

When Will Electric Vehicles be Cheaper than Conventional Vehicles?



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Executive Summary

Automotive manufacturers have set ambitious plans for electrifying their fleets in the next few years. Still, there are many concerns over the price of electric vehicles, their acceptance by consumers and their effect on companies' profitability. In this note, we analyse the cost structure of electric cars to show the contribution of various components and the trajectory of future costs.

- Battery electric cars will be more expensive than equivalent internal combustion engine vehicles for the next 7-9 years, depending on segment. By the end of the 2020's, the average BEV in the US and Europe will be cheaper than a comparable ICE in all market segments, though for small cars the gap will be marginal. We believe that these price signals will drive the mass adoption of EVs.
- Cost reductions are highly reliant on mass manufacturing – both of vehicles and batteries. Policy is critical here, since tough fuel economy regulations play an important role in driving the scale-up in EV manufacturing over the next 5-7 years.
- Watering down fuel economy rules in the US and other countries has the potential to derail the trajectory of price declines forecast here.

2025

The earliest year of price parity between ICEs and BEVs

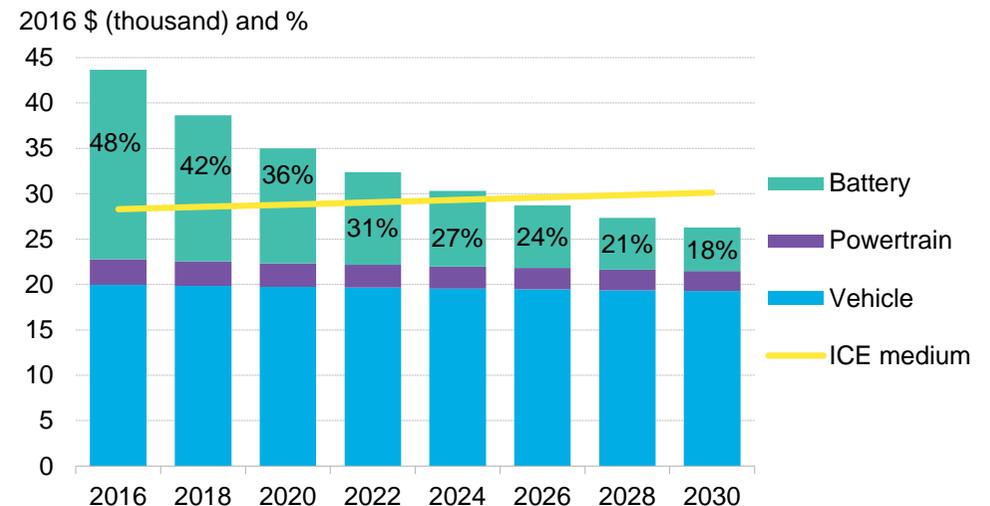
48-55%

Share of the battery in the price of a mass manufactured BEV at the moment

18-23%

Share of the battery in the price of a BEV by 2030

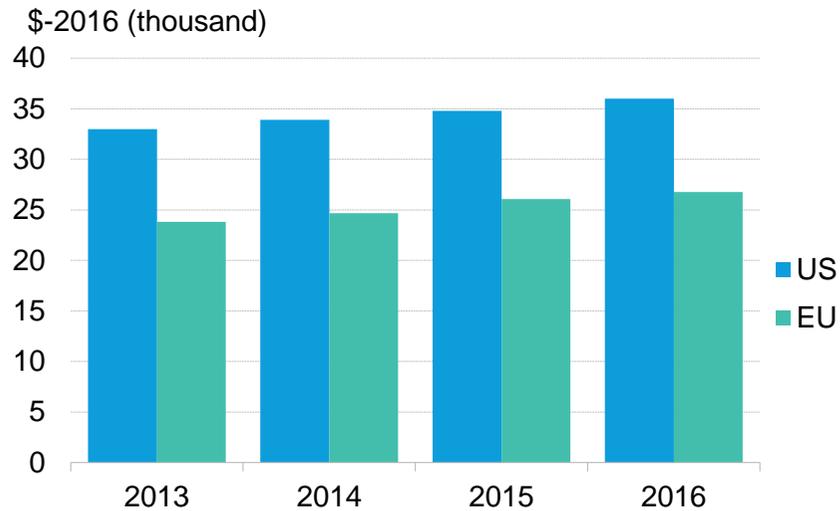
US medium BEV price breakdown, ICE price and share of battery costs



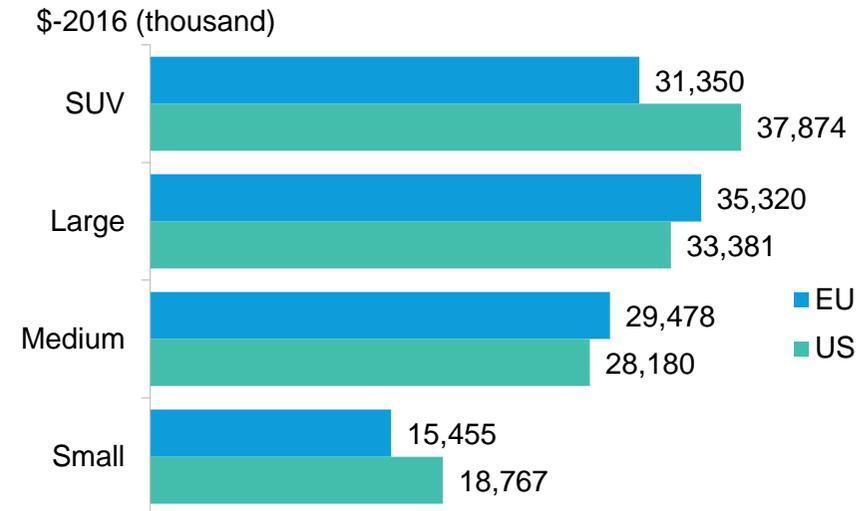
Source: Bloomberg New Energy Finance Note: Estimated pre-tax retail prices

Vehicle segments and EV specifications

Average pre-tax vehicle retail price in the U.S. and EU



Segment pre-tax vehicle retail price in the U.S. and EU in 2016



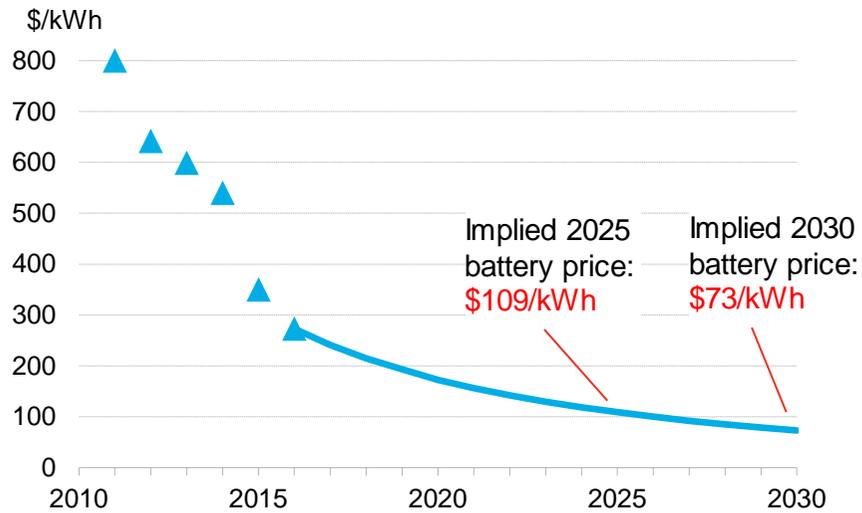
Source: Bloomberg, ICCT, Bloomberg New Energy Finance Note: Prices exclude tax; segment price is the weighted-average MSRP in 2014-15; luxury and sport vehicles are excluded; the FX conversion USD/EUR=1.11 is the average of 2015-16; 2016 prices in the EU are estimated using the CAGR between 2010-15

- Vehicle retail prices have been rising in the past few years in the U.S. and Europe above their historical growth rates of around 1.5% in the US and 2% in Europe.
- Small cars and SUVs are on average markedly cheaper in the EU than the US; a reflection of consistently larger and more powerful vehicles in the US in these segments. In contrast, medium and large cars are slightly more expensive in Europe. However, the after-tax retail prices are higher in Europe across all segments.
- In order to forecast vehicle prices, we assume that in the future battery electric vehicles will populate existing market segments. We have also assigned range and power specifications that we assume BEVs will need to compete in the relevant segments. These are shown in the table, and are applied for all countries

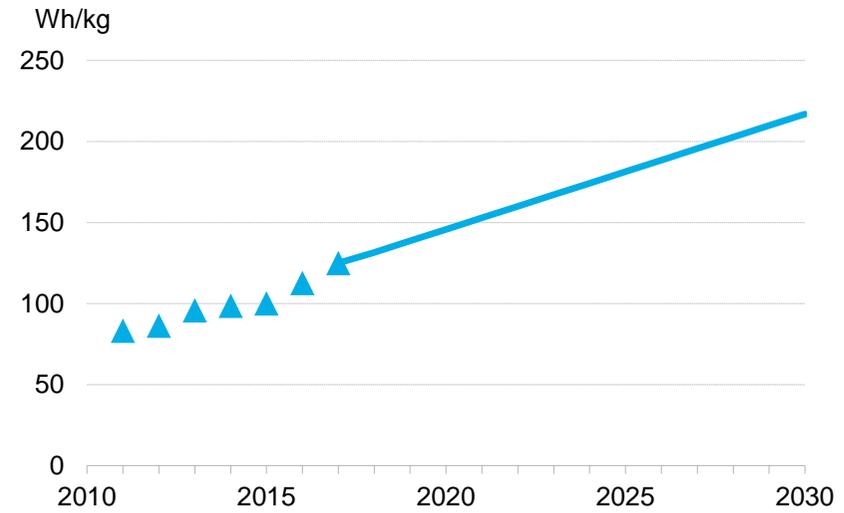
Segment	BEV range in EPA test cycle, miles (km)	BEV Average power in 2015-16, kW
Small	200 (322)	73
Medium	250 (402)	112
Large	300 (483)	173
SUV	300 (483)	150

EV competitiveness is heavily dependent on battery cost and technology improvements

Historical and forecast average EV lithium-ion battery prices



Historical and forecast weighted average battery energy density



Source: Bloomberg New Energy Finance Note: We use a 19% learning rate for future battery prices (which includes cell plus pack) and demand from our 2016 EV sales outlook ([web](#) | [terminal](#)); we will update our forecast in Q2 2017, which will affect total battery demand. However, we believe that the cost trend will not fundamentally change. Triangles denote observed values, the dashed line is our forecast. All forecast values are in real 2017 US dollars. Battery density is weighted by EVs sold.

- Battery costs are dropping at around 19% per cumulative doubling of manufactured capacity. We expect Large manufacturing capacity additions ([web](#) | [terminal](#)) and incremental technology improvements between now and 2025 to sustain falling costs, beyond that costs reductions will likely slow on an annualised basis.
- We expect average battery energy density will double by 2030 to more than 200 Wh/kg, on the back of continuous improvements in battery chemistries, higher material efficiencies and better engineering. The effects of these technological advancements are twofold: smaller battery capacity requirements – up to 15% by 2030 – and lower vehicle weight.

Battery cost and technology analysis

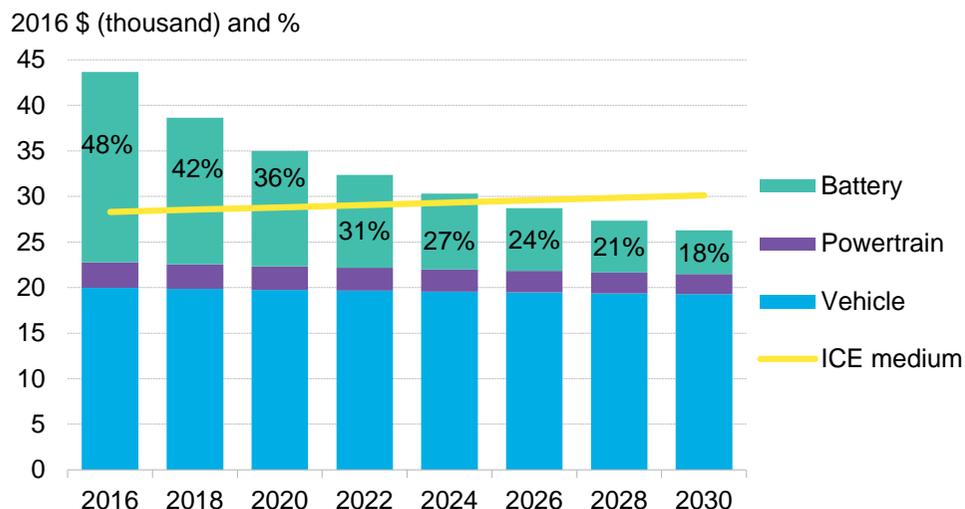
2016 lithium-ion battery price survey ([web](#) | [terminal](#))

Bottom up cost scenarios for lithium-ion batteries ([web](#) | [terminal](#))

Max capacity: energy density improvements in lithium ion batteries ([web](#) | [terminal](#))

BEV prices will become as cheap as ICEs in the 2020's, but segment and regional differences will exist

U.S. medium BEV pre-tax price breakdown, ICE pre-tax price and share of battery costs



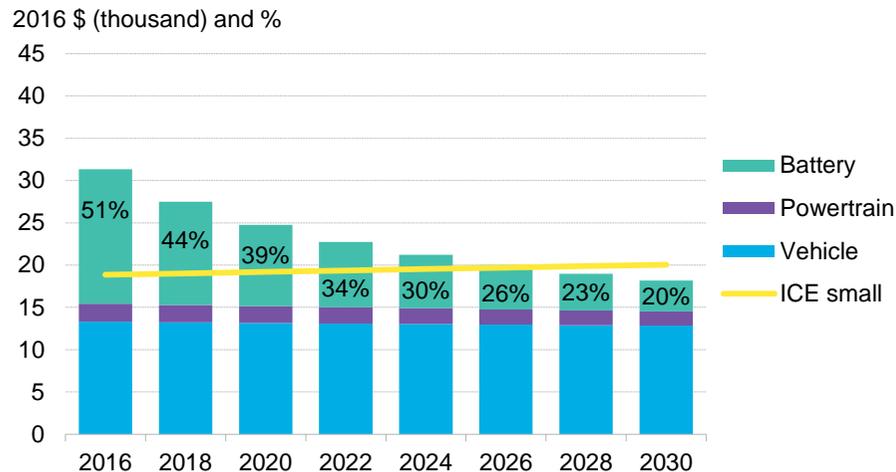
- We expect base vehicle costs, such as body and chassis, to drop for battery electric cars, due to simpler design and easier manufacturing. For ICEs, these costs will slightly increase, as a result of additional light-weighting (web | terminal) and other measures to meet CO2 emissions and fuel economy requirements.*
- We expect electric powertrain costs for BEVs, such as motors, inverters and electronics, to drop by about 20-25% by 2030, mainly due to volume manufacturing.
- The most expensive component of electric vehicles is currently the battery, which we expect to contribute between 18%-23% of the price by 2030, down from around 50% at present.
- In the US, BEVs and ICEs in all segments will cost the same around 2026. In Europe, medium vehicles should reach price parity earlier – by 2025 – compared to small and medium cars and SUVs. In particular, small BEVs will not be price competitive until late in the decade, due to the low ICE prices in the segment.
- In both regions, the SUV and large vehicle segments will reach price parity after 2026. This does not seem to have deterred some OEMs, who are planning SUV and crossover BEV launches around 2020. However, several have acknowledged that generating significant profits from EVs will be challenging over the next few years until battery prices drop further.

Segment	Year of price parity, US	Year of price parity, EU
Small	2027	2029
Medium	2026	2025
Large	2026	2026
SUV	2026	2028

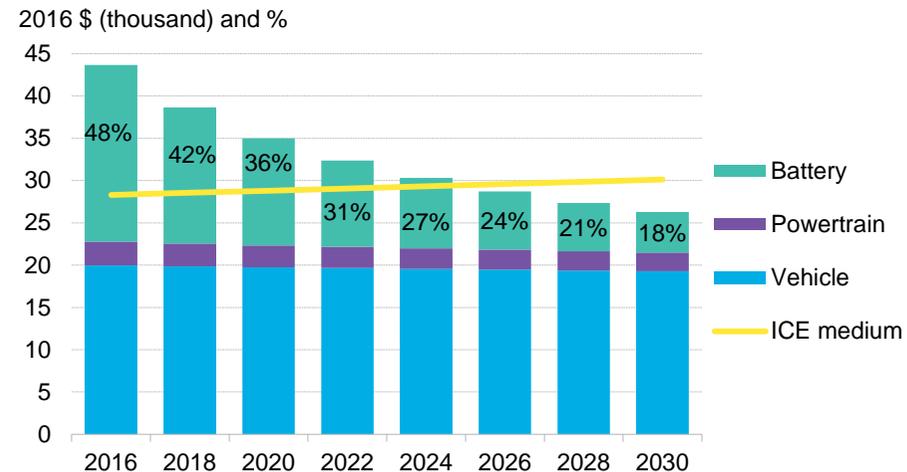
Source: Bloomberg New Energy Finance Note: Estimated pre-tax retail prices; Note: our analysis uses data from the EPA, ICCT, FEV, ONRL, IDL

BEV and ICE pre-tax prices in *the US* and the share of battery costs in the vehicle price

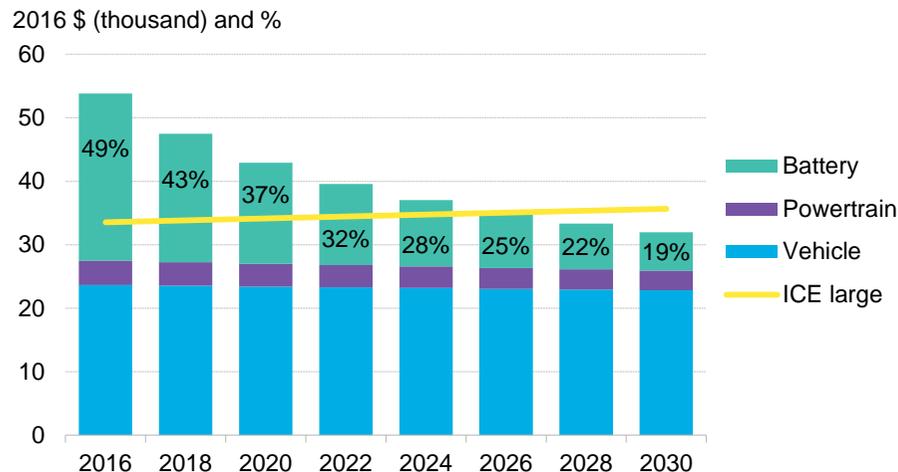
Small segment price and share of battery cost



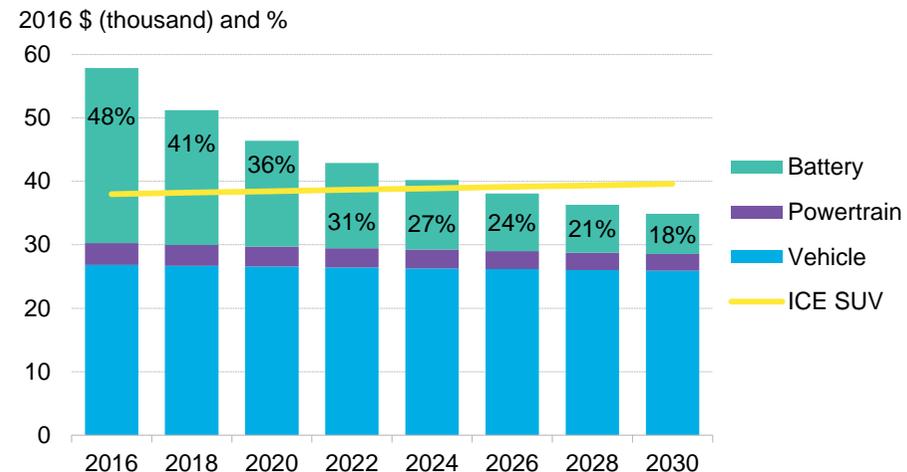
Medium segment price and share of battery cost



Large segment price and share of battery cost

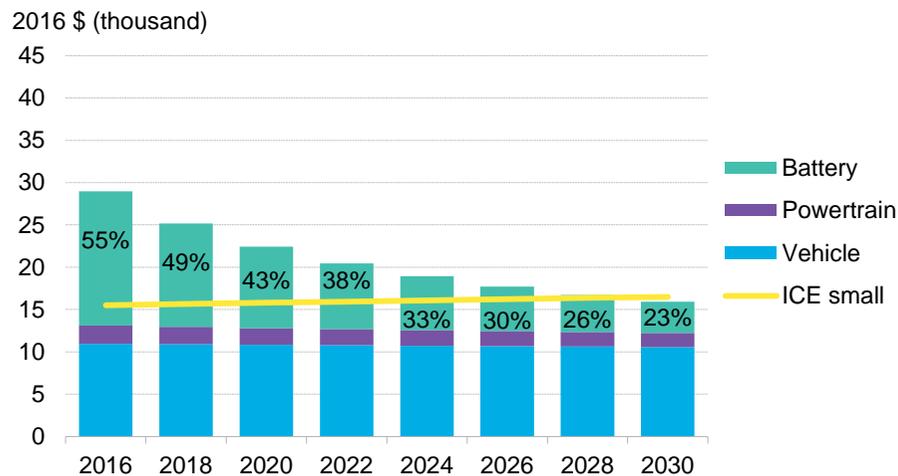


SUV segment price and share of battery cost

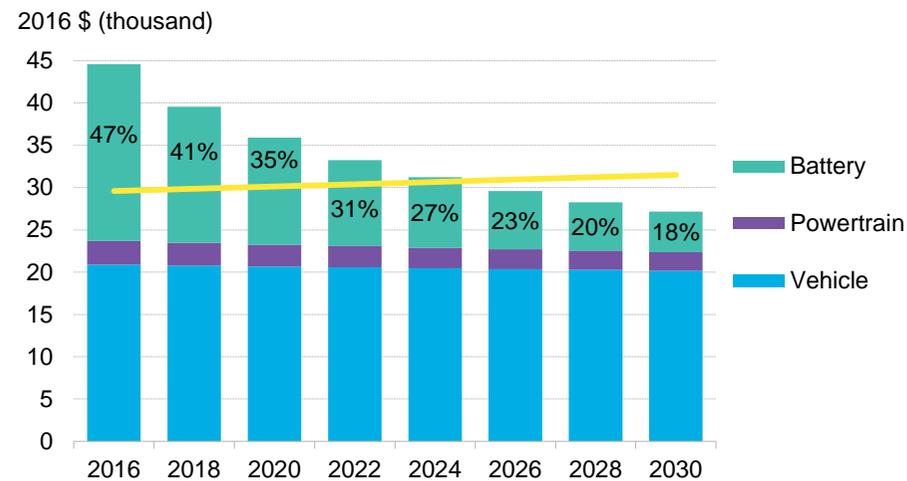


BEV and ICE pre-tax prices in *the EU* and the share of battery costs in the vehicle price

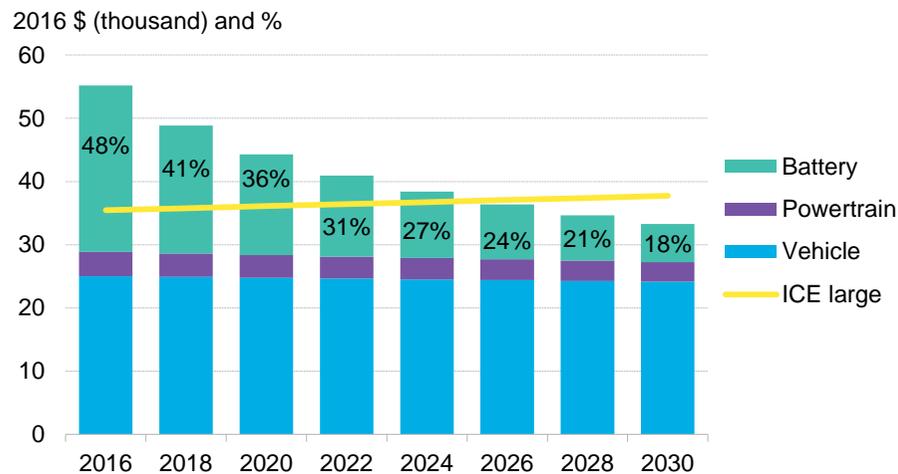
Small segment price and share of battery cost



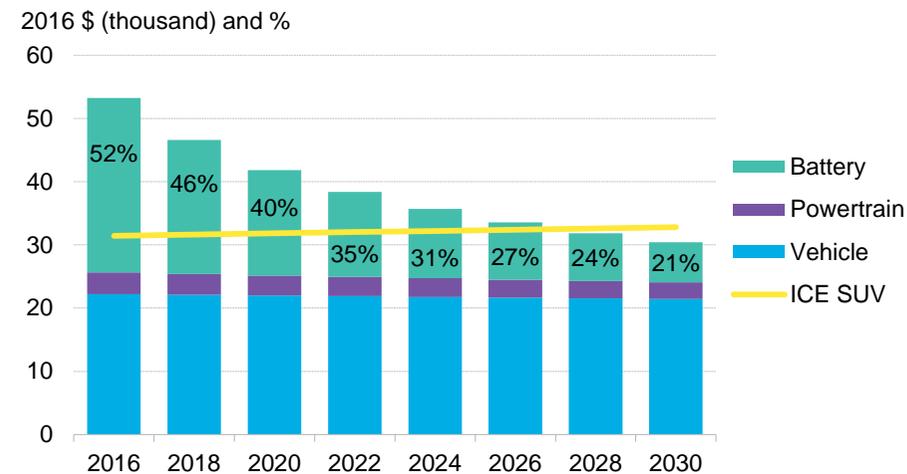
Medium segment price and share of battery cost



Large segment price and share of battery cost

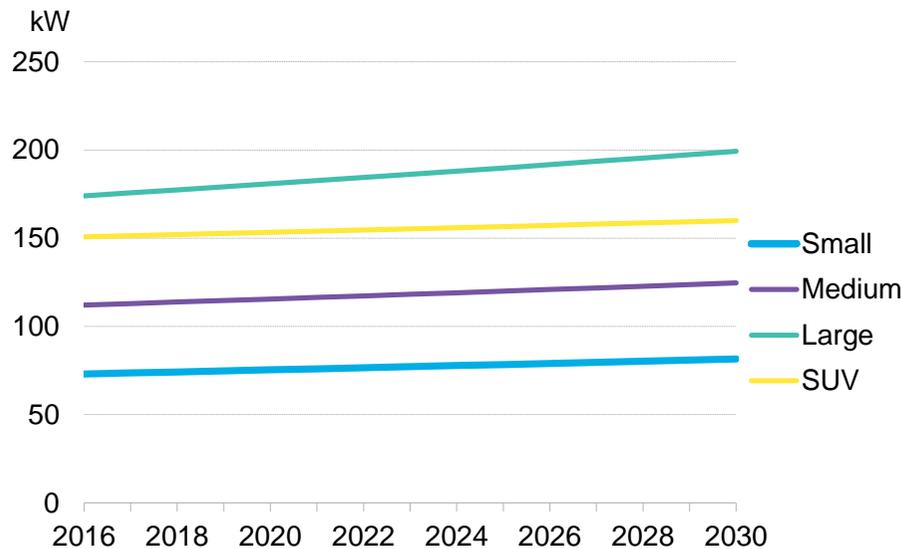


SUV segment price and share of battery cost

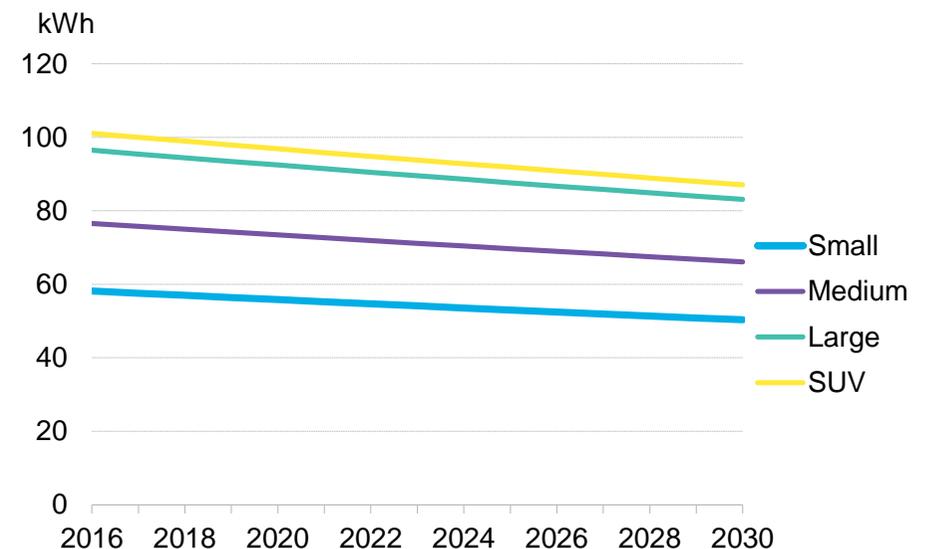


Battery electric vehicle specifications

Vehicle power per segment



Battery capacity per segment



Source: Bloomberg New Energy Finance Note: The required range of a vehicle in each segment is treated as constant to 2030

- In order to derive our forecasts, we have made several estimates on how battery capacity and power evolve for BEVs between 2017 and 2030:
 - We expect battery capacity requirements to drop up to 15% by 2030. This means large cars and SUVs will need batteries of around 85 kWh to cover 300 miles, down from roughly 100 kWh today. Medium-sized vehicles' batteries will be just over 65 kWh for 250-mile range, while smaller vehicles will largely use batteries of about 50 kWh to achieve 200-mile range.
 - We expect power requirements for vehicles to increase over time, but lower vehicle weight will counteract the trend. We expect the weight of the average battery electric vehicle to drop by about a quarter to 2030, with more than half of the gain coming from lighter batteries. Average power requirements will increase between 5% and 15% by 2030.

Outlook

- We expect battery electric vehicles to be up to 15% cheaper than equivalent ICEs by 2030. To make this comparison, we assume that costs for internal combustion engine vehicles will rise slightly in the future to comply with an increasingly stringent regulatory environment. This is supported by analysis from groups like the EPA, NHTSA, and from statements from the car manufacturers.
 - However, automotive manufacturers could delay this trend by merging or otherwise pooling manufacturing capacity, *withdrawing from certain markets* ([web](#) | [terminal](#)) and pursuing higher efficiencies in all aspects of their operations. Potential relaxation of fuel economy and emissions regulations – as is being currently *discussed in the US* ([web](#) | [terminal](#)) following the *change in administration* ([web](#) | [terminal](#)) – could ease these cost pressures and alter the projected pricing dynamics between BEVs and ICEs.
- Our underlying costs for vehicle and component manufacturing of electric vehicles assumes high production volumes. This typically means output of more than 100,000 vehicles per year. At the moment, manufacturers do not produce EVs at this scale, so unit costs for body and other parts are currently higher for EVs than ICEs. We estimate that by 2020-22 production capacity of electric vehicles will scale up for the more aggressive car makers and we expect a premium of 20-30% in the next three to four years to the component manufacturing cost of EVs.
- Changing costs will make EVs competitive with their ICE counterparts over the next ten years, but economics alone will not dictate adoption. Many other factors play a large role. These are covered in-depth in past BNEF publications and will be addressed in our upcoming Long Term EV Adoption Outlook.
- Our analysis is based on modelling an average vehicle in every segment. Individual manufacturers will have distinct cost structures depending on things like the geographical location of their manufacturing assets and their production volumes. In addition, individual brands have different pricing power to position their vehicles in the market.

Further reading



Further analysis

The impact of fuel economy regulations on EV adoption: US ([web](#) | [terminal](#)); Europe ([web](#) | [terminal](#))

Global EV policy support library ([web](#) | [terminal](#))

2016 long term adoption outlook ([web](#) | [terminal](#))

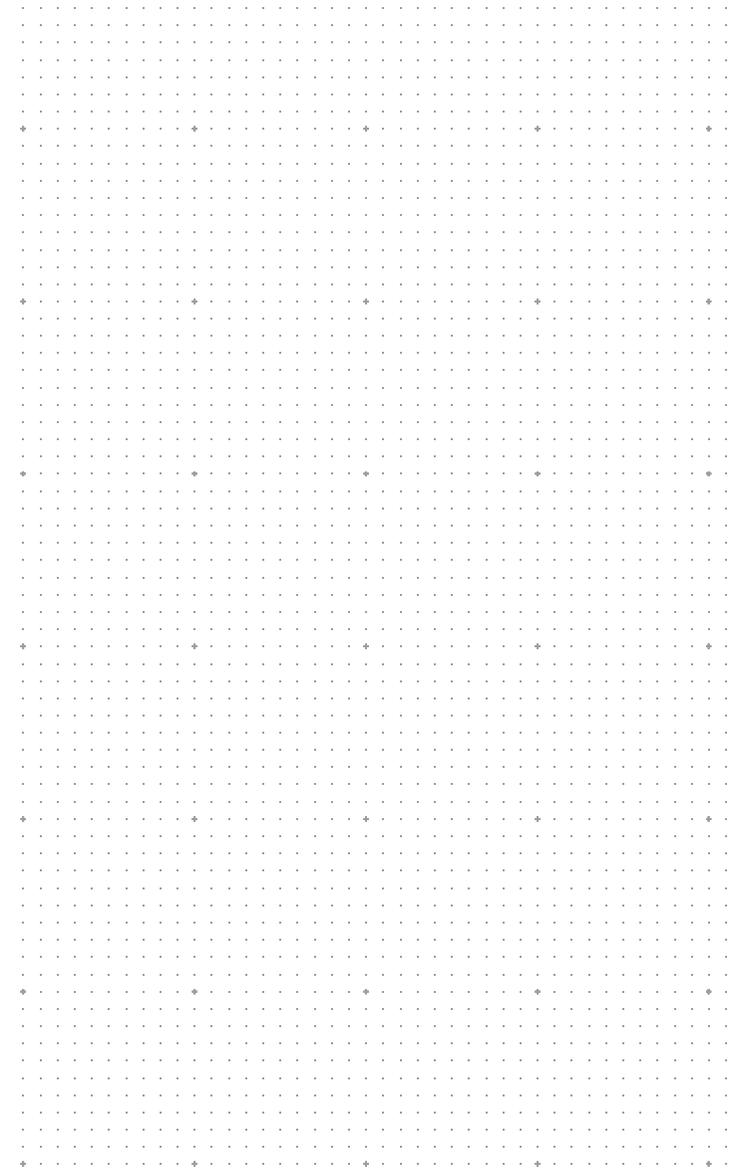
Metals demand from batteries ([web](#) | [terminal](#))

Bottom up cost scenarios for lithium-ion batteries ([web](#) | [terminal](#))

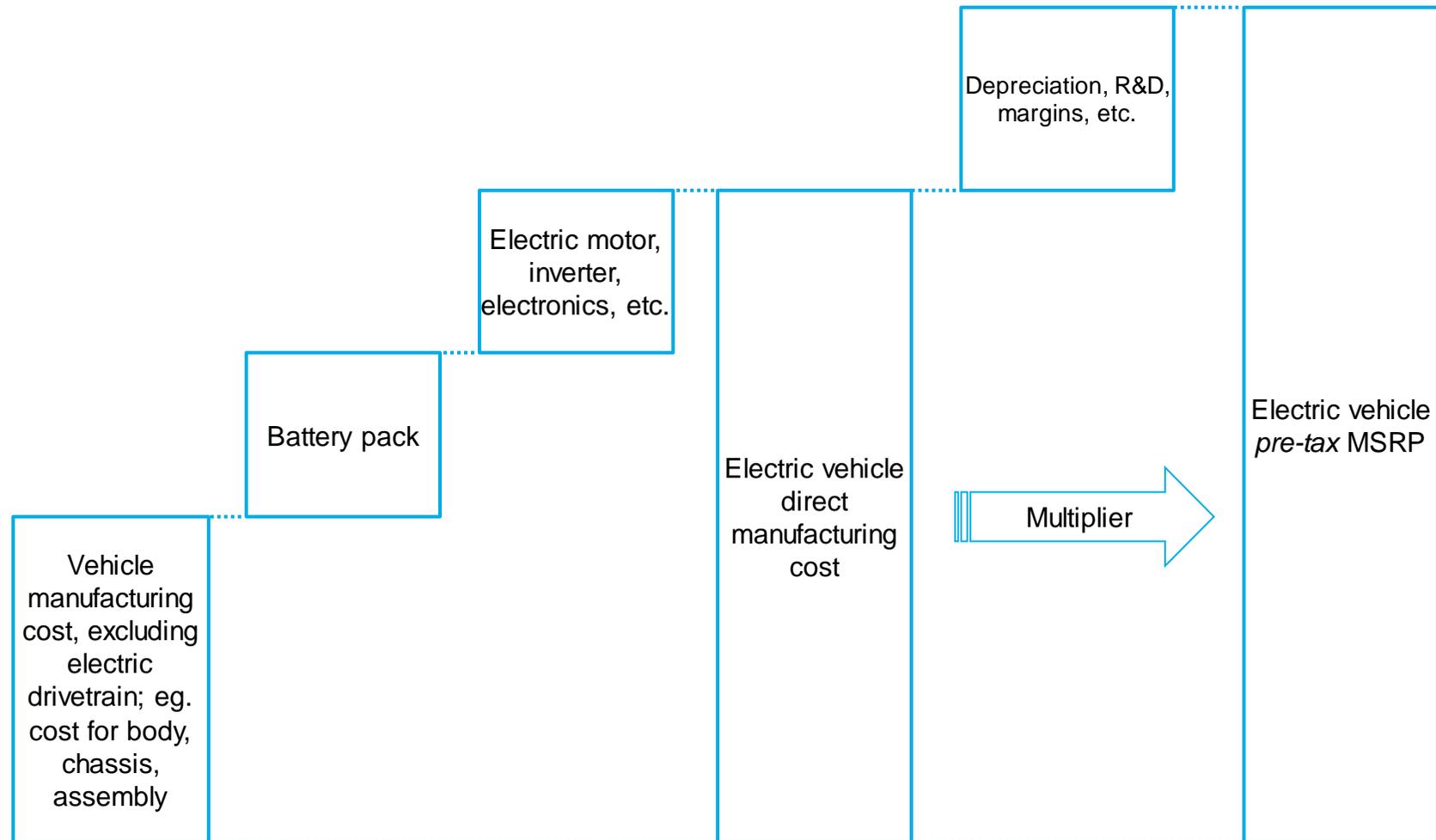
Battery Manufacturing Database ([web](#) | [terminal](#))

Q1 2017 Global Electrified Transport Market Outlook ([web](#) | [terminal](#))

Methodology



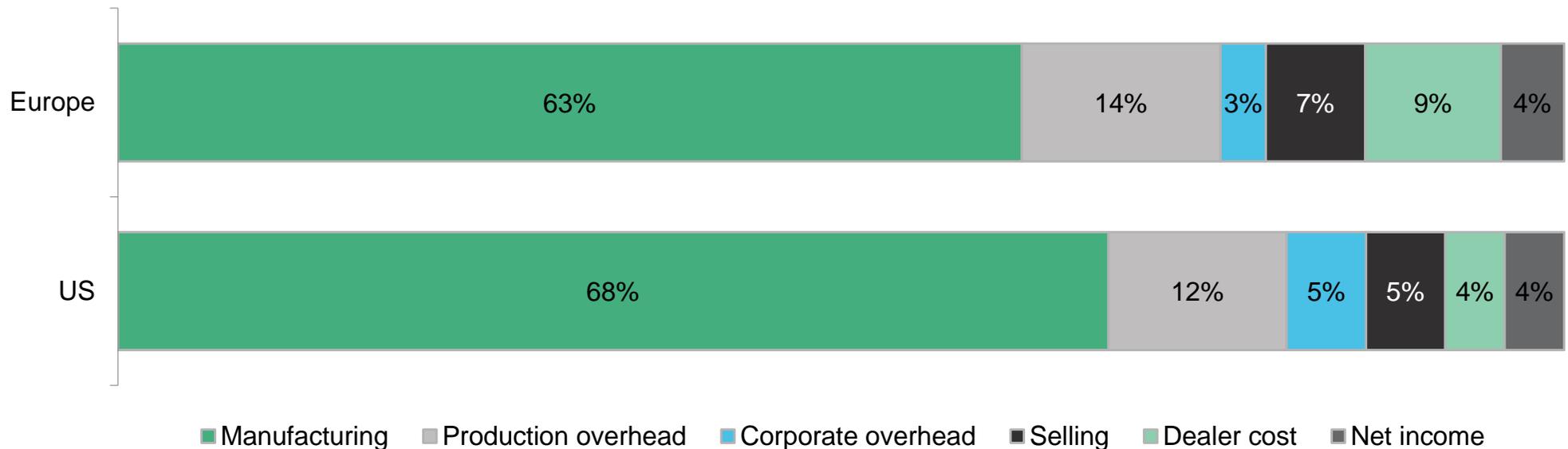
Electric vehicle pricing methodology



Source: Bloomberg New Energy Finance Note: The battery prices in our price survey, which we use in this cost model, are final prices; these include all indirect costs, such as R&D and depreciation, so battery costs are not adjusted with the multiplier to arrive at the retail price.

Vehicle Retail cost breakdown by component

Cost contributions to a vehicle's retail price in the U.S. and Europe (%)



Source: EPA, FEV

- The cost multiplier from the previous slide accounts for depreciation, R&D, Selling and general administrative expenses, and OEM and dealer margins.
- Around two-thirds of a vehicle's retail price cover direct manufacturing costs, such as materials, labour and tools. This leaves 10-12% for dealer and OEM profit.
- The cost structure between the U.S. and Europe is similar, with differences mainly reflecting dealer and labour costs.
- In assessing the manufacturing cost of a BEV we assume volume production of around 100,000 or more vehicles per year. Manufacturers are generally below this now, but we expect many to be at this level around 2020 based on their stated plans.

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