electricity prices than residential due to volume discounts). We have assumed a cost of £15p/kwh in keeping with average retail prices quoted from energy.eu. We estimate that the cost of a driving 100 miles will be £2.57 (Centrica has published a figure of £2.00-2.50). Over the course of a year, we forecast an average driver of almost 10,000 miles would spend £248 on charging.

Versus almost £1500 for petrol

To put this into perspective, we understand that the 2012 Ford Focus model can get about 40 miles per gallon of petrol. This fuel efficiency is relatively high compared to most cars on the road but we think that a relatively new EV should be compared to a new gasoline vehicle. Petrol prices are broadly similar across Europe (see Table 8), except for being c.15% cheaper in Spain due to lower sales tax. Given current oil prices around \$100, a gallon of petrol costs about £6 in the UK. We therefore calculate that the cost of driving 100 miles in a conventional car is about £15. This implies that a car owner would spend £1,444 per year on petrol depending on the engine and fuel efficiency of the vehicle.

Total cost of ownership - a close call (but subjective)

We think EV penetration will be ultimately driven by the economic benefits of ownership. We believe the cost savings must be substantial in order to compensate for the inconvenience and practicalities of a limited charging range. There are some key assumptions that go into calculating total cost of ownership, especially depreciation schedules and we stress that these are very subjective. Based on the various assumptions we have made, we calculate the cost per mile of an EV (based on the Nissan Leaf) is £64p or after a £5,000 government subsidy is considered this falls to £57p. We benchmark this against the 2012 Ford Focus and calculate a cost of £60p.

Table 7: Total cost of ownership

	2012 Nissan Leaf	Leaf ex UK subsidy	2012 Ford Focus
Company quoted OTR price	£25,990	£30,990	£22,500
Depreciation cost	£3,713	£4,427	£3,214
Taxes and Fees	£0	£0	£150
Road tax	£0	£0	£150
Fuel costs	£248	£248	£1,444
Fuel cost per 100 miles	£2.57	£2.57	£15.00
Maintenance	£1,500	£1,500	£1,000
Insurance	£1,000	£1,000	£500
Maintenance	£500	£500	£500
Annual Total cost of ownership	£5,460	£6,175	£5,808
Cost per mile	£0.57	£0.64	£0.60

Source: BofA Merrill Lynch Global Research

- We assume a 7 year depreciation life. While a vehicle may last longer, cars traditionally lose value at an accelerated rate in the earliest years. As a rough rule of thumb, our Auto team suggest a car loses over 50% of its value in the first 3 years. After 7 years we assume the annual maintenance expense climbs to a level where the vehicle could be uneconomic to keep on the road. For an EV, the life of the vehicle is related to how many charging cycles the battery can manage. 2,000 charging cycles would last for 8 years assuming the vehicle was just used for the c.250 annual work days. However, the lithium battery's ability to retain the charge may start deteriorating sooner. Tesla has stated a performance expectation of at least 150k miles before notable deterioration is apparent. Renault is evaluating a leasing model whereby the company retains ownership of the battery so that drivers do not bear the risk of performance deteriorating and the battery can be swapped should the technology be superseded.
- Governments offer a variety of incentives and subsidies to encourage EV adoption. For example, the UK government offers £5,000, no road tax (c.£150) and exemption from the London congestion zone charge (up to

£2,500 a year). The US government offers a federal rebate of \$7,500, although it is worth remembering that gasoline is much cheaper in the US. France offers €5,000 and Spain offers €6,000 off the sticker price. Germany and Italy only give a road tax exemption worth about €125.

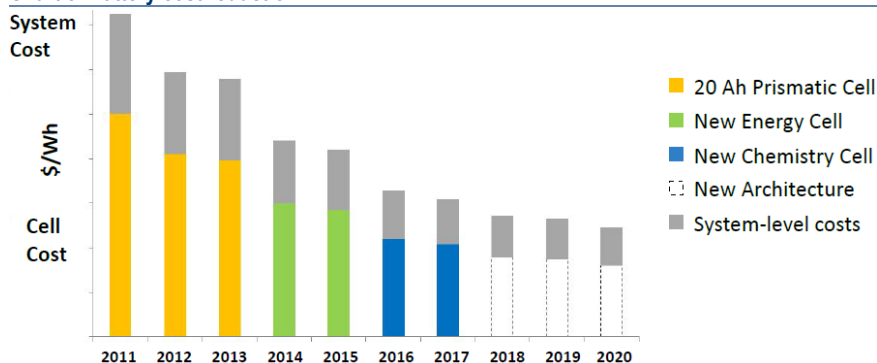
- Insurance can vary widely depending on the characteristics of the driver and value of the vehicle. Based on some quotes, we have assumed the annual cost of insuring a conventional new car is about £500 while the cost of an EV would be about £800-1000. EVs will be more expensive because of the shorter track record for insurance providers to understand vehicle performance and durability (as well as the higher upfront vehicle cost).
- Maintenance is very difficult to forecast given the range of possible problems a car could face. We have read that EVs could be cheaper to maintain given fewer mechanical parts, but these are replaced with electronics that are not necessarily more reliable. Some car dealers have expressed concern that the very profitable service business could be hurt by a move towards EVs. Due to the high degree of uncertainty, we have simply assumed the same annual maintenance cost of £500 on both EVs and conventional vehicle. Our estimate was based on data from the AA roadside assistance provider stating that UK motorists spend an average of £463 each year.

How EVs could be more economically competitive

If battery costs come down

The battery accounts for about £8,000 of the £31,000 Leaf retail price and is therefore a critical part of the cost reduction possibility. Electric battery technology is still at an early stage of development and faces a potentially very steep curve for cost reduction, in our view.

Chart 5: Battery cost reduction



Source: A123

Battery manufacturer A123 has targeted a 40% reduction in production cost by 2015 and 60% by 2020 (see Chart 5). We would caution however that A123 has lost 90% of its market cap over the last two years as key OEM customers have scaled back their electrification plans.

If batteries were to become more efficient (i.e. more km per kwh) then our estimate of 25% more power demand in the UK would be an overstatement. A number of companies are exploring different chemistries and materials which could increase the density of the battery. More advanced software could also help to optimise the battery range.

Public perception over the reliability of EVs will be crucial for facilitating higher penetration. General Motors has experienced a recent set back due to safety fears around the battery of its Chevy Volt battery catching fire. Lithium ion is the same material as used in notebook batteries and has a reputation for overheating.

If you drive further

Driving more miles would reduce the cost of both the EV and the conventional car because it gives a greater base to depreciate the initial vehicle cost. We calculate that at 15,000 miles a year (rather than 9,628), the cost of an unsubsidized EV would fall to £42p (from £62p) a year and the cost of the Focus would fall to £44p (from £60p). While this makes the EV more competitive on paper, the pure economics do not reflect the range anxiety of charging which is likely to be heightened, the more the vehicle is used.

If petrol gets more expensive

If petrol prices in the UK were to increase from £6 to £7 a gallon, this would only increase the cost of a conventional vehicle from £60p to £63p per mile. It is worth considering that a higher oil price could also push up the cost of charging an EV given many gas supply contracts are linked to the price of oil. However, as EV demand rises, demand for oil is likely to fall which would in turn make petrol cheaper.

If regulation gets more demanding

The recently proposed CAFÉ standards will require average fuel efficiency across a car manufacturer's whole fleet in the US to rise from 27 miles a gallon in 2010 to 35.5 mps in 2016, 40.1 mpg in 2021 and 49.6mpg in 2025. Car manufacturers could meet this standard with more efficient gasoline vehicles (although this would likely add more cost), or try and have a higher proportion of EVs in the mix to offset inefficient SUVs. The Leaf is rated at 342mpg.

European country comparison

Table 8 summarises some of the key inputs for calculating the economic attractiveness of EVs in the main European markets. The UK, France and Spain offer large upfront subsidies for EVs while Germany and Italy offer only a small subsidy in the form of lower road taxes.

Petrol prices (as of Dec) are similar across Europe with the exception of Spain which appears to benefit from lower taxes. Electricity prices (as of June) vary widely due to different technology mixes and VAT rates. Germany has the highest power prices due to more expensive renewables while France has the lowest prices due to a large contribution from relatively cheap nuclear power.

Table 8: Key data for European countries

	UK	France	Germany	Italy	Spain
Unleaded petrol price per litre (in €)	1.618	1.588	1.546	1.578	1.300
Diesel price per litre (in €)	1.688	1.444	1.432	1.518	1.324
Unleaded petrol price per Gallon (in €)	6.12	6.01	5.85	5.97	4.92
Diesel price per Gallon (in €)	6.39	5.47	5.42	5.75	5.01
Retail electricity prices (€ per kWh)					
Consumption: 3,500 kWh/year	0.1587	0.1396	0.2671	0.2041	0.2013
Consumption: 7,500 kWh/year	0.1432	0.1254	0.2511	0.2568	0.1839

Table 8: Key data for European countries

	UK	France	Germany	Italy	Spain
Subsidies/Grants for Electric vehicles	The Plug-in Car Grant started on 1 January 2011. The program reduces the up-front cost of eligible cars by providing a 25% grant towards the cost of new plug-in cars capped at £5,000	A premium is granted in France up to €5,000 for the purchase of new cars with CO2 emissions of 60 gr/km. Vehicles emitting up to 125 gr/km or less, such as hybrids and natural gas vehicles, are granted up to €2,000. The incentive cannot exceed 20% of the sales price including VAT. The incentive is available for purchases through 2012	Electric vehicles and plug-ins are exempt from the annual circulation tax for a period of five years from the date of their first registration. In May 2010 the German government announced that it will not provide subsidies to the sales of electric cars but instead it will only fund research in the area of electric mobility	Electric vehicles are exempt from the annual circulation tax or ownership tax for five years from the date of their first registration. Thereafter, EVs benefit from a 75% reduction of the tax rate applied to equivalent gasoline-powered vehicles	The incentives include direct subsidies for the acquisition of new electric cars for up to 25% of the purchase price, before tax, to a maximum of €6,000 per vehicle

Source: Energy.eu, BofA Merrill Lynch Global Research

Penetration forecast

Increasing the penetration of electric vehicles will be driven by improved relative economics and technical advances which increase the battery range. Sufficient charging infrastructure will also be crucial, although whether this leads or follows consumer adoption is a different matter.

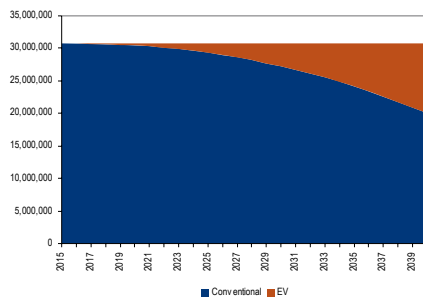
As a very rough guess, based on a collection of respective industry forecasts, we would suggest pure EV penetration of the total car park in the UK may reach 1% in 2020, 15% in 2030 and 40% in 2040.

Auto industry experts JD Power, believe that 2% of all the cars sold globally in 2011 will be a hybrid or pure EV. They forecast this proportion could rise to 7% in 2020. To put this into perspective, the hybrid Prius already accounts for 10% of Toyota's sales in the US and Toyota believe hybrids will account for 20-30% of its global sales in 2020.

The CEO of Nissan/Renault Carlos Ghosn, has been one of the most outspoken supporters of EVs and believes 10% of cars sold globally in 2020 could be pure electric. We understand Nissan are currently sold out of the Leaf due to high demand and capacity constraints with its JV battery supplier, NEC. There is apparently a two year waiting list in the UK for the Leaf.

By 2020, Ford believes that 15-25% of its annual sales will hybrids/EVs. The CEO of General Motors has described the electric vehicle as "our industry's moon shot". Our US team expect Tesla to sell over 20,000 units in 2013, although this would only be 0.2% of US total car sales. The company currently has pre orders for 6,500 units ahead of a late 2012 launch.

Chart 6: Mix of UK car park



Source: BofA Merrill Lynch Global Research

Appendix - Product pipeline

Table 9: Car comparison

	Nissan Leaf	Renault ZOE	Chevrolet Volt	Tesla S	BMW i3
Price pre grants (£)	31,000	18,000	33,500	37,000	Not announced
Release (Year)	2010	2012E	2011	2013E	2013E
Battery (KWh)	24	59	16	42	22
Electric Range (Miles)	109	100	35	160	80-100
Top Speed (mph)	90	84	100	130	93

Source: Companies, BofA Merrill Lynch Global Research

Chart 7: Nissan Leaf



Source: Nissan

Chart 8: Renault ZOE



Source: Renault

Chart 9: Chevy Volt



Source: Chevrolet

Chart 10: Tesla S



Source: Tesla

Chart 11: BMW i3



Source: BMW

Link to Definitions

Energy

Click [here](#) for definitions of commonly used terms.

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