Q-Series®

Global Utilities, Autos & Chemicals

Will solar, batteries and electric cars re-shape the electricity system?

Equities

Global
Utilities

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Batteries and solar at the tipping point: Electricity users will become generators
Solar systems and batteries will be disruptive technologies for the electricity system. Steeply declining battery and solar system costs will enable multiple new applications. In this note, we focus on the impact on the utilities and auto sectors. Our proprietary model suggests a payback time as low as 6-8 years for a combined EV + solar + battery investment by 2020 – unsubsidised. We see Europe, and in particular Germany, Italy and Spain, leading this paradigm shift due to high fuel and retail electricity prices.

EVs entering the mass market, battery demand could grow exponentially
We forecast a c10% EV and plug-in hybrid penetration in Europe by 2025. While the initial growth should predominantly be driven by incentives and carbon regulation, the entry into the mass market should happen because EVs will pay off. The expected rapid decline in battery cost by >50% by 2020 should not just spur EV sales, but also lead to exponential growth in demand for stationary batteries to store excess power. This is relevant for an electricity mix with a much higher share of (volatile) renewables.

Opportunities for utilities: Customers, smart grid and decentralised backup
In this decentralised electricity world, the key utilities' assets will be smart distribution networks, end customer relationships and small-scale backup units. Utilities should be able to extract more value in (highly competitive) supply activities, as customer needs will be more complex. Large-scale power generation, however, will be the dinosaur of the future energy system: Too big, too inflexible, not even relevant for backup power in the long run. Overall, sector EPS could grow 13% by 2025 on capex and higher-margin supply businesses, but differences between the companies should be large.

Stock conclusions: Best and worst positioned players
In utilities, retail- and distribution-heavy companies with strong balance sheets should emerge as structural winners while generators are likely to be losers. We highlight Enel and Iberdrola as main beneficiaries and Verbund and Fortum as potentially most negatively affected. In autos, BMW and Valeo are our top picks. In Chemicals, we favour Umicore for Cathodes, Hitachi Chemical for anodes.

Figure 1: UBS top picks

Utilities	Auto	Chemicals	Industrials
Enel (Buy, €5.15 PT)	BMW (Buy, €105 PT)	Umicore (Buy, €40 PT)	Siemens (Buy, €105 PT)
Iberdrola (Buy, €6 PT)	Valeo (Buy, €130 PT)	Hitachi Chemical (Buy, JPY2200 PT)	Infineon (Buy, €9.5 PT)
Edison International (Buy, USD60 PT)			NARI Technology (Buy, CNY18 PT)

Source: UBSe

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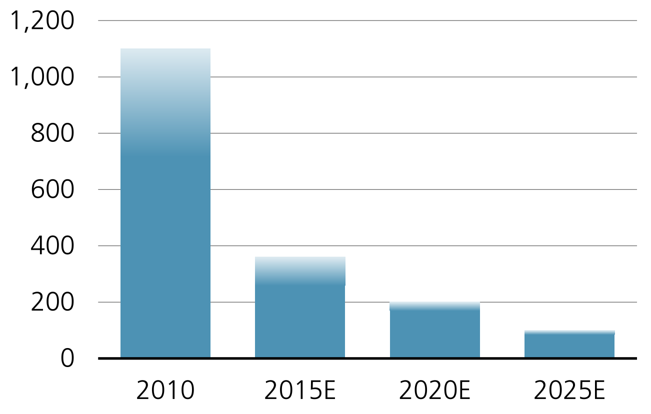
We would like to thank Lukasz Warchol and Chervine Golbaz for their contribution to this report.

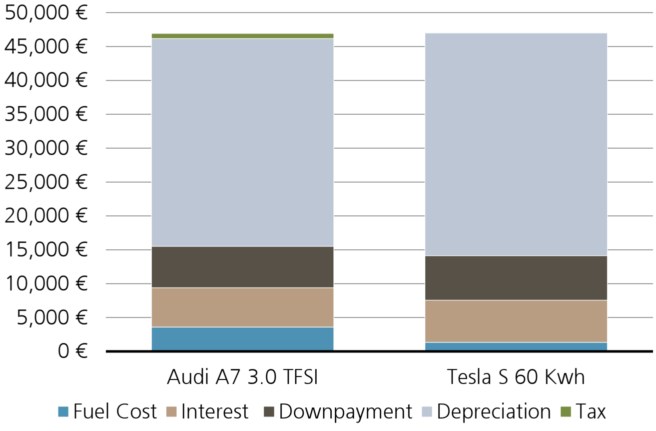
The report in key pictures

Figure 2: Lithium battery cost to decline >50% by 2020



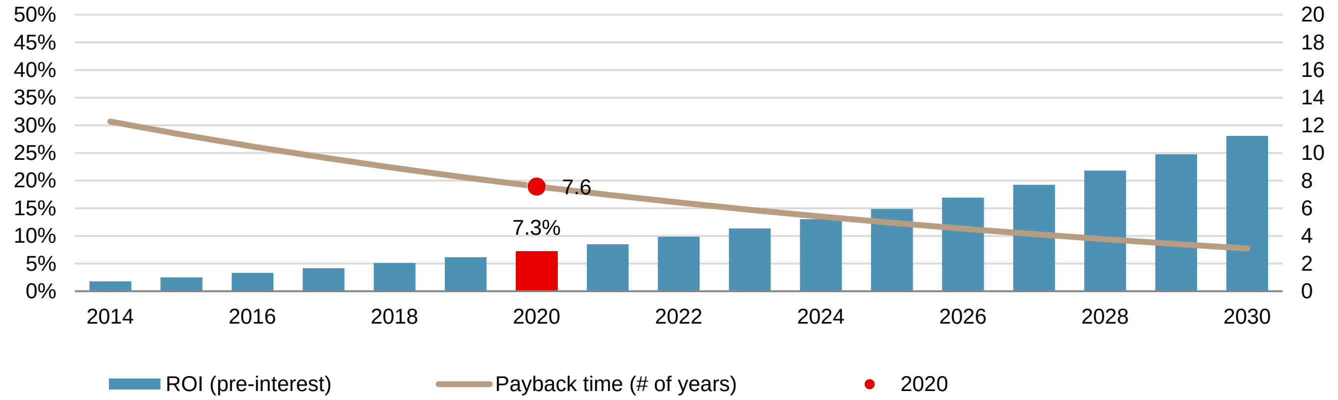
Source: Tesla, Umicore, UBSe. Cost estimates are for the battery pack (€/kWh).

Figure 3: EVs already on parity with conventional cars



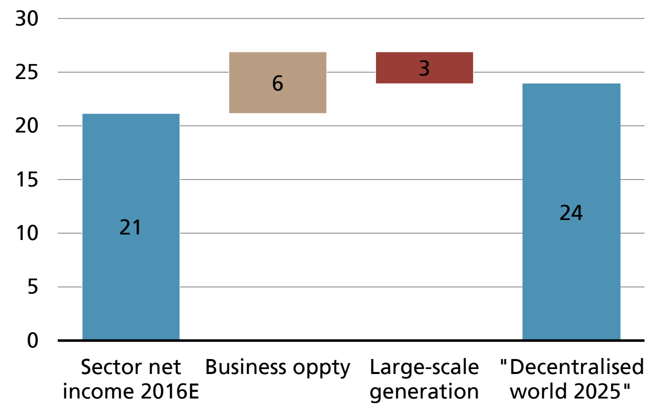
Source: UBSe, on German fuel/electricity cost, 3-year total cost of ownership

Figure 4: Solar + battery + EV already pay off in certain countries, but economics should further improve dramatically



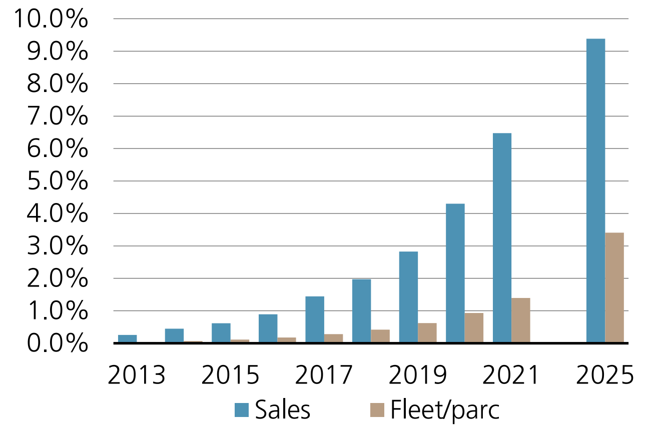
Source: UBSe. Note: Chart shows economics in Germany.

Figure 5: A €3bn net income opportunity for EU utilities



Source: UBSe

Figure 6: EVs accelerating to c10% EU market share



Source: UBSe (estimates for European market)

Why read this report?

Solar and batteries will be disruptive technologies

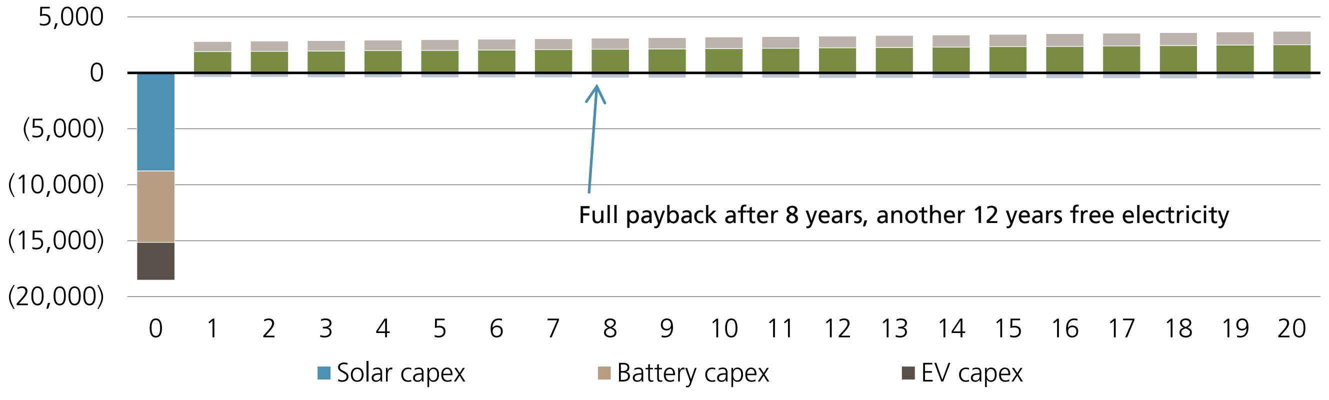
Solar panels and batteries will be disruptive technologies. Solar is at the edge of being a competitive power generation technology. The biggest drawback has been its intermittency. This is where batteries and electric vehicles (EVs) come into play. Battery costs have declined rapidly, and we expect a further decline of >50% by 2020. By then, a mass segment EV will have almost the same sticker price as a combustion engine car. But it will save up to €2,000 per year on fuel cost, hence, it will begin to pay off almost immediately without any meaningful upfront "investment". This is why we expect a rapidly growing penetration with EVs, in particular in countries with high fossil fuel prices. Thanks to EV-driven economies of scale, we also expect the cost of stationary batteries to drop c50% by 2020. Based on our proprietary analysis, battery storage should become financially attractive for family homes when combined with a solar system (and an EV). As a consequence, we expect transformational changes in the utility and auto sectors, which we discuss in this report.

Without subsidies, the purchase of a solar system, electric car and stationary battery will pay off

Key controversial debates

- **Can solar ever be economically viable without subsidies due to its intermittent character? Our answer: YES.** The market is not yet looking at the topics of solar, EVs and stationary batteries with a holistic view. Our proprietary model shows it is the combination of the three that makes solar fully competitive and that has the potential to bring disruptive changes to the electricity sector. Here are the maths: One can leverage the EV purchase with an investment in a solar system and a stationary battery. By doing so, one can optimise the self-consumption of solar power and minimise the "excess waste" of solar electricity. And what also may matter to many EV buyers: The electricity used to drive the car is carbon-free. The combination of and EV + solar + battery should have a payback of 7-11 years, depending on the country-specific economics. In other words, based on a 20-year technical life of a solar system, a German buyer should receive 12 years of electricity for free (purchase in 2020).

Figure 7: Solar system + electric vehicle + stationary battery = 12 years of electricity for free (annual cash flows, €)

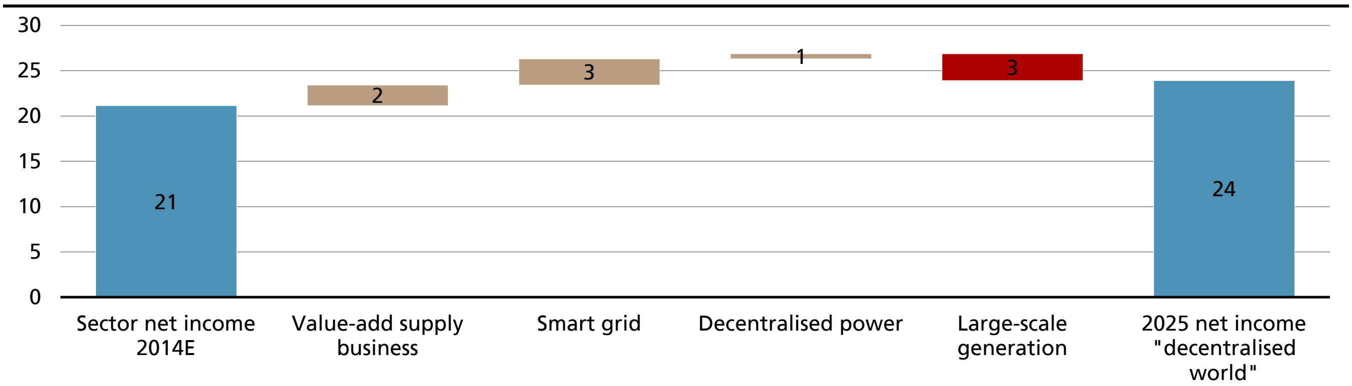


Source: UBSe

Note: Capex estimates for 2020E. Graph shows free cash flow excluding taxes (residential system) and on a project basis (before leveraging, before cost of capital). We assume that the EV after its life cycle can be replaced at zero extra cost compared to a combustion engine car. Based on German retail prices and fuel cost.

- **Will EVs and plug-in hybrids ever be cost-competitive in the mass market? Our answer: YES, especially in the case of pure battery EVs.** Already today, from the perspective of the consumer, the 3-year total cost of ownership (TCO) of a Tesla S model is similar to that of a comparable petrol combustion engine car such as an Audi A7, especially in markets with high fuel prices like Germany – a country where purchase incentives are almost non-existent. We think that by 2020, shrinking battery and solar cost will make EVs in the mass segments the cheaper alternative over a car life cycle in most European markets. While on a global basis, EV sales for the remainder of the decade should be mostly carbon/fuel standards and related incentives, we think penetration rates will accelerate significantly after 2020 driven by compelling economics. As a conservative 2025 scenario, we think c10% of new car registrations in Europe will be EVs.
- **If EVs and solar are that disruptive, is it a threat or an opportunity for utilities? Our answer: IT IS A NET OPPORTUNITY.** On the one hand, there will be an accelerated paradigm shift away from large-scale conventional power plants. Even a blue-sky 20% EV / plug-in hybrid penetration would only add 5% to power demand, which will be more than offset by energy efficiency in other areas. On the other hand, the trends offer vast opportunities for utilities in smart grids, value-add services in end customer supply and decentralised backup power generation. These positive drivers should more than offset the gradual extinction of large-scale power plants, even though we expect intense competition for end customers, also from non-utility industries. The impact on company level varies a lot depending on the positioning in the value chain.

Figure 8: The new decentralised electricity system is a 13% EPS opportunity for European Utilities (€bn, 2025 scenario)



Source: UBSe

Impact on utilities

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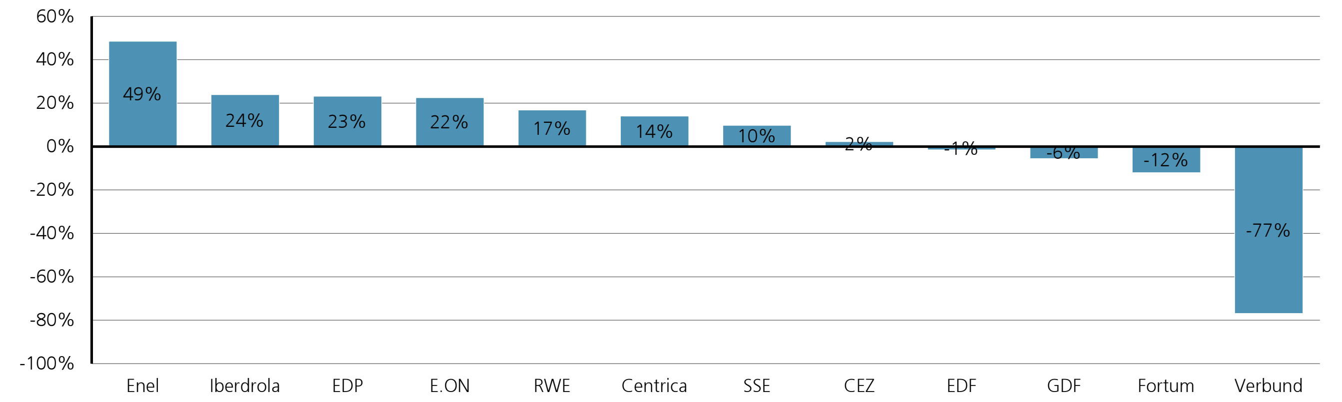
The closer utilities are to the end customers, the better they should be able to benefit from the transformational changes. The number of end customers and the size of the distribution grid are key metrics to look at. On the other hand, we think the generation-heavy utilities will be relative losers, as large-scale power stations will hardly fit into the new, de-centralised electricity world. Europe should be the fastest-moving region. Outside Europe, we think the US (south-west) and Australia could be amongst the early movers. Other regions, such as Asia and LatAm, should follow the trend in Europe with a substantial time lag due to worse EV/solar economics and structurally rising power demand, which will have to be met with new large-scale power plants.

Key beneficiaries: ENEL (Buy, PT €5.15) and IBERDROLA (Buy, PT €6.00) enjoy large customer bases and are owners of large distribution networks assets. Also, both companies will have a solid balance sheet to support the required infrastructure capex. Finally, profitability of their conventional generation assets in Europe is already subdued, which implies only moderate remaining downside risk to earnings in this business.

Potentially affected: FORTUM (Sell, PT €12.70) and VERBUND (Neutral, PT €14.70) are both generation-heavy utilities, with a relatively small position in distribution networks and clients. Baseload power plants (nuclear/hydro) generate the bulk of earnings, and we see structural downside risk to earnings on lower-for-longer power prices. Only a new remuneration model would improve the outlook. We acknowledge that in particular Fortum intends to accelerate investments in decentralised generation, but the opportunity seems relatively small compared to the downside risk in hydro/nuclear generation.

Figure 9: EU Utilities EPS up/downside risk related to solar/EV/battery theme (2025E vs. 2016E)



Source: UBSe

Impact on auto sector

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Most OEMs (Toyota and Tesla excepted) are still developing electric powertrains reluctantly. Developing new powertrain as partial substitutes to Internal Combustion Engines (ICE) should be a negative sum game for several years as OEMs face higher development budgets and lower product margins with few incremental sales if any as demand should be largely driven by regulation and CO2 compliance. Later on we think True cost parity with ICE from a buyer's perspective will spur replacement demand especially as consumers see added benefit from self-generation of electricity as an additional cost reduction. This should lead to further economies of scale for OEMs, particularly in battery costs, and make EVs profitable for OEMs. Lower repair costs should undermine the profitability of after-market. The first phase of EV growth should disproportionately benefit component suppliers, in our view, with new electronic content for power management as well new materials to optimize weight, for example. As EVs grow faster than the industry, some suppliers may also, like OEMs, suffer from the weight of legacy assets in ICEs.

BMW (Buy, PT €105)

Whilst this is not new, BMW has again demonstrated superior strategic thinking and a solid sense of timing in developing a separate brand for electric vehicles, and the strong start to the "i" brand without production glitch should keep BMW at the forefront of electrification. Based on our analysis, it appears that consumers already benefit from cost parity or better in some countries. Interestingly, we calculate near-parity for the i3 and the X1 in Germany, where purchase incentives are limited to an exemption of an annual road tax, and in the UK, where purchase incentives are fairly generous (£5,000).

BMW's operating performance continues to impress by delivering margins well within the guided 8-10% range and 2013 seemingly the trough of the earnings cycle. We are concerned about the risk of fragmentation in Premium auto segments undermining returns but we believe that BMW is in a better position than other "incumbents" to navigate a changing Premium market. We expect BMW's re-investment cycle will peak earlier than at peers. We also note that financial services leverage has now been reduced to a level where finco claims on cash should moderate and leave improved scope for dividends.

Valeo (Buy, Key Call, PT €130)

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The first phase of EV growth will disproportionately benefit component suppliers, in our view, with new electronic content for power management as well as new materials to optimize weight, for example. As EVs grow faster than the industry, some suppliers may also, like OEMs, suffer from the weight of legacy assets in ICEs. Valeo screens well as it offers solutions to improve ICE efficiency (stop-start, air intake module, double clutch transmission, electric turbocharger) as well as solutions for electrification (charger-inverters, hybrid4all, battery management, power electronics and range extender).

Valeo should continue to offer best-in-class organic growth (10%), margin expansion potential and scope for higher cash generation (capex reaching a peak this year). Order intake should reach €16-17bn this year (vs c€15bn over the past 2 years) with China currently running at 4x H114 OE sales. Our upside case, based on the order intake fully translating into sales, assumes Valeo can generate an underlying EPS of c€12 in '16 (implied PE of 7.7x), or almost 40% annual growth.

Beneficiaries in Chemicals

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Umicore (Buy, PT €40) is a long-term play on the substitution potential of metal chemistry in future mass market applications. The company has 3 core business areas, which are Recycling (66% of EBIT), Energy and Battery Materials (8%), Performance Materials – Zinc plating (18%) and Catalysis (24%), and overheads of -16%. Umicore has the most advanced cathode technologies for lithium ion batteries with exclusive usage in most high value electronics applications, and has the lowest cost per kWh solution available to the market for automotive. Umicore is also the only metals "recycler of last resort" for metal residues from electronic scrap recyclers, spent process and automotive catalysts containing high levels of platinum group metals, jewellery industry scrap and residues and complex residues from precious metals miners globally. We see EBIT growing by 75% over the next 5 years driven by a 40% capacity increase in recycling which has already committed volume from the market, ramp up of production of electric and hybrid vehicles and Umicore's recent entry into the truck heavy duty diesel catalyst market. Stock trades on 17x 2014 P/E for a 5 year EPS CAGR of 13% versus the other key technology game changer stock Novozymes, which trades on 31x 2015E PE for 8% earnings CAGR.

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Hitachi Chemical (Buy, PT ¥2,200) enjoys the largest share of the global market for lithium-ion battery anode materials. Regarding car-mounted products, the company is developing natural graphite anode materials for electric vehicles and amorphous carbon anode materials with excellent input characteristics for hybrid electric vehicles. Expansion has primarily come from use in lithium-ion batteries mounted in Nissan Motor's Leaf model. Meanwhile, products for use in consumer electronics lithium-ion batteries recently seem to be enjoying volume growth from some customers after profitability had slackened due to previous intensification of competition. In our view, this could stem from demand for '18650' cells by Tesla, which mounts large volumes of these compact, consumer-electronics batteries. We believe this could be a driver going forward. Making Shin-Kobe Electric Machinery a wholly-owned subsidiary in FY12 meant that Hitachi Chemical now has a wide-ranging line-up of electrical storage devices, including lead batteries, lithium-ion batteries, and various types of capacitors. In the autos-use area, management aims to increase sales of products such as lead batteries for 'Idle Stop' systems and also plans to combine various power storage devices to offer industrial systems for reducing power consumption in peak demand times and for levelling out power use.

Impact on European industrials

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Decentralised generation, electric vehicles and storage offer attractive opportunities and some challenges for Siemens, ABB and Schneider Electric, in our view. Simply speaking, moving the location of the power generation from location A to location B requires investment in infrastructure to distribute and control the energy flow. As suppliers of transmission and/or distribution equipment and software this is positive for Siemens, ABB and Schneider, in our view. In addition, decentralised power generation by renewable sources such as solar power increases the need for software and hardware to control and optimise demand/supply, again benefitting the three companies.

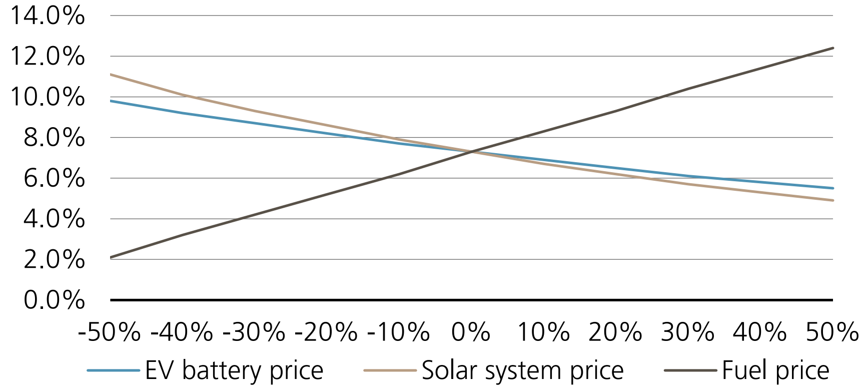
The smart grid is to a great extent about information management. You gather live data on the ebbs and flows of electricity in the grid and use software to optimise the allocation of the energy in the system. With the smart grid, decentralised generation, mobile consumers, prosumers and renewables, supply and demand data that has historically been captive to the traditional power-generating utilities and grid operators will be made available to third parties, such as the equipment suppliers. This opens up for the creation of, for example, virtual power plants where a solution of equipment and software from, say, Siemens can match buyers and sellers of electricity. Managing the vast amount of data that will flow through the smart grid will be a challenge that requires significant investment. As mentioned earlier in this document, our colleagues in the utility team believe the European smart grid is a EUR 290bn capex opportunity. There is little doubt in our mind that Siemens, ABB and Schneider Electric will look to capture a significant proportion of that revenue opportunity.

Our top pick is **Siemens (Buy, PT €105).** At current price levels we find the stock attractively priced relative to its peers. The stock should re-rate as the company de-risks Transmission and launches the next round of cost cutting efforts in 1H15. The re-rating should be boosted further by a future part or full disposal/spin-off of the healthcare assets as well as other smaller parts of the portfolio. A potential catalyst for the stock will be the Capital Markets Day "Vision 2020" in Berlin the 9th of December. Our PT is based on EV/EBIT and PE multiples (2015e). At our PT the stock would trade on 10.5x calendar 2015e normalised EBITA, in line with sector mid-cycle multiple. Siemens generates 16% of group revenues in the power networks business. Siemens claims a number 1 position in the market for grid automation and a number 2 position in the market for rail electrification and smart grid services.

UBS proprietary model is available on UBS Neo

The cost of batteries and solar systems (panels, inverters) are the main drivers of economics. In our main scenario, we assume an 8% p.a. decline in EV battery costs and a 4% p.a. decline in solar system costs. On this basis, a combined investment in a solar system, stationary battery and EV would have a 7.3% ROI (before interest) in 2020 (vs. 1.8% today). Another key swing factor is the price of fossil fuels, which we assume to increase 1.5% p.a. The following figure illustrates these key sensitivities, on a ceteris paribus basis.

Figure 10: ROI sensitivities to solar system / battery prices and fuel cost (2020E)



Source: UBSe

We also provide our interactive proprietary model to our clients, in which all the key assumptions can be modified. It also offers the market-specific input data for the main European countries (solar irradiation, fuel and electricity prices). It is available under the following UBS Neo link:

https://neo.ubs.com/shared/d1fXWW5AKk6

Other reports on the topic

UBS has been highlighting the structural changes in the electricity sector for more than two years. A selection of the reports, which provide further detail to the topics covered in this report, are summarised in the table below.

Figure 11: Selection of UBS reports related to the topic

Title		Date
Utilities:	Expect a smart grid boom: c15% sector EPS uplift	22-Apr-14
Utilities:	Q Series ® Can utilities survive in their current form?	15-Nov-13
Utilities:	Will biz models split sector performance?	30-Aug-13
Utilities:	The unsubsidised solar revolution	15-Jan-13
Utilities:	Power demand has peaked, -10% to 2020	08-Nov-12
Utilities:	Renewables to wipe out 50% of profits	19-Jul-12
Utilities:	We love a sunburnt country	07-May-14
Autos:	Optimistic on EV costs	02-Jul-14
Autos:	Q Series ® Premium segments getting crowded	23-Jun-14
Chemicals:	Q Series ® Is grid parity around the corner?	10-Jun-14
Chemicals:	Electric Vehicle Batteries – Sowing the seeds of an energy revolution	14-Jul-14
Chemicals:	Tesla Motors Initiation – Disruptive Model, But Already Fully Charged	26-Mar-14
Chemicals:	Umicore – Get out of my dreams get into my car	15-Jan-14
Chemicals:	Q Series ® Lithium Ion Battery slowdown temporary?	07-Dec-12
Chemicals:	Umicore – In the vehicle electrification driving seat	01-Jun-12
Chemicals:	Q Series ® Winners in Lithium Ion Battery materials?	13-Oct-11

Source: UBS

Figure 12: Key stocks

	Rating	Currency	Share price	Price target	Upside	PE 2015E	EPS CAGR 2014-18E	EV/EBITDA 2015E	DY 2014E
Utilities									
Enel	Buy	EUR	3.89	5.15	32%	11.2	6.3%	6.0	3.4%
Iberdrola	Buy	EUR	5.44	6.00	10%	15.1	4.5%	8.1	5.0%
Edison International	Buy	USD	58.42	60.00	3%	16.4	2.9%	7.0	2.6%
Auto									
BMW	Buy	EUR	88.98	105.00	18%	9.3	-0.5%	3.2	3.5%
Valeo	Buy	EUR	92.09	130.00	41%	11.3	10.1%	5.5	2.6%
Chemicals									
Umicore	Buy	EUR	36.55	40.00	9%	17.2	19.5%	9.0	2.7%
Hitachi Chemical	Buy	JPY	1,826	2,200	20%	16.9	10.9%	6.4	2.3%
Industrials									
Siemens	Buy	EUR	92.79	105.00	13%	11.7	8.2%	6.6	3.6%
Infineon	Buy	EUR	8.72	9.50	9%	14.5	10.7%	6.0	2.1%
NARI Technology	Buy	CNY	15	18	23%	13.9	24.0%	11.2	0.7%

Source: UBSe

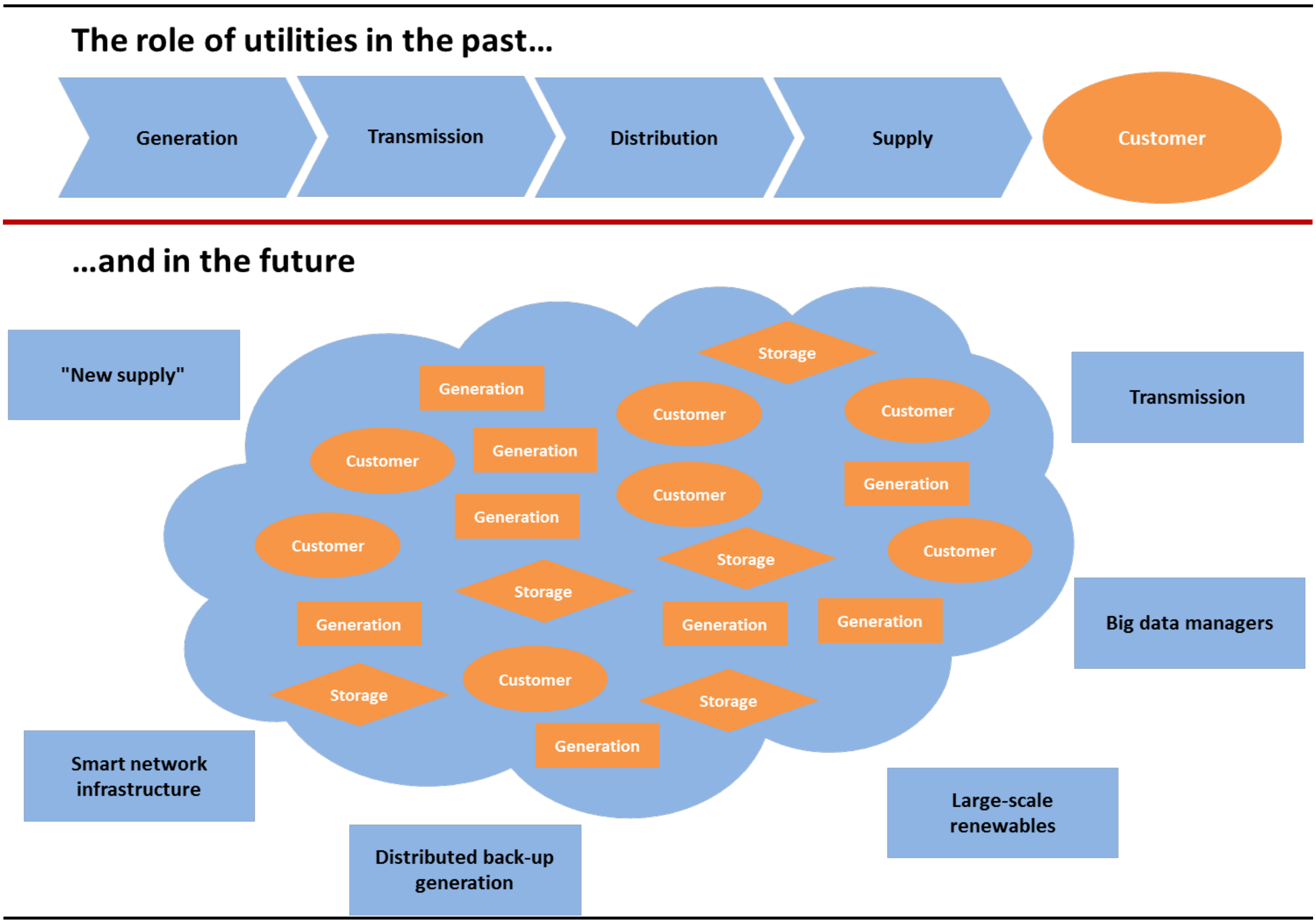
How solar, batteries and electric cars will re-shape the electricity system

Time to re-think the electricity value chain

Millions of customers turn into power generators – utilities help to 'make it happen'

Our view is that the 'we have done it like this for a century' value chain in developed electricity markets will be turned upside down within the next 10-20 years, driven by solar and batteries. As a virtuous circle, lower battery cost will also spur EV sales, which should bring further economies of scale to batteries, also for stationary applications. Power is no longer something that is exclusively produced by huge, centralised units owned by large utilities. By 2025, everybody will be able to produce and store power. And it will be green and cost competitive, ie, not more expensive or even cheaper than buying power from utilities. It is also the most efficient way to produce power where it is consumed, because transmission losses will be minimised. Power will no longer be something that is consumed in a 'dumb' way. Homes and grids will be smart, aligning the demand profile with supply from (volatile) renewables. Utilities will be helping the millions of generators and users to 'make it happen' and provide the suitable infrastructure, even though in a highly competitive environment. In this report, we discuss the technologies behind this trend and the opportunities and threats for utilities related to it.

Figure 13: Utilities will be the facilitators of a decentralised electricity system

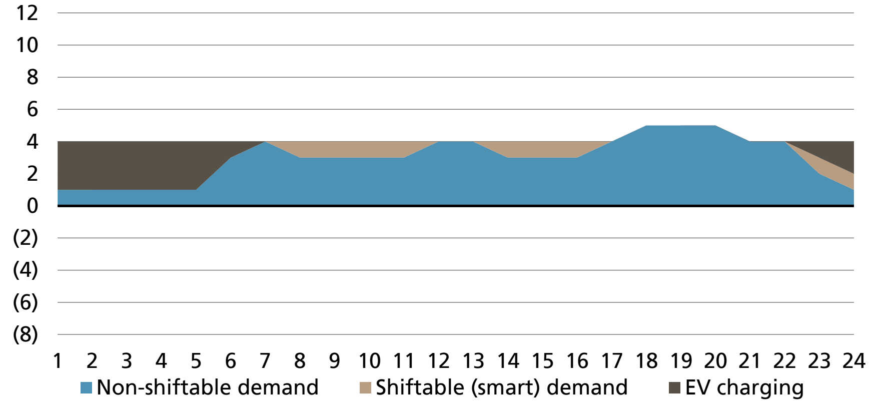


Source: UBS

EV + solar + battery = the natural fit

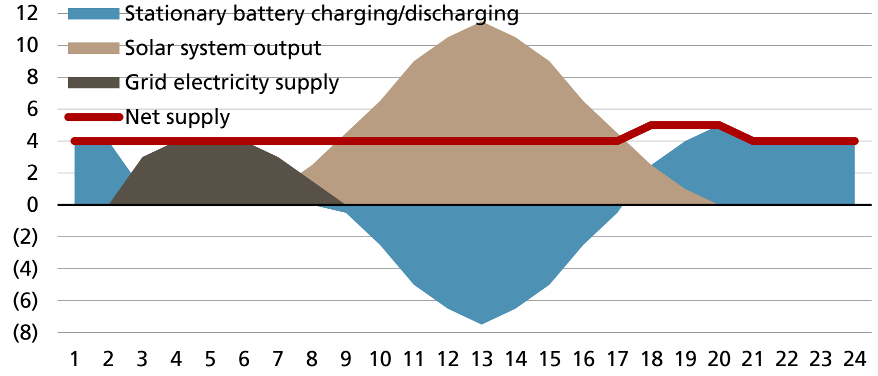
The below figures explain why solar + stationary battery + electric vehicle (EV), in combination with smart demand, is an almost perfect fit. EV charging during the night smoothens the daily demand curve. The stationary battery stores excess solar electricity during the day and releases it in the evening hours. The remaining supply gap will be filled with electricity from the grid during the night/early morning hours, which is when spot prices are low and there is excess base-load and wind power supply. On top (not illustrated below), the stationary battery may be re-charged in the early morning hours with excess grid electricity (at low prices) and supply the morning demand peak during breakfast hours.

Figure 14: Daily demand profile…



Source: UBS estimates (schematic illustration of a typical working day)

Figure 15: …and daily supply profile can be (almost) perfectly matched



Source: UBS estimates (schematic illustration of a typical working day)

Proprietary interactive model: Bringing the economics together

Interactive model on UBS Neo

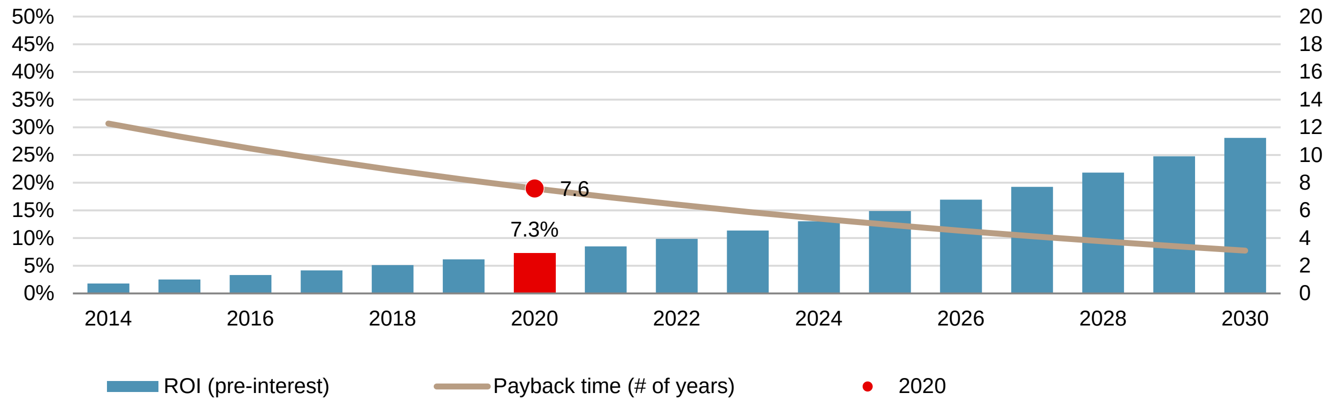
One important remark upfront: All the following analysis is without any subsidies, feed-in tariffs, etc. We have developed a proprietary model, integrating economics of a solar system, a stationary battery and an EV. Here is a hot link to the interactive model on UBS Neo:

https://neo.ubs.com/shared/d1fXWW5AKk6

Our conclusion is that the combination of the three components is an economically viable investment already today, even though returns are low. However, thanks to expected vast cost reductions for batteries (both in the EV and stationary), returns are likely to rise and payback times are likely to shorten dramatically. For example, by 2020, the payback time could drop to c7-8 years – in other words, the owner would receive free electricity for another c12-13 years.

7-8 years of payback on a solar + battery + EV system in Germany by 2020

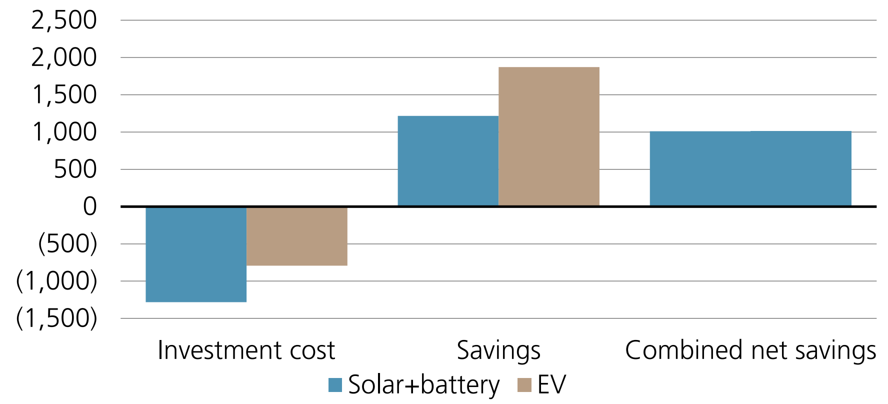
Figure 16: Solar + battery + EV already pays off, but economics to further improve dramatically



Source: UBS estimates
Note: Chart shows economics in Germany.

Looking at the economics from a P&L point of view, we believe the combination of EV + solar + battery will save c€1,000 per year, compared with a conventional car and no solar system on the roof. This is based on an assumed 20-year life for the solar system, a 10-year life of the car, and 4% cost of capital.

Figure 17: Annual 'P&L' of EV + solar + battery = c€1,000 savings per year



Source: UBS estimates
Note: Based on purchase in Germany in 2017; assumes EV is charged with self-generated solar power.

There are two caveats that we have taken into account:

- The **cost for the grid and other fixed cost**, which for now is part of the electricity tariffs on a per kWh basis. Grid fees will add to the solar new entrant cost. Yet, even stripping out grid cost from electricity tariffs, solar will be cheaper. In our model, we assume that the amount of grid fees per year remains unchanged compared to the current consumption-based model. We expect a gradual shift towards flat-fee-based grid remuneration, similar to the development seen with broadband internet.

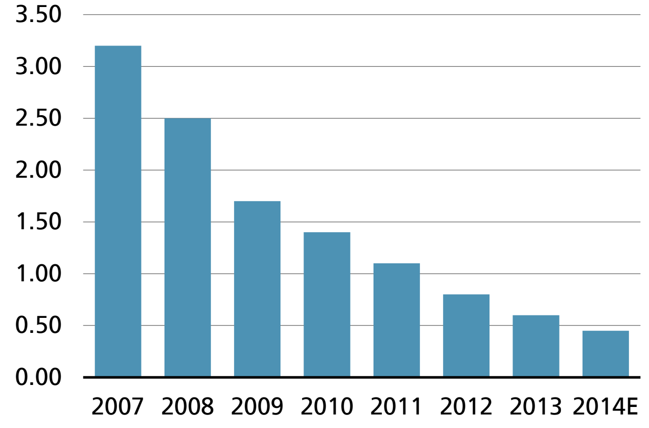
- During certain periods, solar output may exceed on-site consumption (and battery storage capacity). This **excess solar electricity** will have to be dumped into the grid, possibly at a discount to spot prices (there is an optimal solar system/battery capacity, because a too large battery causes too high investment cost). If there is an EV in the garage that will be charged by excess solar electricity, there would not be any 'waste' left. The remaining electricity needs would have to be covered via purchases from the grid, depending on the size of the battery and the solar system.

Solar already competitive, before backup cost

Cost has declined c85% within just 7 years

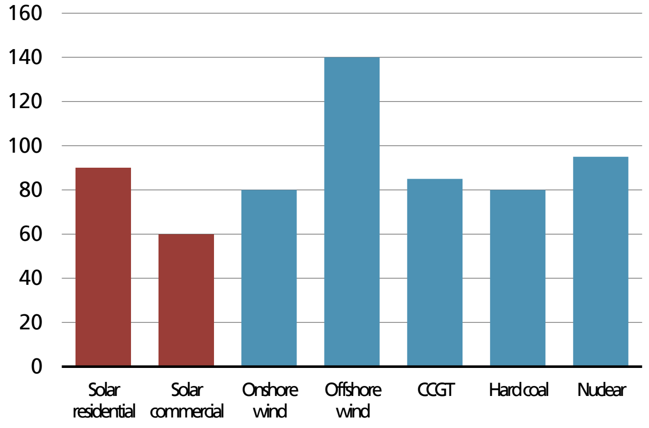
Already today, solar panels have become a commodity. The cost of solar panels has dropped c85% over the past 7 years – a decline that even solar enthusiasts had under-estimated. And the cost degression is likely to continue on further economies of scale and innovation (better solar cell performance).

Figure 18: Solar panel prices have dropped c85% since 2007 (€/W) on innovation and economies of scale



Source: UBS estimates

Figure 19: Solar new entrant cost (€/MWh) now competitive with conventional technologies



Source: UBS estimates
Note: Excludes cost of backup power for intermittent renewables and transmission cost for large-scale conventional plants.

Cheaper batteries will be revolutionary for households…

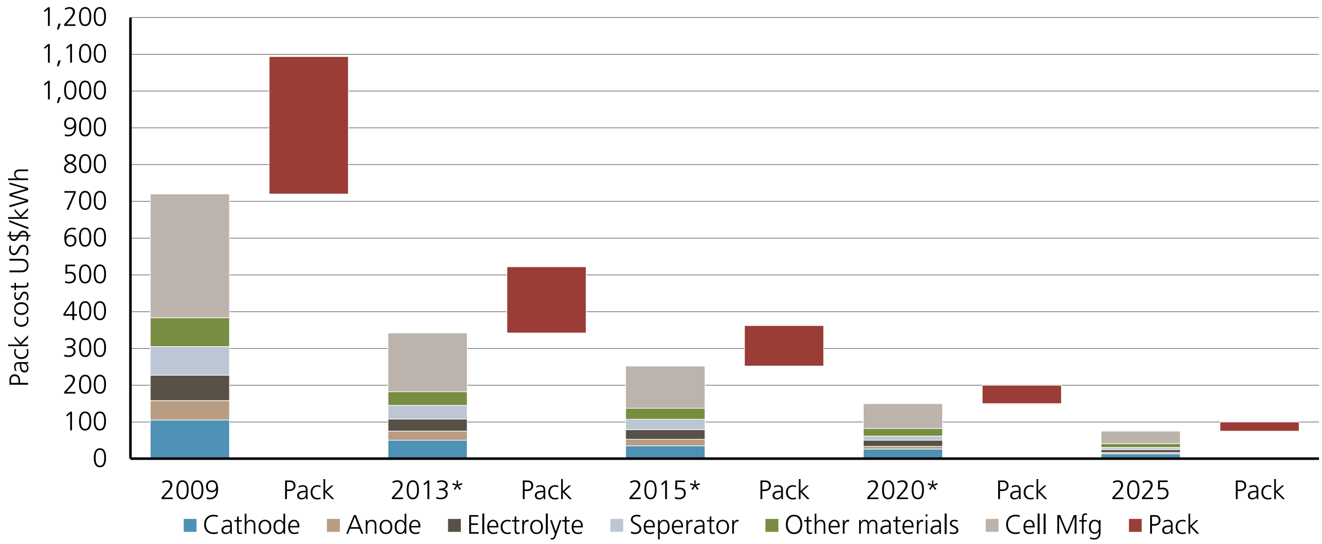
Solar electricity so far is integrated into the power system – to be blunt – in a fairly dumb way. Thanks to generous subsidies, most owners of existing solar systems sell all their electricity at the time it is generated into the grid at fixed subsidised rates, no matter if there is under- or oversupply in the system. Because of that, utilities have to provide backup generation capacity, which adds to the total cost of the system. Key to the future is to consume the solar power on-site. This requires either, or a combination of: (1) storage capacity; and (2) a demand profile that matches supply. We believe batteries will play a dominant role in this context.

…while larger-scale solar should be competitive without batteries

For commercial buildings, a 100% use rate of the generated solar power without a battery system is possible, because there is sufficient electricity demand at the time of production. And the full cost of solar for a commercial rooftop system is €60-80MWh already today. This is less than commercial electricity tariffs in most European countries. Even if the grid fees will be charged on a fixed base fee going forward (as opposed to the current consumption-based grid fees), the economics of commercial solar systems should be competitive.

Battery cost to fall by more than half by 2020

Figure 20: Battery cost should decrease by c75% over the next 10 years



Source: Tesla, Umicore, industry experts, UBS estimates

We believe that by 2020, Lithium battery pack cost will drop by >50%, compared to 2013.

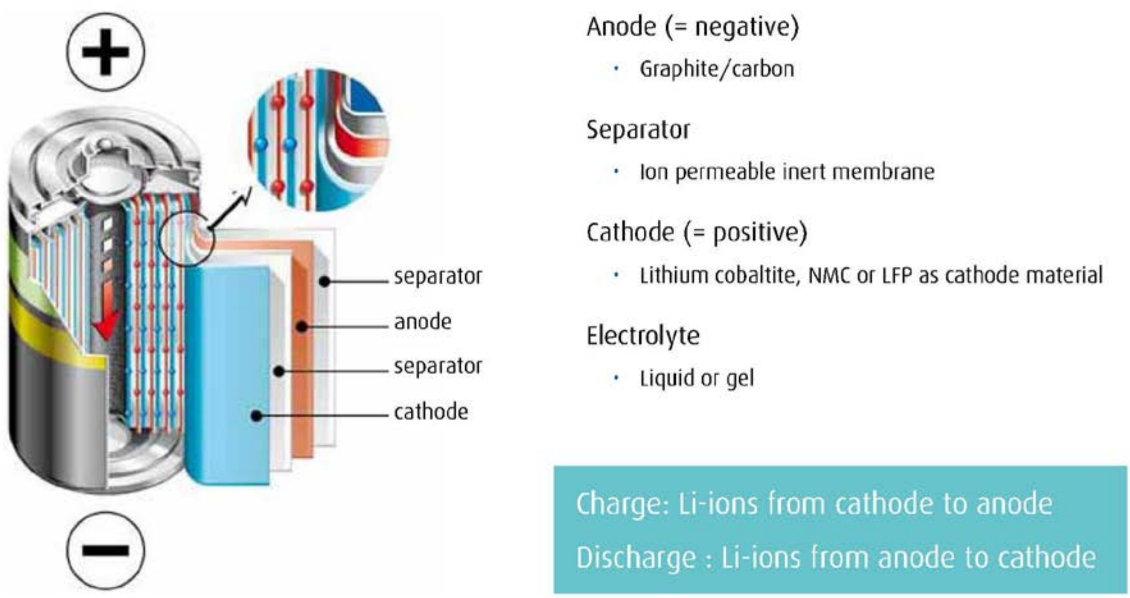
- Lithium-ion batteries (LiB) were invented by the chemicals industry.
- Lithium-ion battery materials include cathodes, anodes, electrolytes and separators, and form the key internal components of a LiB.
- Electric vehicles are the key catalyst for driving mass adoption of battery storage technologies, as autos will fast-track mass production, which will be significant in driving down costs.
- The Tesla Gigafactory aims to double battery production capacity in 3-4 years and should be a significant catalyst in stimulating the market.
- Optimisation of battery materials alone is expected to provide more than 50% of future lithium-ion battery cell cost reductions.
- Cost improvement in battery materials will be driven by optimising energy density, lifetime, safety, charge-up time and power dissipation.
- We see battery costs moving down from US$360/kWh today to US$200/kWh by 2020, and as low as US$100/kWh within 10 years.
- Umicore and Tesla have both indicated that the chemistry and materials science needed to significantly reduce battery costs has already been discovered. Industrialisation is now the final barrier.
- We expect batteries based on lithium nickel manganese cobalt (NMC) to be the most widely used technologies in automotive applications, while lithium iron phosphate (LFP) will likely dominate in the stationary market.
- Umicore and LG Chemical are likely to capture the most value of any companies in the chemicals sector this decade, but companies such as BASF

have significant aspirations of going from zero presently to becoming the largest battery material supplier globally (timescale not disclosed).

- Risks in this market lie more with the material suppliers rather than the consumers. Threats to material suppliers would be driven by lower-cost technologies, which would be an advantage for automotive and stationary application users.

Battery cost potential – where does it come from?

Figure 21: Basic concepts of a Li-ion battery cell



Source: Umicore

Four main components create the 'chemistry' of a lithium ion battery

A lithium-ion battery's chemistry and electricity storage/dissipation capabilities are governed by four key components – the anode, cathode, separator and electrolyte.

Modules are combinations of battery cells with associated control systems and housing

Lithium-ion battery cells are then combined into larger modules that are packaged in housing and utilise electronic control systems, cooling systems and interfaces with the usage applications, such as hybrid/electric vehicles (H/EVs), electronics or utilities' storage devices.

Lithium-ion batteries were originally developed primarily for use in portable electronics, where an aggressive cycle of performance improvement and cost reduction helped spur on technology development significantly.

Vehicle electrification is the catalyst for getting battery prices down, which will then stimulate demand in stationary applications

We see the electric car usage as being the central catalyst for energy storage cost reduction rather than stationary applications. We have a perpetuating circle of lower battery costs leading to more cars sold, leading to lower batteries, and so on.

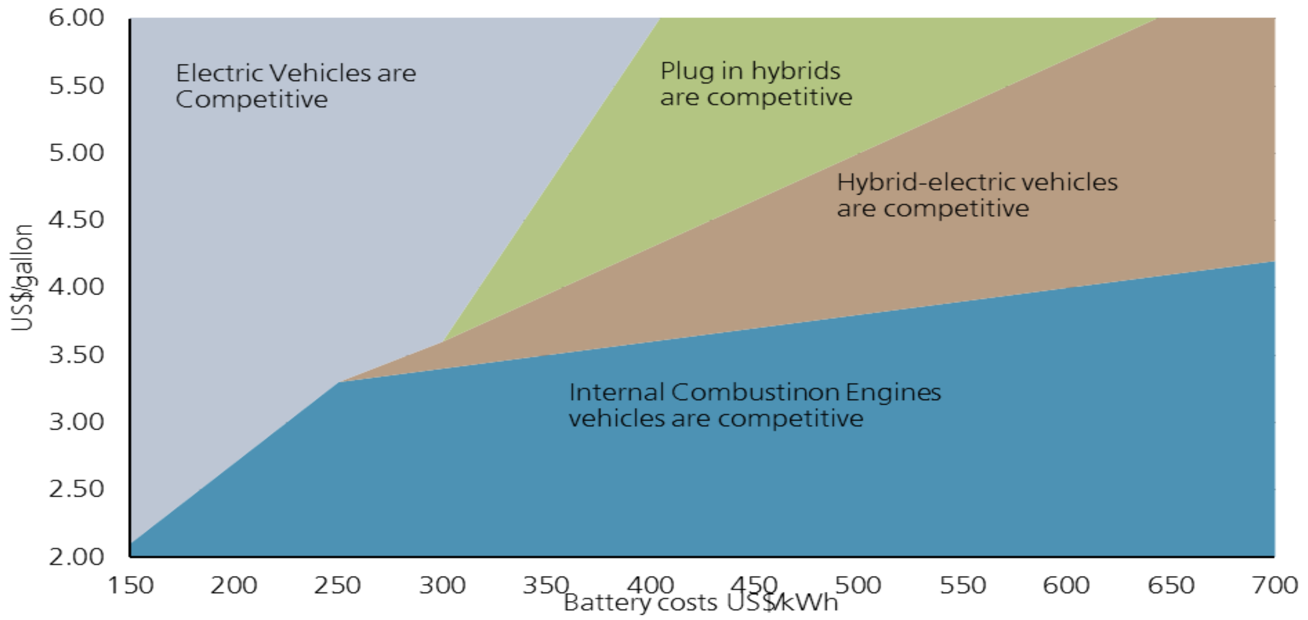
The key drivers for a reduction in total cost of ownership of a lithium-ion battery are:

(1) Increasing manufacturing scale and productivity;

(2) Reducing the cost of battery materials and components;

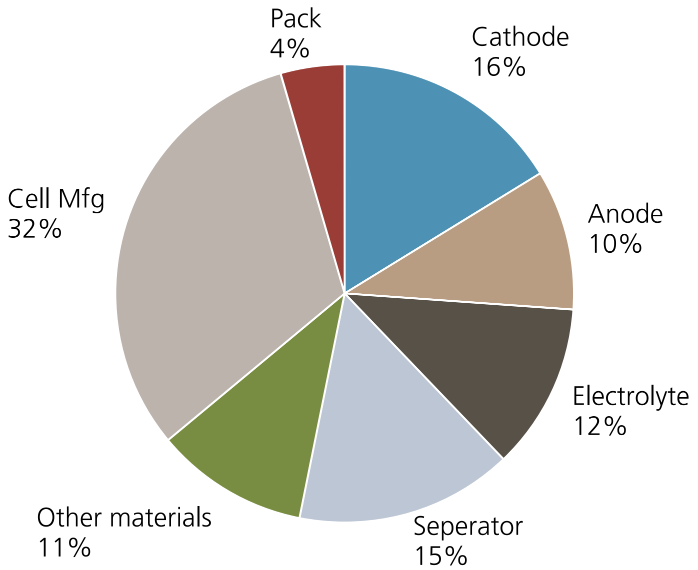
(3) Increasing battery energy density and lifespan (minimising battery fade/maximising the number of charge cycles).

Figure 22: EV, H/EV and PHEV competitiveness versus ICE



Source: McKinsey, EIA

Figure 23: Contributions by technology are taking battery pack cost down from US$360 in 2013 to US$200 in 2020E



Source: Umicore, AABC, Tesla, UBS estimates

Both materials and assembly economies of scale will be instrumental in driving costs down

Cathode material developments are a key area of focus, but cost savings in all areas of the battery are being optimised to bring overall battery costs down. On top of this, there are economies of scale through mass production, which will reduce costs significantly.

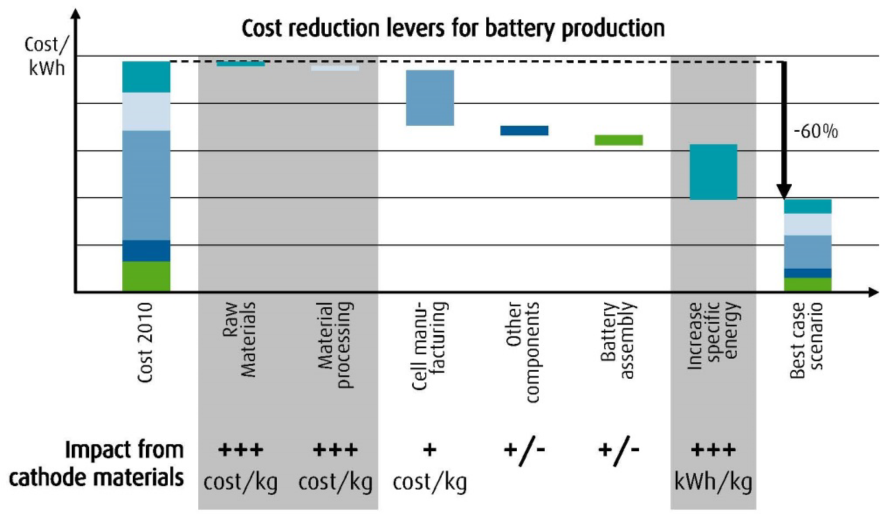
Lithium-ion battery costs for automotive applications have already come down aggressively in the past three years, with pack costs having fallen from US$500/kWh in 2013 to US$360/kWh today. Umicore believes that this total pack cost will fall to below US$200/kWh by 2020. Tesla sees a pack cost of less than US$100/kWh within 10 years.

Both Umicore and Tesla have stated that the chemistry to achieve optimised battery pack costs is well understood and that substantial cost improvement will come through economies of scale and mass production.

Battery chemistry required to achieve low costs has already been developed

This, in our view, significantly reduces the risks to battery pack cost reduction, and initiatives such as the Tesla Gigafactory should give a significant boost to achievement of this lower unit cost level.

Figure 24: The cost reduction cycle is influenced by technology improvement in all areas of the battery – but cathode improvements are most significant



Source: Umicore

EVs to be part of the future decentralised electricity system

As products, cars offer good value, they are increasingly reliable and high tech, and are often sold at low or even no margin. At the same time, they wear and depreciate fast, whether utilised or not, and sit idle 70-80% of the time. Electrification is holding the promise that cars could be used more efficiently in the future, including as a medium for electricity storage/discharge. In this section, we address three questions:

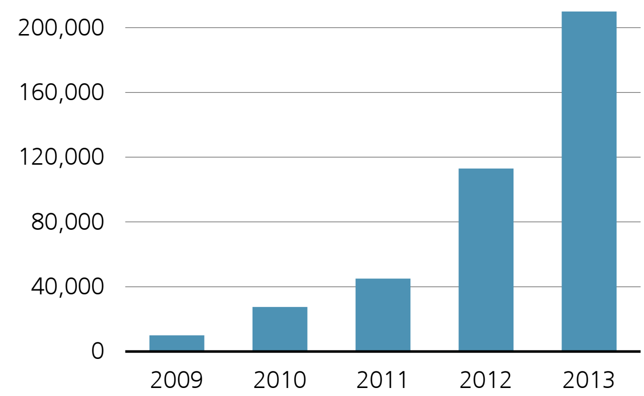
- How fast will EVs grow and when will total cost of ownership take over from regulation as the main driver of growth?
- At what point is there a sufficient installed base for EVs to provide meaningful electricity storage capacity to support self-generation?
- How will this affect the current model of the auto industry?

EV penetration scenarios

Growth rates have been impressive, but overall volume is low and EV penetration (battery, plug-in hybrids and fuel cell) almost immaterial at 0.25% of global light vehicle sales. Only Norway and the Netherlands in Europe have achieved meaningful penetration, mainly by distorting the market through tax.

EV penetration to date remains marginal at 0.25%

Figure 25: Global EV sales (BEVs, PHEVs and FCEVs)



Source: Global EV Outlook

Figure 26: Penetration rates of BEV and PHEV in 2013

	BEV	PHEV	Total
Norway	5.7%	0.4%	6.1%
Netherlands	0.8%	4.8%	5.6%
US	0.7%	0.6%	1.3%
France	0.7%	0.1%	0.8%
Japan	0.4%	0.3%	0.6%
Sweden	0.2%	0.3%	0.5%
Denmark	0.3%	0.0%	0.3%
Austria	0.2%	0.0%	0.2%
Germany	0.2%	0.0%	0.2%
UK	0.2%	0.0%	0.2%
China	0.1%	0.0%	0.1%

Source: ICCT

Growth drivers will shift from regulation to total cost of ownership (TCO)

We think this negligible EV penetration is about to change. Premium brands, such as Tesla or BMW, rather than 'volume' brands, are leading in terms of technology, but also in terms of sales, as the incremental cost of 'going electric' is providing less of a hurdle for premium brand buyers. In H1 14, BMW sold 5,406 i3 versus Renault selling 4,756 Zoe.

For the period 2015-20, we expect growth will initially be dictated by regulation and OEMs needing to adopt electrification to meet the CO_2 reduction targets set across major auto markets. Even assuming the efficiency of ICE engines continues to improve, we estimate CO_2 compliance will require global sales of 3.2m EV by 2020-21, or a 140%-plus CAGR.

CO_2 compliance requires c3.2m EVs sold globally by 2021, a 140% CAGR

Complex rules undermine true CO_2 reduction

CO_2 rules and compliance calculations are complex, with a maze of super-credits and allowances, which largely undermine true CO_2 reduction, and potentially the future growth of EVs.

We expect battery costs will decline from US$350-400/kWh to US$200 by 2020

In this phase, we expect to see sufficient volume growth for the industry and its supply base to acquire experience and scale, driving costs down in the process, especially battery costs, which we expect will decline from an estimated US$350-400 per kWh today to US$200 by 2020, and as low as US$100 within 10 years.

TCO should become the main driver of demand while ICE will remain dominant – we expect true parity cost (ex-incentives) will be reached before 2020

Total cost of ownership (TCO), which is already approaching parity from a user's perspective (ie, including incentives) for a number of models, should logically become the main driver growth by 2020. We expect ICE to remain dominant with EVs an attractive alternative for consumers, depending on their driving pattern.

Emission targets cannot be met without electrification

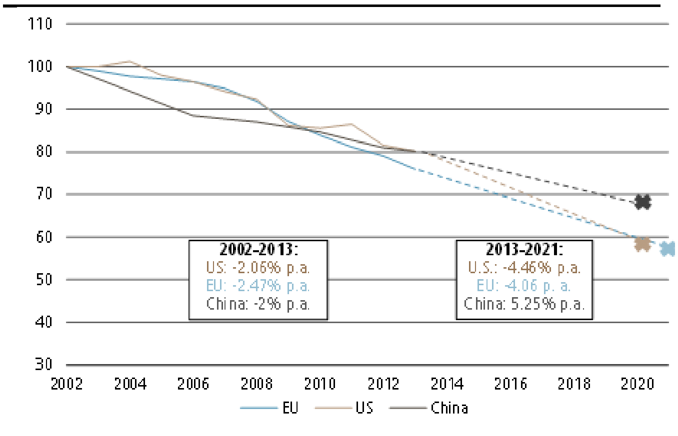
All major auto markets have set targets to reduce CO_2 emissions. These are expressed using different metrics and time horizons, but all have milestones in 2015/16, 2020 and 2025. We summarise them in the table below in their original format and, for comparability, converted into the European standard of grams of CO_2 per kilometre.

Figure 27: CO_2 emission targets – local targets and g/km CO_2 equivalent

Official targets	2013	2015/16*	2020/25*
EU	127 g/km	130 g/km	95/68* g/km
US	30.3 mpg 289.6 g/mi	35.5 mpg 250* g/mi	41.7/54.5 mpg 213/163* g/mi
China	7.35l /100km	6.9l /100km	5l /100km
CO_2 equivalent g/km	**2013**	**2015/16**	**2020/25***
EU	127 g/km	130 g/km	95/68* g/km
US	180 g/km	155 g/km	132/101* g/km
China	171 g/km	160 g/km	116 g/km

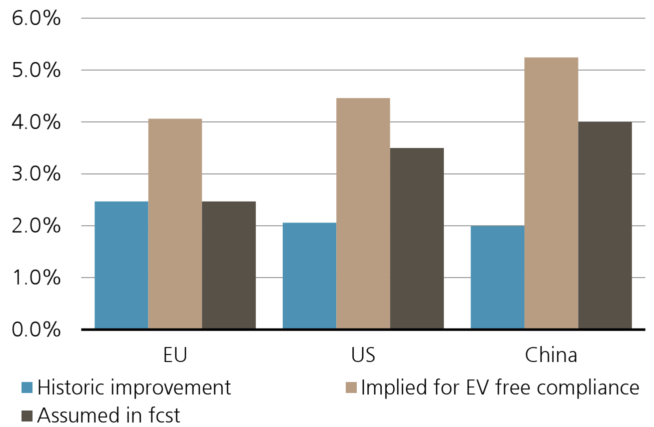
Source: ACEA, EPA, MIIT, UBS estimates
Note: For the EU and US, historical improvement is based on a 10-year period. For the US EPA, unadjusted mpg for 2013 has been converted into g/mi CO_2 to calculate productivity improvements. China targets (stated in l/100km) have been converted from l/100km into g/km of CO_2. * Indicates proposed target.

Figure 28: ICE productivity gains – historical and implied



Source: ACEA, EPA, MIIT, UBS estimates

Figure 29: Rates of ICE efficiency improvements



Source: ACEA, EPA, MIIT, UBS estimates

The charts above summarise: (1) the improvements in CO_2 output delivered in each market since 2002; (2) the rate of improvement in ICE efficiency required to meet the official CO_2 targets without relying on any additional penetration of EVs; and (3) the rate of improvement we assume in each major market towards CO_2 reduction in our forecast of how much EV penetration will be needed to meet the targets.

In our view, there is more scope to improve ICE efficiency in the US and China than in Europe

Given the acceleration of efficiency gains seen in the EU in recent years, we assume a stable rate of future annual improvement of 2.6% between now and 2020. Given the higher starting point of emissions in the US and China, and more modest progress delivered to date, we expect an acceleration of CO_2 efficiency gains to 3.5% per year in the US and 3% in China. In addition to high-profile weight-saving initiatives, such as the aluminium-bodied Ford F-150, we expect to see progress through wider adoption of 8-9-speed automatics, dual clutches and micro-hybrid stop-starts and full use by OEMs of various credits granted for air-conditioning refrigerants, for example, all of which can materially affect the calculation of official CO_2 output. In the case of China, we expect higher sales of smaller cars will bring the mix down and accelerate progress towards CO_2 reduction.

2020 targets will be 'measured' in 2021

From there, using our assumption of further progress in ICE efficiency and keeping the mix constant, we calculate the required penetration of various types of electrified powertrain needed to reach the 2020-21 targets. We chose 2021 as a forecast date as this is the year when policies will be effectively measured and some of the distortion caused by super-credits is reduced. The results are not cumulative; for example in the EU, if we assume ICE efficiency continues to improve 2.6% per year, meeting the targets requires that hybrid cars account for 57% of 2020 sales versus a 43% share for ICE, or that pure battery EVs account for 8% of 2020 volumes, with ICE vehicles down to 92% market share.

In this simulation, we assign 89 g/km of CO_2 for hybrids (Toyota Prius as a benchmark), 49 grams for plug-in hybrids (in line with current offerings) and zero for BEVs. At this stage, we avoid the tailpipe versus well-to-wheel emissions debate.

Figure 30: CO_2 compliance – required penetration of electrified powertrain vehicles by 2021 – without super-credits

		ICE productivity improvement			Comment
	Current penetration	No progress	Historical	Assumed	
Europe		0%	-2.6%	-2.6%	
HEV	<5%	84%	57%	57%	Assumed CO_2 emission for HEVs of 89g/km
PEV	0	41%	15%	15%	Assumed CO_2 emission of PHEVs 49g/km
BEV	<1%	25%	8%	8%	Assumed CO_2 of EVs 0g/km
US		0%	-2.2%	-3.5%	
HEV	5-10%	52%	33%	21%	Assumed CO_2 emission for HEVs of 89g/km
PEV	0	36%	21%	9%	Assumed CO_2 emission of PHEVs 49g/km
BEV	<1%	26%	14%	3%	Assumed CO_2 of EVs 0g/km
China		0%	-1.9%	-3.0%	
HEV	<5%	66%	55%	44%	Assumed CO_2 emission for HEVs of 89g/km
PEV	0	32%	22%	16%	China rules apply zero emission to PHEVs
BEV	<1%	32%	22%	16%	Assumed CO_2 of EVs 0g/km

Source: UBS estimates

Note: Indicates annual improvement in ICE CO_2 efficiency

In the following table, we translate these penetration numbers into millions of units, assuming a 17m market each in the US and Europe (ex-Russia), and 30m for China by 2021.

Given the scope of this report, we mainly focus on BEVs and PHEVs, as they also potentially provide electricity storage and, more than parallel hybrids in our view, will drive progress or any breakthrough in battery technology.

Global average super-credit for CO_2 compliance is still 2.5x by 2021 – real-life CO_2 reductions to remain modest

We average the volume calculated for BEVs and PHEVs, implying a 50/50 split in EV penetration between BEV and PHEVs, and apply each market's 'super-credit' factor to derive how many EVs are needed to reduce CO_2 in line with the regulation. Super-credits materially constrain the growth in electrification, suggesting real-life CO_2 reductions will remain modest.

Figure 31: CO_2 super-credits in the EU and US for BEVs and PHEVs

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
EU	Super-credit below 50gr/CO_2	3.5	3.5	2.5	1.5	1.0	1.0	1.0	1.0	2.0	1.7
	Fleet coverage	65%	75%	80%	100%	100%	100%	100%	100%	95%	100%
US	EV and FCEV						2.0	2.0	2.0	1.75	1.5
	PHEV						1.6	1.6	1.6	1.45	1.3

Source: EU Commission, US EPA
Note: Penalty for non-compliance in the EU is €95 per gram starting in 2019.

There is a material difference between targets and 'real-life' emissions, and therefore significant margin for error

In the EU, each BEV or PHEV emitting less than 50gr will carry a weight of 2.0 in 2020, measured on 95% of the fleet and 1.67x on 100%. The US will apply 1.5x to EVs and 1.3x to PHEVs (down from 2.0 and 1.7x, respectively, in 2017). China's policy is still being refined and we assume that the 5x multiplier is maintained, where both BEVs and PHEVs are counted as zero emissions if they have an electric-only range of continuous 50km at least. After adjusting for super-credits in the world's major markets, the required volume of EV drops from 8.7m to 3.5m units, highlighting the gap between the official CO_2 reduction targets and actual reductions, which themselves are based on tests rather than actual measurements of real driving conditions.

Figure 32: Estimated EV volume 2021E, adjusted for super-credits

	ICE productivity				EV volume	Super-	Adjusted	Implied	Sales
(m of units)	No progress	Historical	Assumed		unadjusted (a)	credits (b)	volume (a/b)	CAGR (7 years)	penetration
Europe*		-2.6%	-2.6%						
HEV	14.5	13.1	9.8						
PEV	7.1	5.0	2.6						
BEV	4.3	2.9	1.3	PHEV + BEV	1.9m	1.67x	1.17m	150%	6.9%
US*		-2.2%	-3.5%						
HEV	8.9	7.5	3.6						
PEV	6.2	4.9	1.5						
BEV	4.5	3.5	0.5	PHEV + BEV	1.0m	1.4x	0.73m	130%	4.3%
China*		-1.9%	-3.0%						
HEV	19.9	18.5	15.0						
PEV	13.4	11.8	4.8						
BEV	9.6	8.2	4.8	PHEV + BEV	4.8m	5.0x	0.96m	165%	3.2%

Source: UBS estimates
* Indicates annual improvement in ICE CO_2 efficiency.

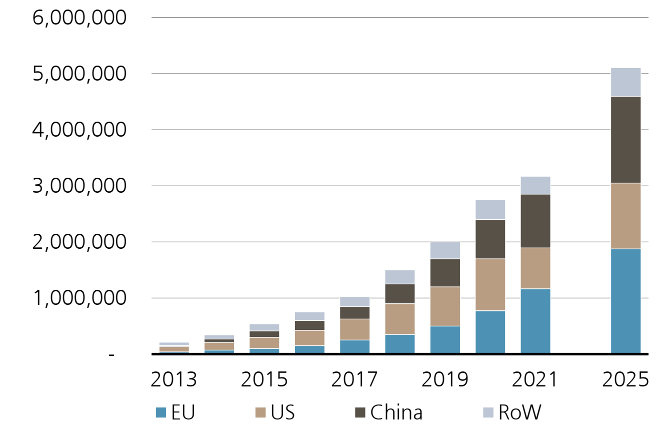
Figure 33: EV sales forecast (BEVs and PHEVs)

(units)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2025
EU	24,150	38,600	70,000	100,000	150,000	250,000	350,000	500,000	775,000	1,165,341	1,876,794
US	52,800	96,500	135,000	200,000	275,000	375,000	550,000	700,000	925,000	728,571	1,173,372
China	12,800	17,600	64,000	115,000	175,000	225,000	350,000	500,000	700,000	960,000	1,546,090
RoW	23,250	57,300	75,000	125,000	150,000	175,000	250,000	300,000	350,000	317,101	510,695
Total	113,000	210,000	344,000	540,000	750,000	1,025,000	1,500,000	2,000,000	2,750,000	3,171,014	5,106,950

Source: Global EV Outlook, UBS estimates

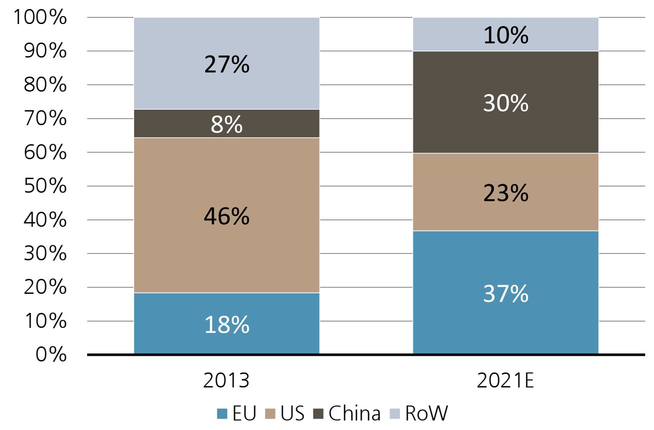
Our regulation-driven forecast implies more than 140% CAGR for EVs between now and 2020, and would suggest a 'hockey-stick' pattern as OEMs rush to meet deadlines as we approach 2020-21.

Figure 34: Global EV sales – 2014-21 and 2025 spot forecast



Source: Global EV Outlook, UBS estimates

Figure 35: EV sales distribution by region



Source: Global EV Outlook, UBS estimates

Forecast sensitivity

Our forecast is largely 'compliance-driven', with a large variable coming from future progress in ICE, which is as sensitive to mix and weight as it is to technology. We estimate that a 50bp annual increase in ICE efficiency would reduce the required number of EVs by c15%.

Forecast highly sensitive to ICE productivity – 0.5% deviation from our assumed ICE efficiency translates into 10-15% change in EV volume

In all markets, CO_2 regulations remain subject to review – either relaxation, should the industry prove to be unable to meet the targets, or stricter standards, for example, in the US, where the EPA is considering moving to targets adjusted for 'real-life' driving conditions, ie, some 20% stricter than headline data currently in use.

Europe: We believe EU rules are both more constraining in terms of CO_2 reduction and super-credits, but also more likely to be enforced as the industry has tended to deliver and sometimes over-deliver on targets, despite initial complaints. The main risk we see is that the compliance burden falls disproportionately on premium brands in terms of requiring electrified powertrains. We estimate the parc of EVs in Europe would reach 2.5m units by 2021, but still account for less than 1% of the European light vehicle parc.

We believe the EU is more committed to targets than other regions

US: We think the US is more likely to see further progress from: (1) improvements in ICE efficiency from a relatively low base; and (2) an already larger penetration of parallel hybrids, like the Toyota Prius. Targets are set to be reviewed in 2018 and we see a high probability that these will be toned down, in effect relaxing the rules. Our forecast of 4% sales penetration of EVs and PHEVs implies 1.6% of the

We see the highest margin of error in our US forecast, given rule complexity

2021 fleet, and is higher than the EPA's own estimate of 1%. We note the EPA is assuming a high penetration of mild hybrids, which is the main risk to our forecast.

China rules rather less demanding than they look

China: Despite public policy statements and unless generous super-credits are reduced, Chinese rules on CO_2 compliance appear comparatively easier to achieve, with sales penetration of EV at c3%, less than half of the implied penetration in Europe. The relatively high volume of EVs forecast to be sold in 2020, 960k units, also reflects the market growing from c23m currently to 30m by 2020.

Rest of the world: Japan accounts for most of the rest of the world as the next-generation vehicle forecast calls for 5-10% penetration of BEVs and PHEVs by 2020 (mid-point 375k units in a 5m unit market).

Finally, selling these EVs requires that there is a sufficient supply of CO_2-efficient vehicles. The table below summarises the main BEV and PHEV product introductions in the coming years. OEMs tend to keep product plans under wraps as long as possible, but supply looks tight and continues to suggest a 'hockey-stick' growth pattern.

Figure 36: Major EV product introductions

	2013	2014	2015	2016
BEV	BMW i-3 Chevrolet Spark Ford Focus Honda Fit VW e-Up!	Tesla Model X VW e-Golf Mercedes B Class Mercedes SLS AMG	Infiniti LE	
PHEV	LaFerrari Ford Fusion Energi Porsche Panamera S E-Hybrid Volvo V60	Porsche 918 Spyder V BMW 3 Series VW Golf GTE Audi A3 Sportback BMW i-8 Cadillac ELR Honda Accord Mercedes S Class Mitsubishi Outlander	VW Passat BMW X5 Mercedes C Class Mercedes ML Class Mercedes S 500 Volvo XC90	BMW 7 Series plug-in hybrid

Source: Trade press, OEM data

Beyond 2020

Urbanisation, growth in self-generation and taxation will be the main fundamental drivers of EV demand – we forecast 8-10%CAGR.

After 2020, we expect consumer demand will become the main driver of demand as true cost parity (discussed in the next section) makes EVs a financially attractive alternative to ICE for a growing number of motorists. By that stage, we expect publicly funded incentives will have been reined in, considering their cost, leaving OEMs responsible for any incentives if needed. We expect EV penetration will remain a negative for OEMs at this stage, as their legacy ICE assets are less utilised, therefore raising the importance of battery cost delivering at least true cost parity.

The pool of buyers should remain relatively modest for a while due to range restrictions (even assuming battery progress), insufficient access to private charging points (collective housing) and easier access to public/shared transport in urban areas, which are the natural markets for EVs. However, the trend of urbanisation should remain a powerful driver of electrification, particularly in China.

Self-generation of electricity (see section on solar parity) should also help reduce TCO, particularly in markets like Germany, where electricity and carbon fuel prices are relatively high.

Future taxation policy set to be a key driver of growth

Future taxation could materially influence demand. As discussed earlier, we expect governments will need to change the way vehicles are taxed as a result of the cost of initial purchase incentives, and lost revenue from the tax levied on petrol and diesel. Should tax burdens increase on fossil fuels, there would be additional incentives to switch to EVs due to fuel cost. We see such a scenario as likely to support a faster replacement of older ICE cars. The alternative would be to tax drivers on road usage, which could be more neutral on EV versus ICE demand.

Incentives are helping, but for how long?

TCO parity already achieved including incentives

Few consumers are likely to give up ICE vehicles for EVs today without some form of incentive in addition to an EV-friendly driving pattern (short distance, urban setting) or coercion (such as looming zero emission zones in major cities). On our estimates, a number of EVs already match equivalent ICE vehicles on a total cost of ownership basis including incentives.

The table below lists various types of incentives available to buyers or leasers of EVs around the world.

Figure 37: EV incentives in different countries

France	45€ million in direct subsidies and 405 million in rebates given to customers buying EV's
UK	No exercise duty for EV's and purchase incentives of up tp £5,000
Germany	EV's are exempt from road taxes
Netherlands	Tax reduction on vehicles amounting to 10-12% of net investment
Sweden	4,500€ for vehicles with emissions below 50g/km CO2
Finland	National EV development program ended in 2013
Denmark	Exemption from registration and road taxes
Italy	1.5 million€ in consumer incentives, ending in 2014
Spain	Incentives of up to 25% of vehicles purchase price before taxes
U.S.	Up to $7,500 tax credit for vehicles (based on battery capacity), phasing out after 200k vehicles
Japan	1/2 of the price gap between EV and comparable ICE, up to 1 million YEN
China	Purchase subsidies for vehicles of up to RMB 60,000

Source: EVI

EV drivers cost the government more than purchase incentives by no longer paying fuel duties

However, the total cost of incentives is higher than the purchase incentives listed in the table above – when taking into account lost tax duties on fuel. We estimate that the driver of a BMW i3 who switched from an X1 diesel and covers 10,000km per year will cost the French or German government between €200 and €250 of lost tax revenue, and the UK government as much as £300 as a result of not paying fuel duties. Duties levied on transport fuels account for 3% of EU members' tax revenue, on average.

Governments will need to change the way fuels and cars are taxed

As a result, we also think states will need to reform the way vehicles are taxed by either increasing duties on carbon fuels, thus switching the economics towards EVs, raising taxes on electricity, or switching to road usage-based taxation.

As battery technology progresses, governments will be inclined to reduce incentives, potentially leaving OEMs to take up that cost in order to meet CO_2 targets. For reference, since 2012, EU rules apply penalties per car sold in the EU on the basis of €5 for the first gram of excess (over the weight-adjusted average), €15 for the second, €25 for the third, and €95 for every gram thereafter. The penalty is set at €95 for every gram starting in 2019, setting some pressure for early compliance as every gram of excess would collectively cost the industry €1.5bn, assuming an EU market of 16-17m cars.

By 2019, missing EU targets by 1gr could cost the industry as much as €1.5bn

The path to cost parity

In this section, we look at the total cost of ownership and at what point EVs become competitive against traditional ICE vehicles. At the high end, TCO including incentives is already attractive for BEVs. We think true cost parity, ie, without purchase incentives, can be achieved before 2020.

Cost parity methodology

We have selected a few vehicles for comparison from a user's perspective using incentives available in various countries. We model a three-year leasing contract, as an outright purchase makes little sense, given the risk of technology obsolescence. In all cases, we have chosen the basis version of each model with minimal adjustments, such as adding leather seats to the Tesla for comparability with the A7. We assume 3.5% interest and a 10% down-payment on the price before incentives.

We calculate fixed costs (depreciation and interest) net of incentive costs if any, and the running cost based on distance driven. Miles driven are an important parameter since the running costs of an EV are materially lower than for an ICE car.

However, we base our calculations on relatively low miles driven (6,000 miles/10,000 kilometres versus a fleet-wide average of 9,000/14,000 as we think this is more representative of EVs more urban driving patterns). We do not include maintenance cost, which should be lower for EVs but not for PHEVs.

Figure 38: Vehicles reviewed

Location	EV	ICE	Comment/rationale
US (California)	Tesla S 60kWh	Audi A7 3.0 TFSI, petrol	A7 better comparable (size, design) than 7 series used as comp by Tesla
UK (London)	Renault Zoe	Renault Clio Tce 90, petrol	Similar size, high efficiency of petrol version
Germany	BMW i3 BEV only	BMW X1 Sdrive 20d, diesel	Different vehicle style but similar interior space – Germany as least EV-friendly market
Norway	BMW i3 BEV only	BMW X1 Sdrive 20d, diesel	Different vehicle style but similar interior space – Norway as most EV-friendly market
France	Volvo V60 PHEV	Volvo V60	One of few models available in ICE/EV configuration – France most diesel-friendly market

Source: Manufacturer data, UBS estimates

In the table below, we detail a few of our calculations/assumptions for two of the model pairs we have analysed. We have used 50% depreciation for the Tesla and A7 as this is the amount guaranteed by Tesla after three years (pre-incentives). For other vehicles, we have assumed a 40% residual value after three years. We acknowledge that the EV residual value may be affected by uncertainty about long-term battery life.

Figure 39: Sample of assumptions/methodology – Tesla vs Audi A7 and Renault Zoe vs Clio, with and w/o incentives

	US			UK		
	Audi A7 3.0 TSFI Gasoline	Tesla S 60kWh BEV	Tesla (no incentive) BEV	Renault Clio TCe 90 Gasoline	Renault Zoe BEV	Zoe (no incentive) BEV
	US$/gallons/miles	US$/kWh/miles	US$/kWh/miles	£/litre/km	£/kWh/km	£/kWh/km
Power (hp)	310	302	302	90	88	88
Purchase price	65,900	75,070	75,070	£13,195	£17,793	£17,793
Down-payment - 10%	6,590	7,507	7,507	1,320	1,779	1,779
Government incentive	0	7500	0		£4,448	
Local incentive	0	2500	0			
Total incentives as % of price		13%			25%	
Total financing required	59,310	57,563	67,563	11,876	11,566	16,014
RV guarantee	50%	50%	50%	40%	40%	40%
Interest rate	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Annual depreciation	10,983	9,178	12,512	2,639	2,076	3,559
Annual interest	2,076	2,015	2,365	416	405	560
Total fixed cost p.a.	13,059	11,193	14,876	3,055	2,481	4,119
Driving distance p.a.	6,000	6,000	6,000	10,000	10,000	10,000
Petrol/diesel cost/kWh	3.90	0.12	0.12	1.34	0.15	0.15
Cost per mile/km	0.170	0.035	0.035	0.0603	0.016	0.016
Battery lease					£840	£840
Total fuel costs p.a.	1,017	208	208	£603	157	157
Total cost p.a.	16,273	13,903	17,586	4,097	4,071	5,709
Monthly cost	1,356	1,159	1,466	341	339	476

Source: Manufacturer data, UBS estimates

Cost parity already achieved with incentives …

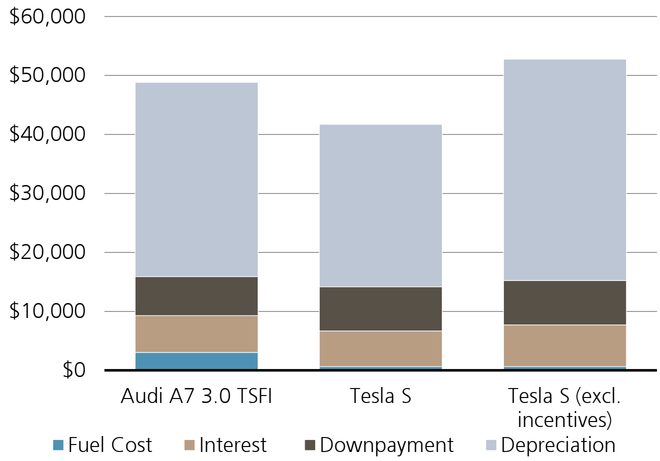
Based on our analysis, it appears that consumers already benefit from cost parity or better as a result of incentives, with the choice of EV versus ICE being down to driving distance requirements, availability or ease of recharging and, of course, consumer preference.

On our calculations, TCO for the consumer is at parity or lower than ICE after incentives

In terms of monthly payment, we work out a cost of US$1,159 for a Tesla S 60kWh driving 6,000 miles per year versus £1,356m for our benchmark Audi A7 3.0 TFSI. Every 1,000 additional miles driven per year would add US$2 to monthly cost versus US$14 for the A7. Various subsidies amount to a saving of US$309 per month.

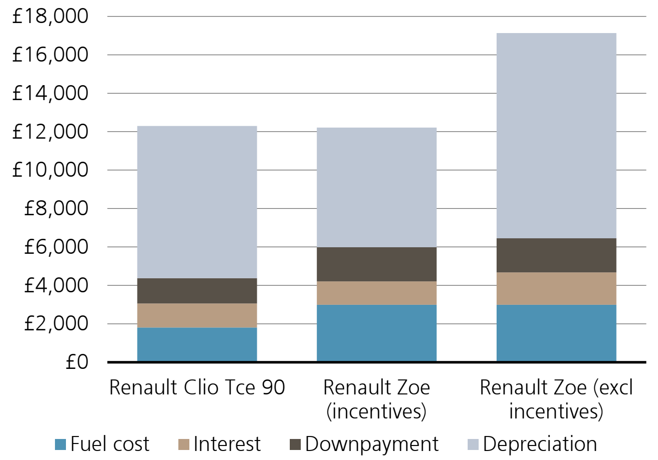
Incentives on the Renault Zoe in the UK yield almost exact parity with a Petrol Clio. The pricing model is different from Tesla's as Renault is leasing the battery pack separately. Starting from the £70 monthly cost for maximum driving of 7,500 miles per year, excluding interest and assuming a residual value of 40% after three years, we calculate the battery pack of the Zoe as leased by Renault costs cUS$6,600 or US$300 per kWh if we assume that the retail price of Zoe does not also include a portion of the battery cost. If that is correct, the selling price of almost £18,000 for the Zoe looks high and leaves considerable room for improvement compared with the £13,000-plus retail price of the petrol version of Clio, including the ICE. Alternatively, the Zoe could be very profitable or the battery cost relatively high, and buried in part in the selling price.

Figure 40: A7 3.0 TFSI versus Tesla S 60 – 3-year TCO (US$)



Source: Manufacturer data, UBS estimates

Figure 41: Renault Clio versus Zoe – 3-year TCO (£)

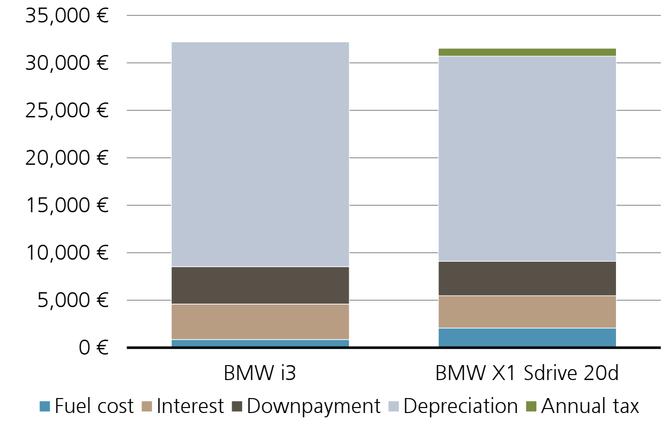


Source: Manufacturer data, UBS estimates

…and in some cases parity already exists without incentives

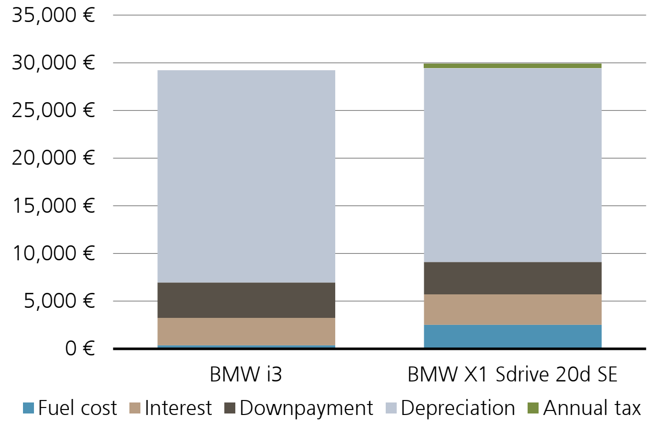
Interestingly, we calculate near-parity for the i3 and the X1 in Germany, where purchase incentives are limited to an exemption of an annual road tax, and in the UK, where purchase incentives are fairly generous (£5,000). Part of the difference reflects fairly unattractive running costs as petrol prices in Germany are relatively low, while electricity prices are high due to the renewable tax. However, we assume the difference is mainly down to the OEM's pricing policy, with OEMs adjusting down pre-tax prices in markets with higher VAT or sales tax.

Figure 42: BMW i3 versus X1 in Germany – no incentive



Source: Manufacturer data, UBS estimates

Figure 43: BMW i3 versus X1 in the UK – with incentives



Source: Manufacturer data, UBS estimates
Note: Converted from £ into € at 1.21.

What battery cost reduction is required for true cost parity (TCP)?

We now look at the difference in cost between an EV model with and without incentives to determine by how much battery or other costs need to decline in order to achieve true cost parity. In other words, what battery cost decline is required to offset the various incentives that are currently in existence.

Figure 44: Battery cost reduction required to offset incentives

(US$/kWh)	Tesla S – US	Zoe – UK	i3 – Norway	Comment
Monthly cost difference, local currency	307	137	1,379	
Monthly cost difference (US$)	307	227	225	Local currency converted into US$ at 1.65/£ and 6.14/NKr
- of which interest	66	77	134	
- of which excluding interest	241	150	91	Assumed to be mainly related to battery cost
RV	121	90	55	Assumed 50% at Tesla and 40% at Renault and BMW
x36 months	4,343	3,231	1,966	
Capacity	60.0	22.0	18.8	
Reduction needed per kWh (US$)	72	147	105	

Source: UBS estimates

We calculate that TCP requires battery cost to fall US$70-150 per kWh

We look at three different models in different markets and calculate the difference in monthly cost for the same vehicle with and without incentive. We remove the portion of interest charged every month and adjust the residual amount for depreciation since, in the monthly calculation, consumers are only charged for the depreciation (50% for Tesla and 60% for the other vehicles). We multiply the monthly amount by 36 months to calculate by how much the price or cost of the vehicle must decline to offset the benefit of purchase incentives only (not running costs). If we assume that the extra cost of an EV versus a comparable ICE car is exclusively linked to the cost of the battery pack, we calculate by how much the cost of the battery pack must fall to reach true cost parity.

Based on the examples in the table above, we estimate that battery costs must fall by between US$70 and US$150 per kWh, which is very consistent with our assumptions that battery costs per kWh can fall from the current US$350-400 to our estimate of US$200 by 2020. Tesla is already reporting more competitive battery costs, with disclosure of a US$200-300 cost per kWh in FY 13 – see the section on battery cost in this report.

We see a risk that OEMs may currently subsidise prices through high residual value guarantees, which may be reduced over time.

Self-generation is the other key driver of cost parity or advantage

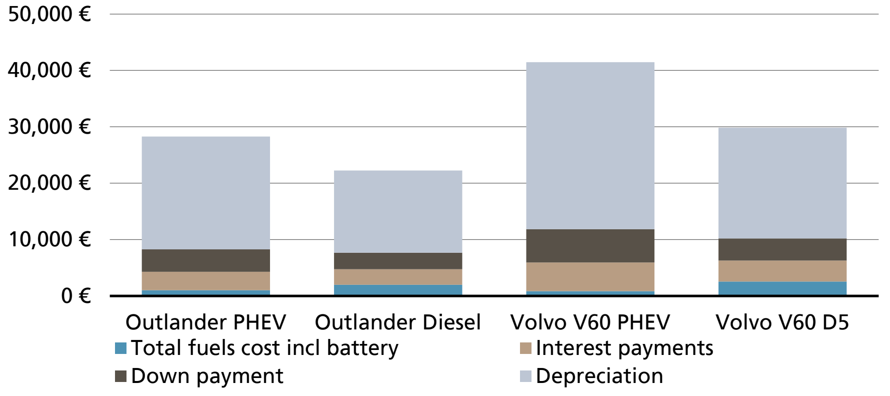
In this report, we also review the economics of self-generation of renewable electricity as another driver of reaching cost parity or creating a meaningful cost advantage, in particular if technology can help optimise charging throughout the day to benefit from the most favourable rates.

PHEVs still far from parity – opportunity for fuel cells

Flaws in PHEVs create opportunities for FCEVs

A quick cost comparison between the ICE and PHEV versions of the same cars shows a very significant cost disadvantage for the plug-in versions whose retail prices can be 40-50% higher than their ICE counterparts before incentives. To be fair, the choice is still limited and cost may improve rapidly. The main attraction of PHEVs, in our view, is that transitions costs are relatively painless for users. One can continue to fill up at the local petrol station and enjoy long drives on a tank fill while switching to electric mode and zero emission in urban areas, especially when zero emission zones are in place. The flaw, however, is that PHEVs carry a weight penalty of 200-250kg over their ICE peers, which translates into 7-10 additional grams of CO_2 per km on the road. PHEVs in particular will require major weight loss if CO_2 standards evolve from test to real-life measurements.

Figure 45: Three-year TCO for PHEVs versus diesel counterparts



Source: Manufacturer data, UBS estimates

We think the weight challenge of PHEVs still creates reasonable opportunities for fuel cell EVs (FCEVs) as they offer extensive driving ranges (500-700km) on a single tank and refuelling only takes a few minutes, and could conceivably be available through existing petrol stations over time. From the perspective of electricity storage, FCEVs do not provide storage, but they do provide opportunities for self-generation.

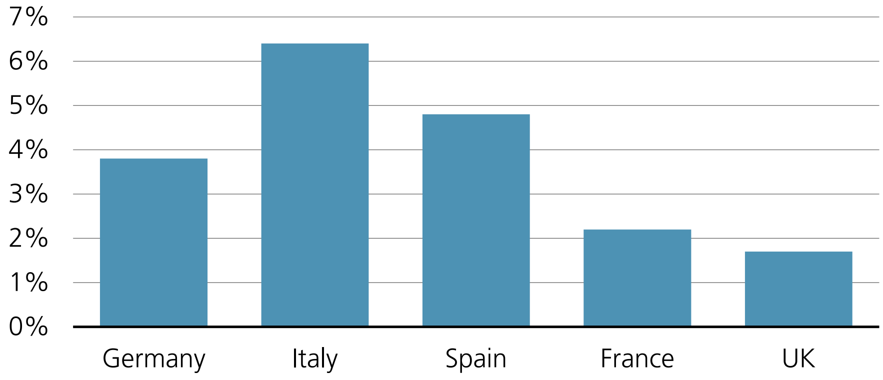
Leading and lagging European countries

Italy, Germany and Spain should be the leaders

The higher retail/commercial grid electricity tariffs and the higher fossil fuel taxes, the more rapid the solar/EV penetration rates should rise. Of course, southern European countries are more predestined to use solar power than those in the north, which may, to some extent, be impaired by the worse economic situation in the Mediterranean area. Other potential leading countries include Norway, which incentivises the purchase of EVs (and dis-incentivises the purchase of ICE cars).

- **Germany, Italy** and **Spain** are the countries with the best economics among the larger European countries.
- **France** and the **UK** should be followers. French power prices are low in a European context today, but may increase faster going forward due to high nuclear replacement cost.

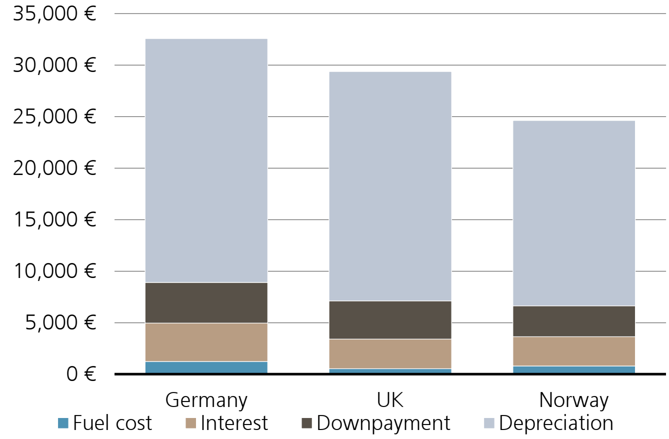
Figure 46: EV + solar + battery ROI (unlevered, pre-tax on 2017 cost estimates)



Source: Manufacturer data, UBS estimates

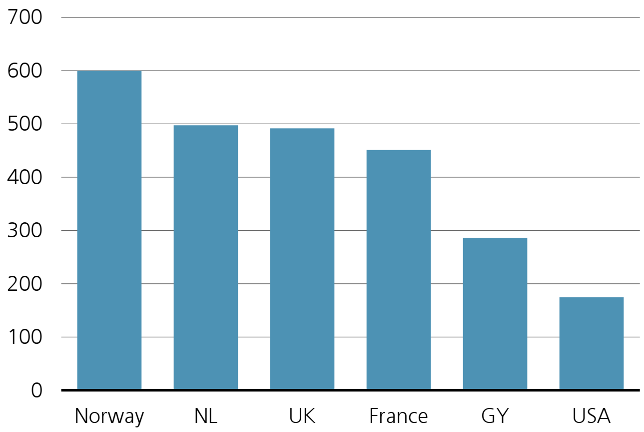
Just looking at the EV economics (excluding solar and stationary batteries), we also observe meaningful differences in TCO across countries for the same vehicles, based on incentives, of course (left-hand chart below), but also the net differences between the retail price of petrol versus electricity. Interestingly, countries offering some of the more generous purchase incentives, such as Norway, also offer the biggest favourable gap between high petrol prices and low electricity prices, whereas in Germany, for example, the absence of purchase incentives is compounded by high electricity and relatively low petrol prices.

Figure 47: BMW i3 3-year TCO including incentives



Source: UBS estimates

Figure 48: Fuel cost savings – electric versus petrol – Zoe/Clio, € per year



Source: EC (Eurostat), EIA

Note: Based on 10,000km per year.

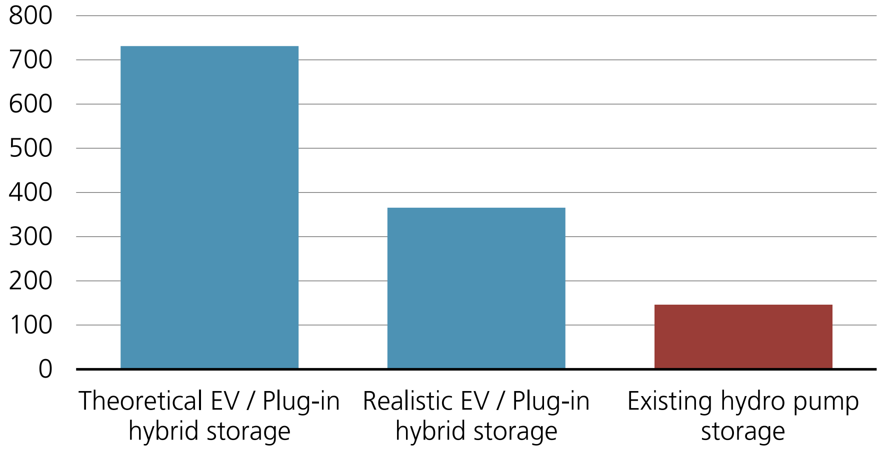
Impact of rising EV penetration on the grid

Electricity storage capacity to more than double

Doubling storage capacity at zero incremental cost

The increasing penetration by EVs and plug-in hybrids will add a vast amount of small-scale, decentralised storage capacity to the grid, at effectively zero incremental cost. Nobody will buy an EV or a hybrid car because it offers storage capacity to the grid. It is just a nice, yet very relevant side-effect. Tesla's S model, in its highest-range configuration, comes with an 85kWh battery. For an average, medium-sized EV, we assume a 40kWh battery. Plug-in hybrids have only a fraction of the storage capacity of EVs, at about 5-10kWh. If only 10% of the European car fleet were EVs and plug-in hybrids (assume a 3:1 split between the two types), there would be 23m batteries or 731GWh of storage capacity hooked to the European power grid per day, equivalent to five times the existing European pump storage capacity today. Even if only a certain proportion of that battery capacity would be available (some batteries may be full and cars will not be connected to the grid all the time), EV penetration would still be a game-changer, as it would amount to 4% of daily electricity demand. And, in combination with stationary batteries (which are not included in the chart below), the storage capacity is likely to be even greater.

Figure 49: 10% EV/plug-in hybrid penetration would more than double electricity storage capacity, at zero incremental cost (GWh/day)



Source: European Commission, UBS estimates Note: Assumes 75% BEVs and 25% PHEV, with an overall penetration of 10%.

Rising electricity demand to be offset by energy efficiency

We do not think overall electricity demand will grow even in an accelerated EV-penetration scenario

One of the oft-cited constraints on the potential growth of EVs is whether utilities are able to cope with the increased demand for charging – excluding any capacity increase linked to solar self-generation required from utilities. We believe that additional power demand from EVs can largely be met by existing and new renewable sources. Assuming a blue-sky 20% EV penetration in Europe by 2025, the incremental electricity demand would be 5% (ie, growth of 0.5% p.a.), as the following table shows. We think the annual energy-efficiency impact on demand is larger than the potential EV impact, which is why we do not think overall electricity demand will grow even in an accelerated EV-penetration scenario.

Figure 50: 20% EV penetration rate implies 5% growth in electricity demand

Electricity consumption of average EV	kWh/100km	20
Average annual distance per car	km	15,000
Annual electricity consumption per car	kWh	3,000
EV penetration rate in 2025 (blue-sky)		20%
Total passenger cars EU	million	250
Electricity consumption EV fleet	TWh	150
Total electricity consumption EU-27	TWh (2014E)	3,100
EV consumption as % of total electricity demand		**5%**
Generation capacity need at 100% load factor	GW	17.1
Total installed capacity 2014	GW	900
Required new capacity in % of total		2%
Renewables capacity need at 15% load factor	GW	114

Source: UBS estimates Note: 20% EV penetration also includes plug-in hybrids.

Smart grids and smart demand are the backbone

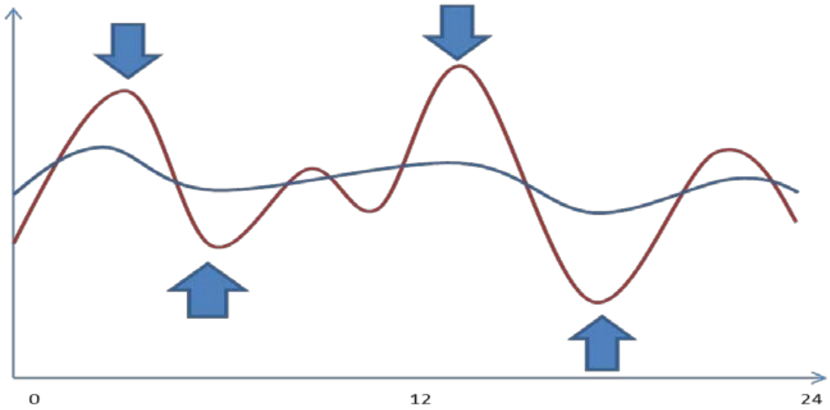
The new decentralised electricity world will only work in a smart grid environment. Collecting and analysing data from millions of electricity users will optimise the grid and reduce grid cost. The benefits to the system could amount to €50bn p.a., on our estimates, thanks to (1) lower and more intelligent consumption (peak shaving); (2) a reduction in theft/losses; (3) lower opex and maintenance capex; (4) lower back-up capacity needs and avoided replacement of thermal capacity; and (5) lower carbon emissions.

Charge the EV with solar power from home while at work

In the context of EVs, smart grids could provide the technical basis for innovative solutions. For example, an EV could have a personalised 'ID' for charging/discharging, no matter where it is hooked up to the grid. The EV could be charged on a company parking lot with solar power from the owner's rooftop panels at home while the owner is at work during the day. The utilities would charge the customer for the grid use and the metering/billing services. This would reduce the amount of stationary battery capacity required at home.

Electricity demand is set to become smart in both the household and commercial/industrial segments. Demand will be much better aligned with the available supply, and it will minimise cost to electricity users and the entire system. Demand-side response – that is, large electricity users cutting demand at peak times and getting compensated for that by grid operators, will be a commonly used tool to keep the system in balance. Smart grids will be the enabling technology for this response. As a result, peak demand should be greatly reduced (as should the need for back-up power stations).

Figure 51: Smart demand irons out peaks and troughs (illustrative example)



Source: UBS estimates

- **Households:** Think about the concept of a 'smart home', in which all devices connected to a power wire can communicate with each other. An intelligent 'electricity control centre' which communicates with the smart meter will be able to switch on/off devices or communicate via WLAN when it is best to use them (fridge/freezer, washing machine, dishwasher, etc). Sensors will be used to switch on/off lights and heating.
- **Commercial:** Companies will be able to do everything that a smart home system can, and large users will in addition be able to monetise a reduced load during peak times (demand side management), which will help the grid operator to stabilise the grid at times of bottlenecks.

We estimate that smart demand could save the EU-28 economy several billion euros a year through avoiding the need for capex into back-up power stations and through lower power prices (as there would be fewer hours during which high-marginal-cost plants set the wholesale power price).

Where could we be wrong?

Downside risks

- **High degree of complexity and many participants.** The disruptive changes described will be driven by electricity users. Country-specific regulation, differences in fuel and electricity prices and consumer propensity to 'try something new' is difficult to predict. Also, to some extent, there is a chicken-and-egg problem when it comes to infrastructure requirements, such as smart meters and EV charging facilities.

- **Adverse regulation/taxation changes.** More solar systems and more EVs mean lower electricity grid revenues for grid operators and fuel tax revenues for governments. At this point, it is not clear how the regulatory/political framework will change over time. Exclusively flat-fee-based grid remuneration and higher taxation of EVs could undermine the trend.

- **Battery/solar cost curve slowing down.** Our estimates already factor in a less steep cost degression for solar panels and batteries compared to latest trends. A further slowdown (which may also be driven by rising raw materials prices) would make our cost projections too optimistic.

- **Warranty/liability issues.** A question we cannot answer today is whether OEMs will approve or oppose the usage of battery charging/discharging for non-transport applications, as that could undermine the longevity of the battery. Our cost calculations use EV batteries only for charging, even though discharging would make the decentralised power model more economically viable.

Things that we may be underestimating

- **Green consumers and companies.** Irrespective of the economics, we think the increasing awareness of a sustainable, local supply chain as seen in other areas (for example, food) will spur investments in a clean, de-centralised electricity system. Not just consumers, but companies, too, are likely to jump on the bandwagon. As an example, Wal-Mart plans to switch its stores to 100% renewable power by 2020, up from around 20% today. They may be doing that to appeal to consumers, but probably also to save money.

- **Technologies.** There are further technologies that have the potential to be disruptive, even though the economics do not seem compelling to us yet. For example, fuel cells have made significant progress in the past few years. Stationary fuel cells can be used to heat homes and to provide back-up power. Also, alternative battery technologies for stationary storage might have an even steeper cost-decline curve.

- **Geopolitics.** We would not see political tensions between fossil-fuel-producing and -consuming countries as a main argument in favour of our projected 2025 electricity system, but clearly the latest developments in Ukraine and Russia are, if anything, intensifying the political support for renewables and a smart, efficient electricity system in Europe, with the ultimate aim of reducing dependence on fossil fuel imports.

A €3bn net opportunity for EU utilities

Opportunities and threats overview

Being close to the customer is more relevant than ever

The disruptive changes in the way power is generated, stored and used will structurally change the utilities' business model over time. In this chapter, we analyse the opportunities and threats in detail. The closer utilities are to the electricity user (both residential and commercial/industrial), the better they should fare in a decentralised electricity system. We think large-scale power plants are the structural losers from this trend, as they are too big and most of them are too inflexible. We acknowledge that the profitability of conventional plants is already subdued, but we believe there is too much unfounded optimism in the market about a recovery in generation earnings ('This is too bad to last', 'Capacity mechanisms will restore profits', etc).

Positive drivers likely to accelerate only after 2020

We expect to see differences in timing among the main European countries. Based on today's fuel and electricity prices, we think development will happen fastest in Germany, Italy and Spain. Also, we think the positive drivers are likely to accelerate only after 2020 due to the 'hockey stick' characteristics of the EV penetration curve. Therefore, the near-term impact to be felt in the utilities space would be negative. Our analysis uses 2025 as target year.

Figure 52: Several opportunities for utilities, one big threat (2025 scenario)

Opportunities	Threats
+ Value-add supply business	- Large-scale power generation
+ Smart grid	
+ Decentralised back-up power	

Source: UBS estimates

Products and services supporting costumers

Leverage existing large client base = €2.3bn opportunity

The larger the existing electricity customer base, the easier it should be for utilities to grow profits in their supply businesses. Instead of the traditional supply model, which consists of nothing more than sending power to consumer's sockets and billing for it, there will be a variety of earnings opportunities in the new, de-centralised world. The NOPAT per customer could increase by c30-40% or €14 per year. However, we highlight that competition is likely to be intense, and will also come from non-utility competitors including equipment providers and big data companies, such as Google.

Utilities are likely to:

- Manage, maintain and even own solar and battery systems, so that the consumer would not have to pay the upfront investment, nor deal with maintenance. It would also hugely increase customer loyalty, potentially leading to a valuation multiple expansion of the supply businesses.
- Offer smart consumption solutions, which help electricity users to manage their power demand in the most efficient way. This can include the charging of the EV or the management of the heating system if running on electric heat pumps. The offering may also be integrated in a 'smart home' environment.
- Package virtual power plants from various decentralised generation/storage units (portfolio effect) and sell electricity to customers under longer-term power purchase agreements (PPAs).

Figure 53: Value-add supply opportunity (€bn)

	EBITDA	EBIT	NOPAT
10m solar + battery systems	6.7	3.4	2.3
Smart home equipment sales (€5/customer p.a.)	0.8	0.8	0.6
EV charging management (€50/customer p.a., 10% penetration)	0.2	0.2	0.1
EV charging points (€50/unit p.a., 10m units)	0.3	0.3	0.2
Volume decline in 'traditional' supply business	-1.3	-1.3	-0.9
TOTAL	**6.6**	**3.3**	**2.3**

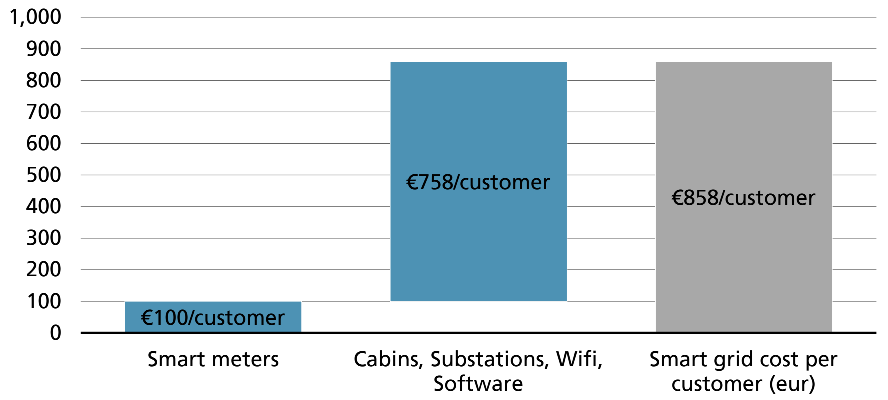
Source: UBS estimates

Smart grid opportunity

€290bn investments in smart grids will provide the platform

As detailed in Alberto Gandolfi's report *Expect a smart grid boom: c15% of sector EPS uplift* from 22 April 2014, we see smart grids as a €290bn capex opportunity for European utilities. We estimate that developing power distribution smart grids could cost €500-1,300 per customer, which would to a large extent be part of the regulated asset base (RAB) of distribution companies. Assuming a 7% ROA (and full cost-savings pass-through), we estimate a c15% average long-term EPS uplift (vs 2014) for European integrated utilities.

Figure 54: Smart grid investment could amount to €850 per customer



Source: UBS estimates

Distributed energy/small-scale back-up stations

Decentralised (back-up) plants could create a €0.6bn net income opportunity, in a high-multiple business

In a decentralised electricity system, power generated by small and flexible units will be a pre-requisite. Utilities could build, own and operate small-scale combined heat and power units (CHPs) for companies or municipalities for back-up power and heat supply under long-term PPA contracts. Alternatively, such units will be built as back-up plants under the existing distribution regulatory framework, and consequently capex would increase the RAB and receive a highly visible regulated return. It is therefore a high-multiple growth business for utilities.

However, it remains unclear what market share the utilities will eventually capture in this segment, because barriers to entry into this business are smaller than in the large-scale conventional power plant business. We estimate 10GW of CHPs will be built across Europe over the next 10 years, which offers a €0.6bn NOPAT opportunity for the companies under our coverage.

Structurally threatened: Large-scale power plants

Sharing the fate of the dinosaurs: Too large, too inflexible, on their way to extinction

Big, centralised power stations will not fit into the future European electricity system, because they are too large and too inflexible – or at least most of them are. Not all of them will have disappeared by 2025, but we would be bold enough to say that most of those plants retiring in the future will not be replaced.

If fewer and fewer large-scale power plants are needed, the last survivors will be the low-marginal-cost plants (nuclear, hydro). But what will their revenues be? For now, thermal plants (coal, gas – high marginal cost) are the price-setting technologies in the wholesale market. Once they fall off the merit order 'cliff', the power price would drop steeply (and carbon prices would become irrelevant as they would no longer be part of the marginal plant pricing). Therefore, either remuneration mechanisms have to be changed (PPAs, regulated returns), or baseload plants will face a profit squeeze similar to that faced by coal/gas stations today. In this context, we believe that what is perceived as an 'optionality' in conventional power generation by some investors will never materialise.

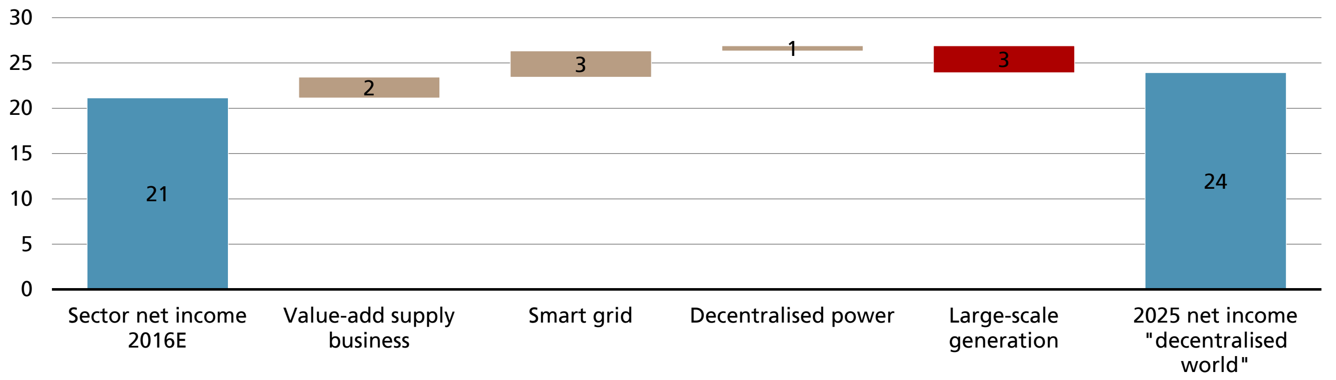
Earnings impact on EU utilities

In this section, we summarise the financial impact of the opportunities and threats discussed above.

- **Value-add supply** could contribute €2.3bn to sector net income.
- **Smart grids** could add €2.9bn to sector net income.
- **De-centralised back-up power** could add €0.6bn to sector net income.
- **Large-scale power stations** could be on a path to extinction. While most coal/gas stations are already at or below break-even at a net income level, we see further downside risk for nuclear/hydro/lignite plants. The total remaining downside amounts to €3.0bn.

Summing up the drivers, we see a €2.8bn net income opportunity for utilities, or c13% of sector EPS. This is taking a 2025 view, net of the downside risk in conventional generation and everything else equal.

Figure 55: The new decentralised electricity system is a 15% EPS opportunity for European utilities (€bn, 2025 scenario)



Source: UBSe

Figure 56: Net earnings opportunity by company, 2025E (€m)

	E.ON	RWE	EDF	GDF	Enel	IBE	EDP	FUM	VER	CEZ	SSE	CNA
Value-add supply NOPAT	200	224	455	74	665	197	94	26	15	136	7	115
Smart grid NOPAT	310	217	756	0	953	305	146	0	0	208	7	0
Decentralised back-up power NOPAT	89	59	28	96	0	92	54	68	6	34	0	34
Conventional generation NOPAT at risk	-210	-322	-1,300	-350	0	-35	-35	-192	-206	-360	21	26
Total net opportunity	**389**	**178**	**-61**	**-179**	**1,618**	**559**	**259**	**-98**	**-185**	**18**	**106**	**175**
% of EPS 2016E	22%	17%	-1%	-6%	49%	24%	23%	-12%	-77%	2%	10%	14%

Source: UBS estimates

US utilities

Edison International (EIX; Buy; PT $60)

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As management has described it, "by far the largest additional future investment in the grid" not yet in plan is a set of distribution system upgrades to support two-way flow from distributed generation. EIX intends to submit a distribution resource plan to the California regulators in 2015 per compliance with AB 327, which implements residential rate re-design and tier collapse along with fixed charges. A decision on these issues is due from the California Public Utilities Commission (CPUC) in Spring 2015 and a separate docket was just established on July 10 to overhaul the net metering tariff as well (decision on that expected in Falll 2015).

On California's coming energy storage solicitations, solutions are expected to include everything from compressed air to advanced lithium and other battery technologies. About 580 MW will be in EIX territory (290 MW ratebase opportunity), with 150 MW coming in a solicitation at the end of 2014. SCE would be eligible to submit proposals for half this amount to enter ratebase. Recovery would come through normal ratecases (unless the project was sufficiently large enough to warrant a carve-out). Storage costs are probably in the range of $3,000-$5,000/kW today, although this will almost certainly come down over time. This is another driver of ratebase and EPS growth above management's current disclosed range. The first procurement cycle begins in December 2014, with SCE targeting a net 14 MW storage capacity, excluding 74 MW existing and LCR storage.

EIX is also planning on competing to build economic transmission lines under a FERC Order 1000 solicitation process between California and Arizona, which could help import renewable generation from neighboring desert regions. In particular, the Delaney-Colorado line is a potential opportunity which has been proposed for economic reasons (rather than engineering). While it's all very tentative for now, the project was last speculated to cost ~$400M (years ago). EIX already owns the required rights-of-way. Management thinks that the California Independent System Operator's (CAISO) 2020 tentative in-service date is probably too aggressive considering required lead times for this type of project. For its part, the company has no public cost estimate available for this potential project yet, nor will it comment on financing plans or potential partners. While only modestly sized projects appear to be pending before the CAISO in the current year's batch of projects, we look for EIX to increasingly participate in such efforts either through SCE or a separate competitive Transco arm. We see California as leading peer ISOs on this front, having already conducted three such processes, albeit all of them small in size.

Bottom Line: We see EIX as among the best positioned companies to benefit from continued spend on grid upgrades to enable technologies, with a specific focus on Electric Vehicles. We suspect ever-expanding green energy plans out of the state will continue to require the utilities participation to enable interconnectivity, focusing on large-scale renewables and continued integration of these resources into Southern California. With upside to company estimates on the back of continued cost cuts (potential ability to out-earn its ROE in 2015) as well as upside to its authorized transmission rates, coupled with continued ratebase revisions including storage/transmission, we suspect the story will remain propelled forward, beyond just the resolution of its ongoing nuclear decommissioning scrutiny of its SONGS plant.

Consolidated Edison (ED; Neutral; PT $55)

Can the Utility 2.0 concept of distribution-level power dispatch get off the ground? While we increasingly view the Utility 2.0 (Reforming Energy Vision – 'REV') compact proposed by the NY Public Service Commission (NY PSC) as a net benefit to utilities (despite their more cautious attitudes), we believe significant implementation hurdles remain. Perhaps most notably, we sense a palpable sense of skepticism from a wide array of constituents over a seeming 'over-reach' of the PSC in terms of setting a wide ranging agenda. The question remains what could the Utility 2.0 initiative include? We believe a lot is on the table. While likely the more controversial and slow-moving aspect of the reforms, we see the potential to accelerate capital spend at utility subsidiary CECoNY on the back of reforms designed to build out 'behind-the-meter'. As an interesting gating item, we see a potential for a renewed discussion on smart meter rollout, seeing the city opted to forgo installation as too costly in 2006. Please refer to case no. 14-M-0101.

Despite the NY PSC granting approval for O&R and CECoNY to install 100MW of solar, ED has done "next to nothing" on the front as it is not economic. We have heard from solar supporters and developers that areas of New York, particularly Long Island, are ripe for solar growth, but Con Ed was quick to downplay the opportunity. Management did note that the situation is getting better in New York but is still not at the tipping point yet. Nevertheless, on the topic of Con Ed Development, management noted that the increased capex from ~$100Mn to ~$300Mn per year was done largely to make the placeholder more realistic but stressed that it is still a placeholder and it is under no pressure to meet that level of spending if the projects are not there. Con Ed Development has in recent years benefitted from a series of utility-scale solar projects developed in California, largely splitting projects with Sempra (SRE). Following its latest announcement to acquire a 50% stake in SRE's Copper Mountain III project, we see line of sight to continued EPS growth worth ~$0.02/sh. We understand management intends to use less leverage than many conventional solar developers, in an effort to keep its consolidated metrics roughly in-line with its utility capital structure (~roughly 40% levered); we perceive this as a structural disadvantage vs. industry peers willing to employ substantially greater leverage (~70%). How can Con Ed still be competitive? It appears the answer is its own organic tax appetite, in lieu of peers seeking tax equity to finance projects (particularly now without the benefit of CITCs on solar deals).

Where is the unregulated business headed? In exploring this question with management, it appears the company is most intrigued by potential C&I opportunities around Distributed Generation, seemingly as a function of New York's interest in pursuing wider-scale implementation of micro-grids and other 'behind-the-meter' solutions. Similarly such opportunities could yet be open to utility (rate-base) investment as well according to our discussions with the PSC as well (part of a quasi-re-regulation of the state, in our view). Further afield, we sense the Development business as open to pursuing contracted Hydro (run-of-river) and Battery solutions to delivery on further growth. Generally speaking the company has targeted levered IRRs in the mid-teens on investments.

Bottom line: ConEd remains among the least favored utilities in the US given its challenging regulatory dynamic. While we suspect company management will remain risk averse in pursuing any new ventures (particularly outside of the utility construct), we see this as a potential turn-around story should New York's pending regulatory construct work out favorably. We believe the state is serious in its endeavors to more meaningfully embrace a reinvigorated grid with greater renewables, with ConEd a centerpiece of its execution potentially. The question is if the ongoing NTSB investigation, among other meaningful issues, won't de-rail the company's plans first.

Impact on the auto industry business model

We mostly have a negative read of the impact of electrification on incumbent OEMs, as we see a structural increase in costs that is not offset by either incremental sales or meaningful incremental revenue streams from new activities, such as infrastructure or re-charging.

We mostly have a negative read of the impact of electrification on incumbent auto OEMs

High development costs and potential duplication

We view CO_2 compliance through electrification mainly as a negative-sum game. Years into simultaneous development of hybrid, PHEVs, BEVs and now fuel cells, there is no clear 'winning' technology, and there probably will not be one as various needs will be met by different technologies. In the meantime, OEMs continue to invest into multiple technologies.

Vertical integration in battery production and ICE legacy costs

Engines and powertrain have historically been the 'heart' or DNA of OEMs, with a high degree of vertical integration. Although plans remain vague or undisclosed, it seems the industry is now looking at vertically integrating the manufacturing of battery cell and electric motors, rather than relying on external purchases. Whilst this may make sense for new entrants like Tesla in order to drive down battery costs, most OEMs are confronted with looming legacy costs from their traditional internal combustion engine (ICE) expertise should the ICE lose meaningful market share to EVs.

Tax shift could lower profitability or accelerate replacement demand

Earlier in this report, we discussed the probability that governments will at some point reassess their financial incentives to buyers of EVs, given the upfront cost and subsequent loss of tax revenue from fossil fuels. Should governments reduce tax incentives to consumers, meeting CO_2 targets could require OEMs to substitute their own subsidies and discounts, thus reducing profitability. Alternatively, an even bigger transfer of the tax burden onto fossil fuels could create incentives to switch from ICE to EV power and accelerate replacement demand and a renewal of the auto parc.

Reduced demand for carbon fuels could affect the oil price

With vehicles accounting for about 60% of oil demand, the growth of EVs could negatively impact oil prices and skew running costs calculations more favourably towards fossil fuels

Reduced earnings from spares and repairs

Battery EVs benefit from simpler design and fewer components, which is translating into lower maintenance needs and lower spending on replacement parts. Given the industry's high reliance on spare parts profitability (estimated margins 2-3x higher than on new cars; estimated 5-7% of revenue and 10-15% of industrial EBIT), high EV penetration would reduce the profitability of OEMs and their dealers. The industry would need to revise its pricing structure to ensure that dealers generate profits from selling new cars.

Higher exposure to leasing and residual value risk

Given the pace of technological change, we expect the large majority of EV buyers will choose to lease rather than buy EVs, in effect leaving the technology risk with the OEM. As a result, we expect to see further growth in the OEMs' financial services balance sheets in excess of revenue growth, and higher risk from the residual values kept on balance sheets.

Impacted stocks

As discussed above, we see the implications of electrification as negative factors for OEMs and their dealers.

Tesla has highest leverage to falling battery costs

In our analysis, we find Tesla is the most levered to further progress in battery cost reduction. We estimate that the battery cost per kWh must fall by more than $70 to compensate for the benefit from incentives currently available in California. Given our expectations of a €100-150 reduction per kWh, Tesla would see the biggest impact on earnings, given the total mass and cost of its battery (3-4x higher than BMW's i3).

BMW highest leverage to weight reduction as source of ICE progress

Having reduced the weight of the required battery pack through extensive use of carbon fibre, we believe BMW is less geared to reductions in battery cost, although these of course will contribute to profitability and potential range extension. We believe the biggest leverage will be in using carbon fibre and other composites to reduce weight at the high end of its product range, thus lowering one of the hurdles to CO_2 reduction.

More positive for suppliers but beware of new entrants and legacy costs

Most auto component suppliers are positively geared to the theme of electrification, as well as the efficiency of internal combustion engines, either directly with solutions such as stop-start, turbo-charges or battery management systems (Valeo, Continental, Denso, Borg-Warner, and many others), or indirectly through weight reduction efforts which are affecting all auto components.

Among the risks and opportunities to consider, we would highlight:

- The growing role of suppliers which have traditionally been more diversified into other industries and are now growing their exposure to automotive applications, such as Infineon or Panasonic.
- The weight of legacy assets for suppliers where high growth in electrification represents a threat to their exposure to ICE technology.

Impact on European industrials

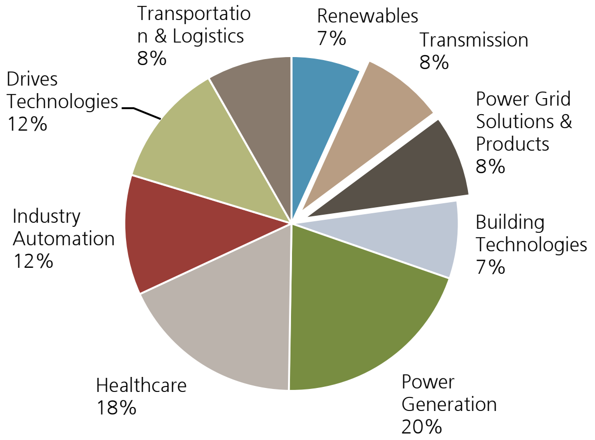
Decentralised generation, electric vehicles and storage offer attractive opportunities and some challenges for Siemens, ABB and Schneider Electric in our view. Simply speaking, moving the location of the power generation from location A to location B requires investment in infrastructure to distribute and control the energy flow. As suppliers of transmission and/or distribution equipment and software this is positive for Siemens, ABB and Schneider, in our view. In addition, decentralised power generation by renewable sources such as solar power increases the need for software and hardware to control and optimise demand/supply, again benefitting the three companies.

The smart grid is to a great extent about information management. You gather live data on the ebbs and flows of electricity in the grid and use software to optimise the allocation of the energy in the system. With the smart grid, decentralised generation, mobile consumers, prosumers and renewables, supply and demand data that has historically been captive to the traditional power generating utilities and grid operators will be made available to third parties such as the equipment suppliers. This opens up for the creation of, for example, virtual power plants where a solution of equipment and software from, say, Siemens can match buyers and sellers of electricity. Managing the vast amount of data that will flow through the smart grid will be a challenge that requires significant investment. As mentioned earlier in this document, our colleagues in the utility team believe the European smart grid is a EUR 290bn capex opportunity. There is little doubt in our mind that Siemens, ABB and Schneider Electric will look to capture a significant proportion of that revenue opportunity.

Below we provide a high level description of the exposures of our companies to the smart grid.

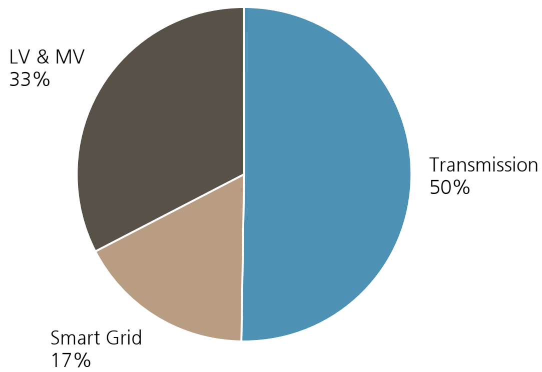
Siemens (Buy, PT EUR 105)

Figure 57: Siemens business split by revenues - 2013



Source: UBS, company data

Figure 58: Grid exposure - 2013



Source: UBS, company data

Siemens' smart grid operations generated EUR 2.1bn of revenues in fiscal 2013 while all grid related revenues including high, medium and low voltage totalled EUR 12bn or 16% of group revenues. The smart grid business has circa 9,500 employees, of which 1,600 are software engineers. In 2013 EBITDA margins were circa 12%. Siemens claims a number 1 position in the market for grid automation and a number 2 position in the market for rail electrification and smart grid services. Siemens' product offering includes power system protection equipment, grid control equipment (control centers), rail electrification solutions and smart meters that collect data to enables software solutions for end to end management of the grid. The latter is alongside microgrids, smart distribution and rail grids growth areas identified by Siemens with a combined growth potential of 8-10% per annum. Overall the smart grid market is expected by Siemens to grow 4-5% p.a. until 2018. Hence, with the information we have today, Siemens's smart grid business is likely to be a tail wind but not one that can drive the share price on a stand-alone basis.

Large scale power plants a potential drag

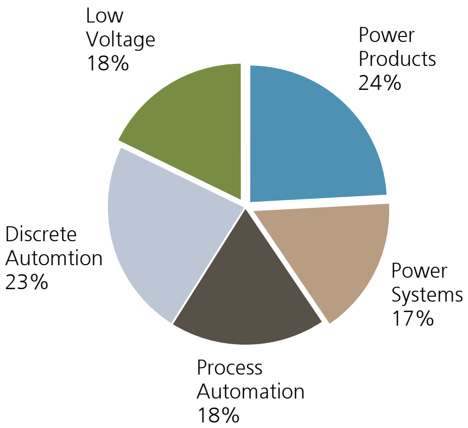
If our colleagues are correct in their view that large scale power plants have played out there role in Europe it will most likely provide an equal or greater headwind for the share price than the smart grid opportunity. The old Fossil Power business generated EUR 10.7bn of revenues and EUR 1.8bn of underlying profits in fiscal 2013, equal to 22% of group underlying profits. Margins have come under pressure since but it is still a considerable contributor to the group. Assuming that Europe generates a third of profits in the business, the threatened profit pool could constitute 5-7% of group profits today in our view.

Value with catalysts

At current price levels we find the stock attractively priced relative to its peers. The stock should re-rate as the company de-risks Transmission and launches the next round of cost cutting efforts in 1H15. The re-rating should be boosted further by a future part or full disposal/spin-off of the healthcare assets as well as other smaller parts of the portfolio. A potential catalyst for the stock will be the Capital Markets Day "Vision 2020" in Berlin the 9th of December. Our PT is based on EV/EBIT and PE multiples (2015e). At our PT the stock would trade on 10.5x calendar 2015e normalised EBITA, in line with sector mid-cycle multiple.

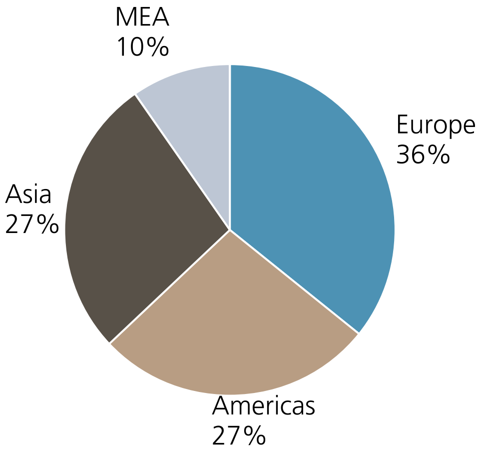
ABB (Neutral, PT CHF 21)

Figure 59: Divisional split, revenues – 2014e



Source: UBS, company data

Figure 60: Geographical split, revenues - 2012



Source: UBS, company data

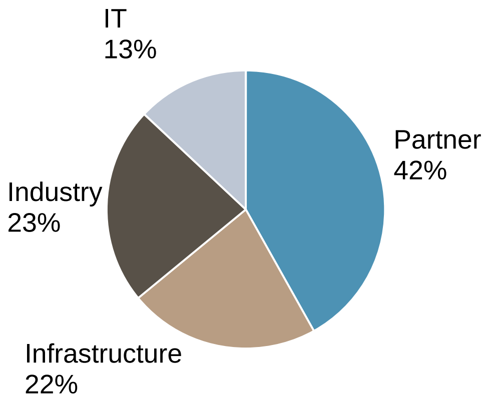
ABB is expected by us to generate almost 60% of revenues from products and solutions in the markets for low, medium and high voltage power flow. We believe that ABB has a strong offering in the transmission and utility side of the smart grid as well as on the distribution side in terms of substation automation, local grid measuring, monitoring and control for example. Through the 2010 USD 1bn acquisition of Ventyx as well as a number of smaller acquisitions, ABB has added to its software offering within smart grid. At the time of acquisition, Ventyx generated USD 250m in revenues and according to ABB tripled its addressable market for network management. ABB's product offering for smart distribution networks and buildings include electric vehicle charging equipment, solar inverters, distribution transformers and smart meters.

ABB is fairly valued

We keep our Neutral rating and PT unchanged. The stock is close to fairly valued at these levels in our view. On 10x EBITA it is trading at what we think is the fair mid cycle level but considering the spate of negative news in recent quarters and poor share price performance the stock has relative valuation support at these levels. However, for the stock to move we think management needs to announce a buy back and/or a strategic review. Given recent management commentary the latter seems unlikely today. The next expected catalyst is the London capital markets day on 9 September.

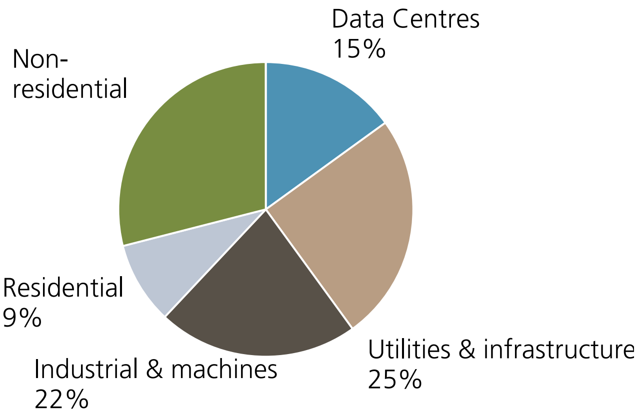
Schneider Electric (Sell, PT EUR 52)

Figure 61: Divisional revenues – 2014e



Source: UBS

Figure 62: End market exposure - 2012



Source: UBS, company data

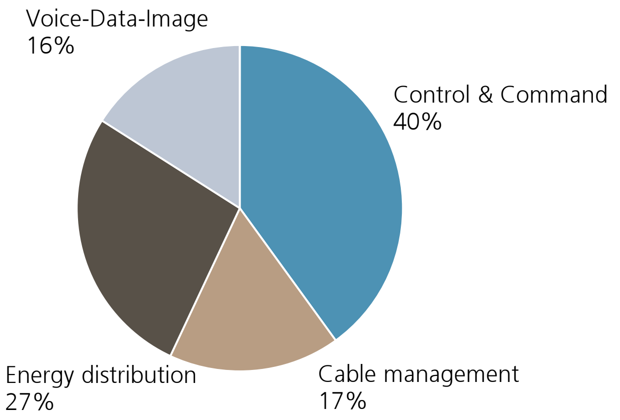
Schneider is alongside Siemens and ABB one of the market leaders in low and medium voltage distribution. Similar to its key competitors it offers products and solutions for smart distribution, renewables integration, smart meters, demand response, electric vehicle charging and solutions for homes and other buildings. Schneider has made a number of acquisitions to strengthen its hardware and software offering including the 2010 acquisition of Areva D for just over EUR 1bn as well as Telvent (software) for EUR 1.4bn in 2011.

We are Sellers because of IT and valuation

We downgraded Schneider to Sell late September 2013 on the back of an analysis that suggested Schneider's IT division revenues would go into decline and margins fall as a result (see our reports "Interruptible growth – downgrade to Sell" from 27 September 2013 and "Trends and dynamics around Schneider IT" from 12 December 2013 for more details). We continue to believe that IT will be a drag on the group and that consensus estimates as a result remain too high. We forecast IT LFL growth to decline 2% in 2014 (-1.2% in 2013) and 7.1% in 2015. Our group adjusted EBITA forecasts are 7% and 10% below consensus for 2015 and 2016e and our EPS forecasts are 4% and 9% below. On our estimates the stock trades on 12.5x 2015e EBITA and EV/revenues of 1.67x. Far too high, in our view, for a company with EBITA margins of 14% and a fair mid cycle EBITA multiple of 10-11x. At our EUR 52 PT, the stock would trade on 10.7x 2015e EBITA, 1.43x revenues and 13x EPS.

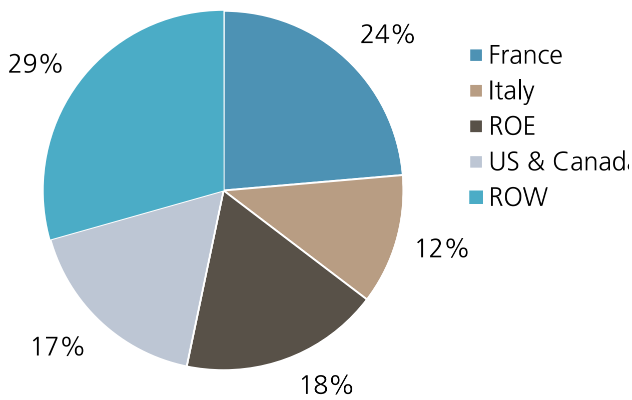
Legrand (Neutral, PT EUR 47)

Figure 63: Revenue split, product group - 2013



Source:

Figure 64: Revenue split, region - 2013



Source:

Legrand's smart grid offering is largely concentrated to the building and the measurement and control of energy consumption. Products include meters, equipment to visualise and analyse consumption as well as control the same. We rate Legrand Neutral with a PT of EUR 47. At our PT the stock would trade on c13x 2015e EBITA, full on an absolute basis but in line with Assa Abloy.

Wärtsila (Sell, PT EUR 30)

Our utilities team believes that in a decentralised electricity system, power generated by small and flexible units will be a pre-requisite. Utilities could build, own and operate small-scale CHPs for companies or municipalities for back-up power and heat supply under long-term PPA contracts. Alternatively, such units will be built as backup plants under the existing distribution regulatory framework, and consequently capex would increase the RAB and receive a highly visible regulated return. In our view Wärtsilä is one of the leading suppliers of such plants and it would therefore benefit from higher demand. However, this only seems a long-term upside as at least for the next five years we see the European power market being heavily oversupplied.

Impact on chemicals sector

Key component suppliers have largely developed as a result of the growth in battery materials for electronics. Cathode producers in particular have found it difficult to scale up to automotive-scale cathodes from electronic-scale, owing to stability and safety impacts.

Battery material suppliers evolved as a result of electronics demand; cathode upgrade to automotive levels is proving a significant challenge for some incumbents

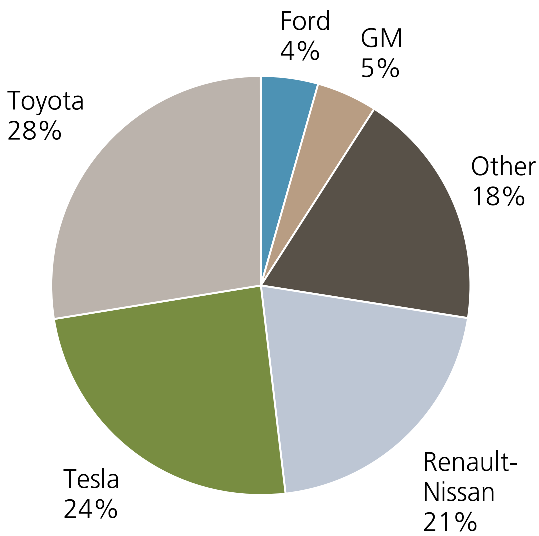
Due to the proprietary nature of emerging technologies, data on battery material sales by supplier into automotive applications remains limited. But analysis of electric vehicle sales shows some indicators of the current market. Tesla is currently utilising Panasonic and Sumitomo Metal Mining (SMM) NCA (nickel cobalt aluminium) cathodes.

Toyota is still using non-lithium-ion nickel-metal hydride legacy technology, which we believe will be replaced in the near future.

We believe that Umicore has won the largest number of platforms for the non-Tesla and Toyota business and, we believe, probably has a market share comparable to the SMM into Tesla share. Umicore does not disclose the size of its cathode material sales into automotive applications.

Umicore and SMM appear to be capturing about 50% of the automotive battery market

Figure 65: Electric car sales in terms of MWh sold as % of 5.72MWh annualised forecast sales for 2014



Source: Wall Street Journal, Lux Group, UBS estimates

Lithium-ion batteries were invented by Asahi Kasei, a Japanese Chemical company, and the technology today is largely a creation of the global chemicals industry.

While Umicore probably has the largest market potential this decade, with sales in automotive batteries likely to exceed €0.5bn by 2022, other companies – and in particular BASF and Johnson Matthey – have high ambitions. Vehicle electrification can be considered a significantly disruptive technology and introduces significant risks to auto-catalyst markets dominated by Umicore, BASF and Johnson Matthey. However, it also offers significant risks and opportunities to plastics and materials suppliers to the automotive industry.

Umicore likely to capture the most value from evolving vehicle electrification this decade; BASF aims to be largest supplier of battery materials globally

The drive for vehicle energy efficiency will likely move to a new level, which will increase the penetration of advanced composites, specialty polymers and high efficiency tires Key companies in this area include Solvay, DSM, BASF, Tokuyama, Toray, DuPont, Ems-Chemie, Arkema, Lanxess and JSR.

Figure 66: The chemicals supply map into lithium-ion batteries

Stock	Market Cap	Comments	Cell Assembley	Cathode	Anode	Separators	Electrolytic Solutions	Battery recycling
LG Chemical (051910 KS)	US$17.5bn	A leading assembler of batteries and through the LG group providing a wide range of components for use in Lithium Ion Battery Packs	Top 3 supplier in total batteries market Leading supplier of automotive batteries					
Umicore (UMI BB)	US$5.7bn	Key developer of cathode materials with particular focus on NMC, NCA, LFP technologies. Pioneering technology to recover metal from spent cathodes		Leading supplier of lithium ion battery cathodes into EV autmotive applications.				Pilot facility in operation for metal recovery from NMC cathodes
Hitachi Chemical (4217 JT)	US$3.7bn	Graphite anode material technology and sales leader			No1 Producer Globally of Lithium Ion Anodes			
Mitsubishi Chemical (4188 JT)	US$6.7bn	Only supplier to provide the combined platform of technologies - anodes, cathodes, electrolytes and separators		NMC Cathode producer	Second largest Producer Globally of Lithium Ion Anodes	SEPALANT ® - Poly propylene based separator technologies	No.2 producer globally	
Asahi Kasei (3407 JT)	US$11.3bn	Inventor of the Lithium Ion Battery technology in the 1980's				No1 separator producer glohally. Hipore ® microporous polyolefin technology		
Toray (3402 JT)	US$11.2bn	A Leader in separator technologies				No.2 separator producer glohally SETELA ® brand		
Ube Industries (4208 JT)	US$1.7bn					Top 10 producer globally UPORE ® polyolefin technology	No.1 producer globally Purelyte ® brand	
Tokuyama (4043 JT)	US$1.2bn						Top 10 producer globally	
Arkema (AKE FP)	US$4.7bn					PVDF technology Kynar ® brand		
Solvay (SOLB BB)	US$13.1bn					Top 10 producer globally Utilises Monofluoroethylene carbonate technologies F1EC ®		
BASF SE (BAS GR)	US$92.3bn	Targets €0.5bn of sales in battery materials by 2020 and EBIT breaking even from 2020. The business will be an ongoing €60-80m burden for the catalyst business line until 2020 Plans to become the world's leading system supplier of functional materials for high performance batteries						
Johnson Matthey (JMAT LN)	US$10.2bn	Acquired lithium ion battery manufacturing assets from A123 and Axeon						
Clariant (CLN VX)	US$6.0bn			Leading supplier of LFP cathodes and manufacturing technology				

Key	
	>15% of revenues
	10-15% of revenues
	5-10% of revenues
	0-5% of revenues
	R&D interest only

Source: UBS estimates

Appendix: Battery technologies

Cathode technologies are the core differentiator for end usage, as they largely dictate energy, power, safety, lifetime and cost considerations.

- Specific energy – the energy density of the battery – ie, kWh per kg
- Specific power – the rate at which a battery can dissipate energy – ie, kW/kg

NMC cathodes are likely to dominate in electric vehicles

NMC technologies are likely to dominate automotive platforms

The high specific energy rating, coupled with high ratings in safety and lifespan, has made NMC (nickel, manganese, cobalt) the most favoured cathode material for low-cost electric vehicle batteries. Tesla has utilised NCA (nickel, cobalt, aluminium) materials in its Model S, but we believe that it will probably need to shift to NMC cathodes if it is to achieve the kind of cost per kWh aspirations it hopes for.

While LMO, NMC and LFP all have strong application potential in hybrid electric vehicles

The lower requirement for energy density means that both LMO and LFP can also be used in hybrid electric vehicles.

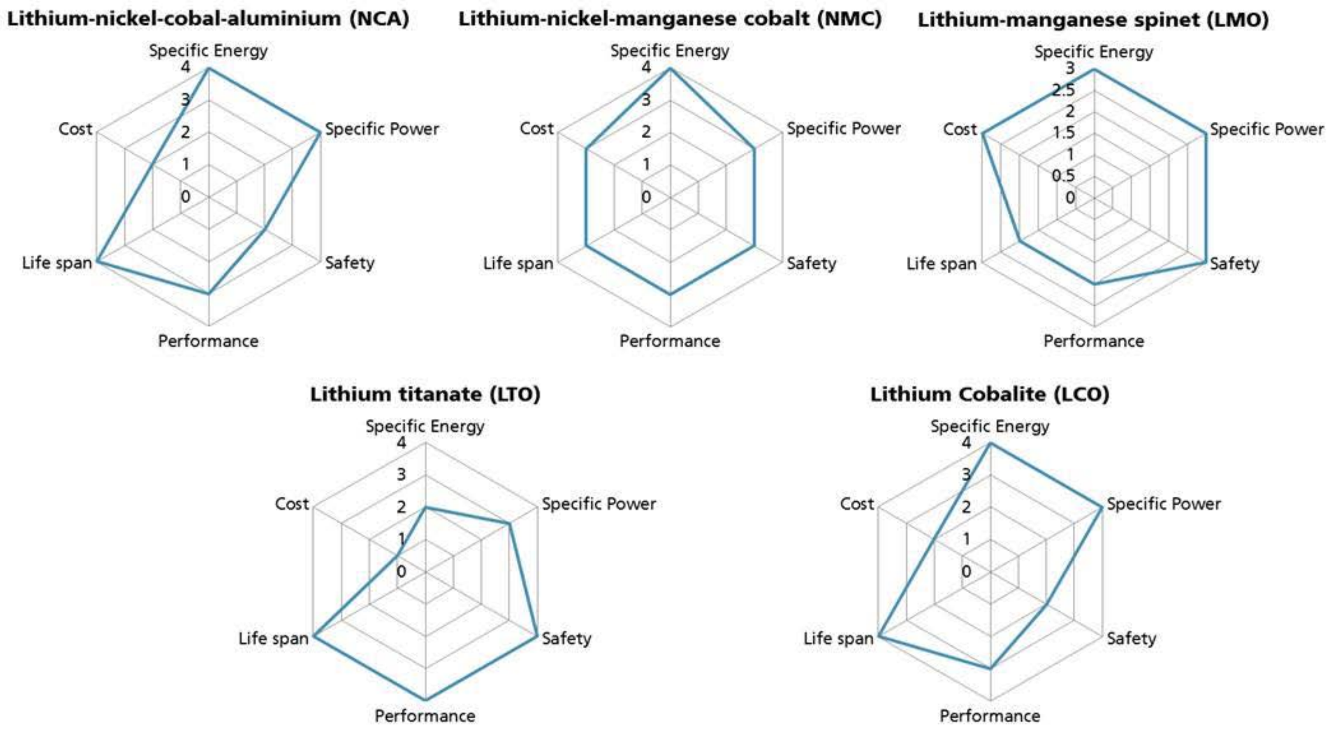
Figure 67: Battery performance summary

	Energy	Power	Safety*	Life	Cost
LCO lithium cobaltite $LiCoO_2$	+++	+++	-	++	+
LMO lithium manganese oxide $LiMnO_2$	-	+++	++	-	++
NMC nickel manganese cobalt $Li(Ni_xMn_yCo_{1-x-y})O_2$	++	++	++	+++	+++
LFP lithium iron phosphate $LiFePO_4$	+	+++	+++	++	++

* Impacts battery package design

Source: Umicore

Figure 68: Battery technologies – several options available, with varying capabilities



Source: UBS Chemicals & Autos Expert Conference Call slides, 2 July 2014. Slide material prepared by Bob Feldmaier.

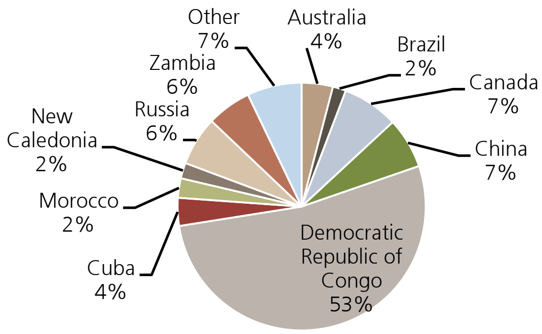
A low specific energy number favours LFP along with NMC for energy storage applications

Energy storage applications, particularly for areas such as residential or smart grid applications, can potentially make do with technologies with a lower energy density and power level. Material costs in particular become increasingly important for storage applications, as these can become quite large.

LFP and NMC will likely find significant penetration in stationary storage applications

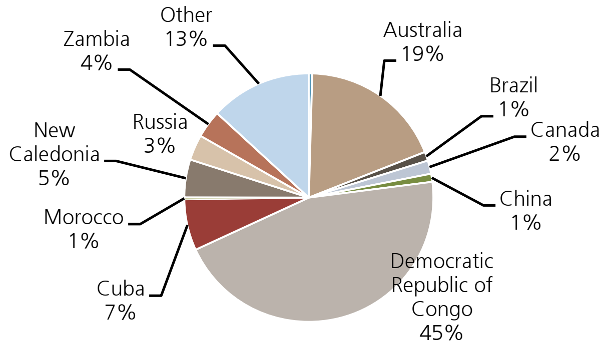
Battery material recycling – critical for long-term sustainability

Figure 69: Global cobalt production, 2011 basis (% of 98k tonnes)



Source: USGS

Figure 70: Global unmined reserves of cobalt (% of 7.53m tonnes)



Source: USGS

The primary risk to users of lithium-ion batteries are raw material supply risks. Technology risks, while significant for battery material suppliers, would be supportive for purchasers of lithium-ion battery technologies in automotive and solar.

NMC technologies carry significant commodity risk, given exposure to cobalt.

Umicore is the only company developing and researching recycling processing technologies for nickel cobalt spent materials

Umicore is in the process of piloting an ultra-high-temperature (UHT) smelting technology which offers the ability to purify cobalt and nickel metal from spent cathode materials. This is something that has proven to be difficult to achieve in the past. Initial estimates indicate that the cost of metal recovery from spent materials will be more than the value of recovered nickel and cobalt metal, and at current spot prices it is unlikely that economics would shift significantly for the process to make it net positive. Clearly, lithium-ion battery end-of-life handling costs become an additional life-cycle cost for the auto producers as legislation requires recycling; we believe the onus may well fall on the aftermarket activities of auto producers. Umicore has indicated to us that the impact on the total cost of production is similar to adding satellite navigation system – ie, less than €1,000.

Statement of Risk

Utilities are driven by commodities, power prices, M&A, regulatory intervention and interest rates.

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Source: UBS. Rating allocations are as of 30 June 2014.
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BMW	BMWG.F	Buy	N/A	€88.98	19 Aug 2014
Clariant[4, 5, 18a]	CLN.VX	Buy	N/A	CHF16.66	19 Aug 2014
Consolidated Edison[6, 16]	ED.N	Neutral	N/A	US$57.38	19 Aug 2014
Edison International[6, 16]	EIX.N	Buy	N/A	US$58.42	19 Aug 2014
Enel[2, 4, 6]	ENEI.MI	Buy	N/A	€3.89	19 Aug 2014
Fortum[5]	FUM1V.HE	Sell	N/A	€19.19	19 Aug 2014
Hitachi Chemical	4217.T	Buy	N/A	¥1,830	20 Aug 2014
Iberdrola[2, 4, 5]	IBE.MC	Buy	N/A	€5.44	19 Aug 2014
Infineon Technologies AG[18b]	IFXGn.DE	Buy	N/A	€8.72	19 Aug 2014
Legrand	LEGD.PA	Neutral	N/A	€42.04	19 Aug 2014
NARI Technology Development	600406.SS	Buy	N/A	Rmb14.62	20 Aug 2014
Siemens[3a, 4, 5, 14]	SIEGn.DE	Buy	N/A	€92.79	19 Aug 2014
Tesla Motors[13, 16]	TSLA.O	Neutral	N/A	US$256.76	19 Aug 2014
Umicore	UMI.BR	Buy	N/A	€36.55	19 Aug 2014
Valeo	VLOF.PA	Buy	N/A	€92.09	19 Aug 2014
Verbund AG	VERB.VI	Neutral	N/A	€14.80	19 Aug 2014
Wartsila[3b, 5]	WRT1V.HE	Sell	N/A	€37.64	19 Aug 2014

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