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Battery Storage Costs and Implications for the Electrification of Transportation

California Energy Commission

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May 2, 2019

 @LoganGoldieScot

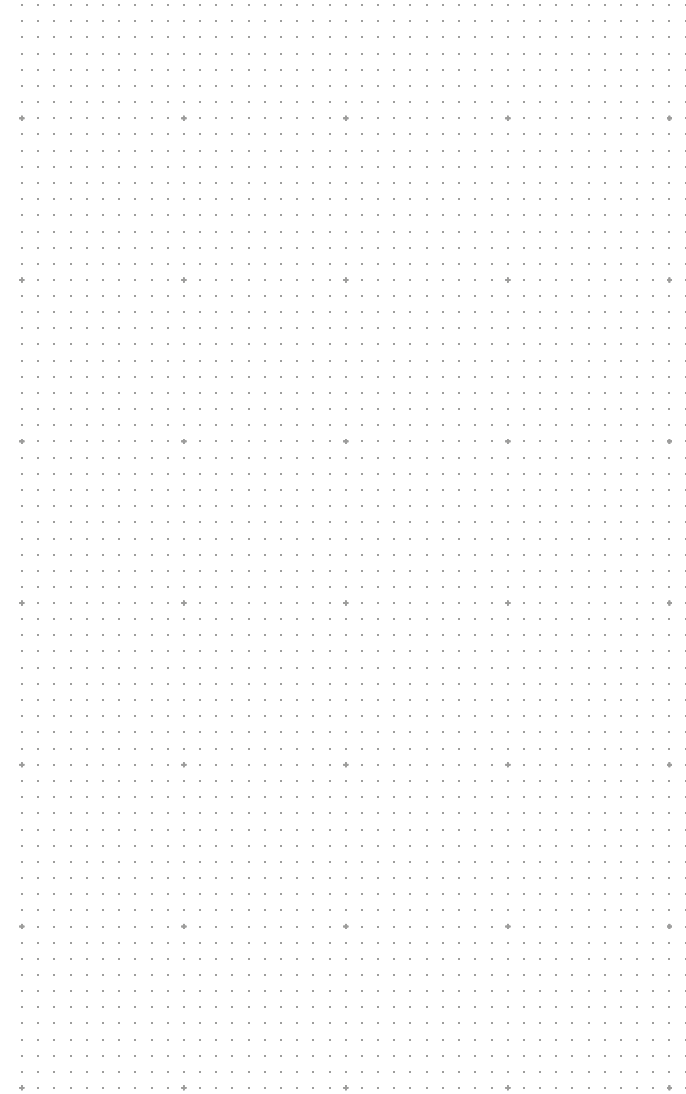


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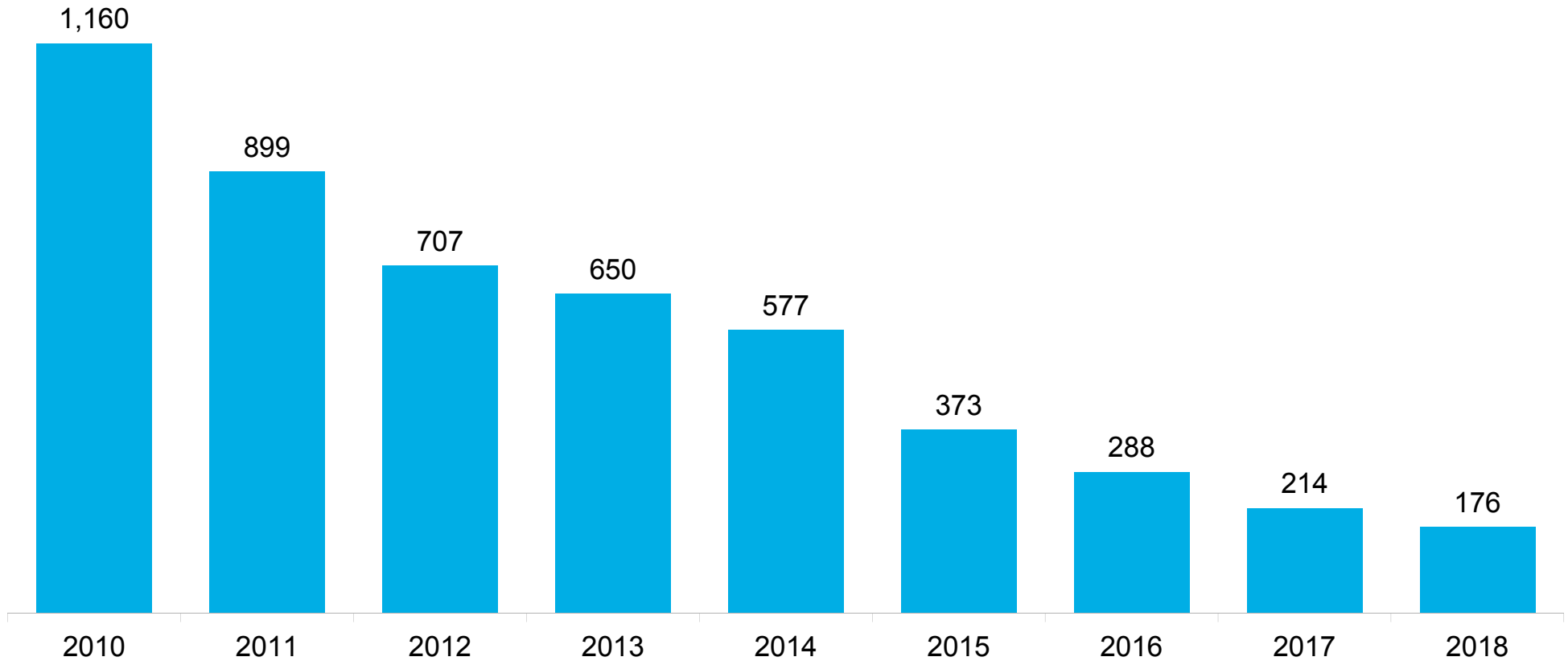
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Battery technology outlook



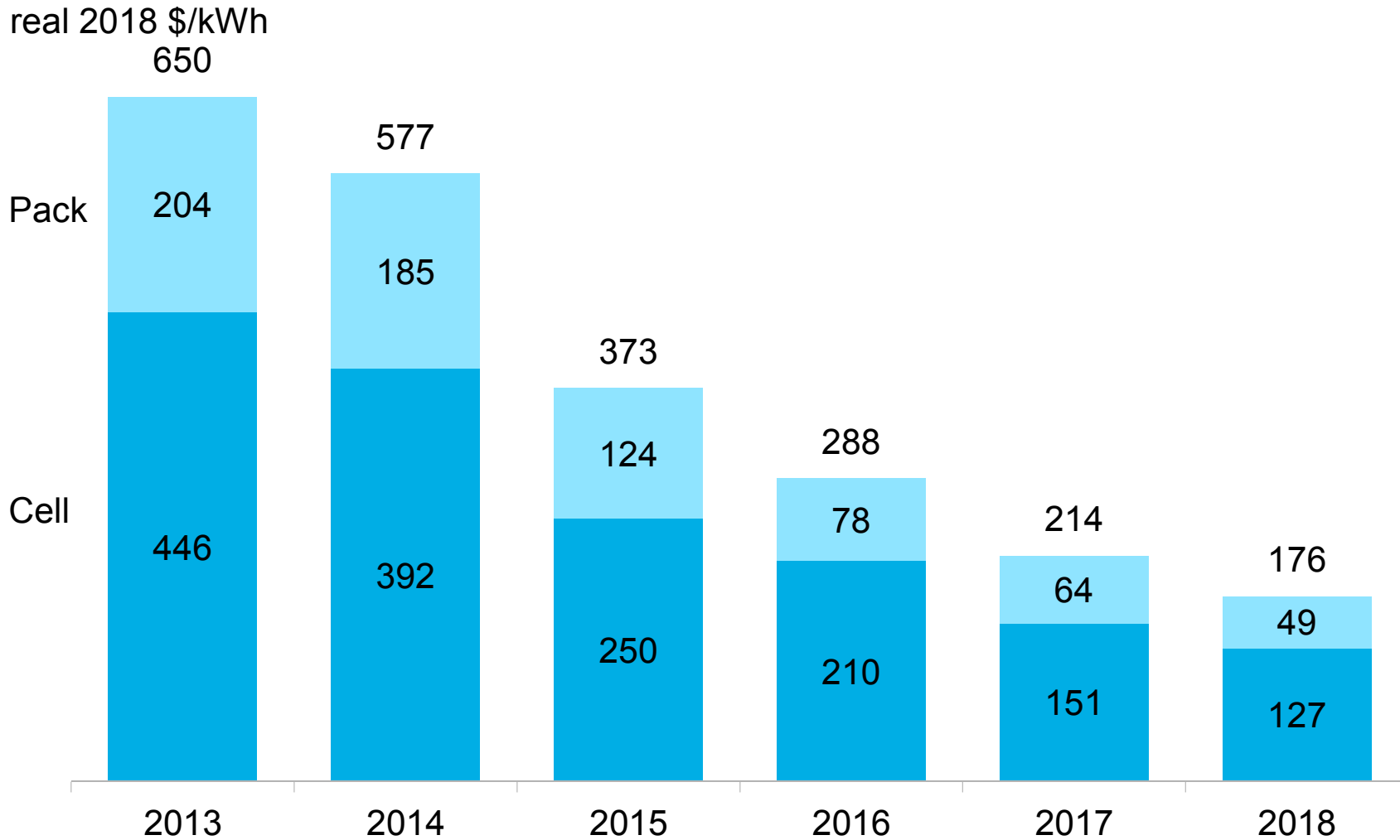
Average lithium-ion battery pack prices have fallen 85% since 2010

Battery pack price (real 2018 \$/kWh)



Source: BloombergNEF

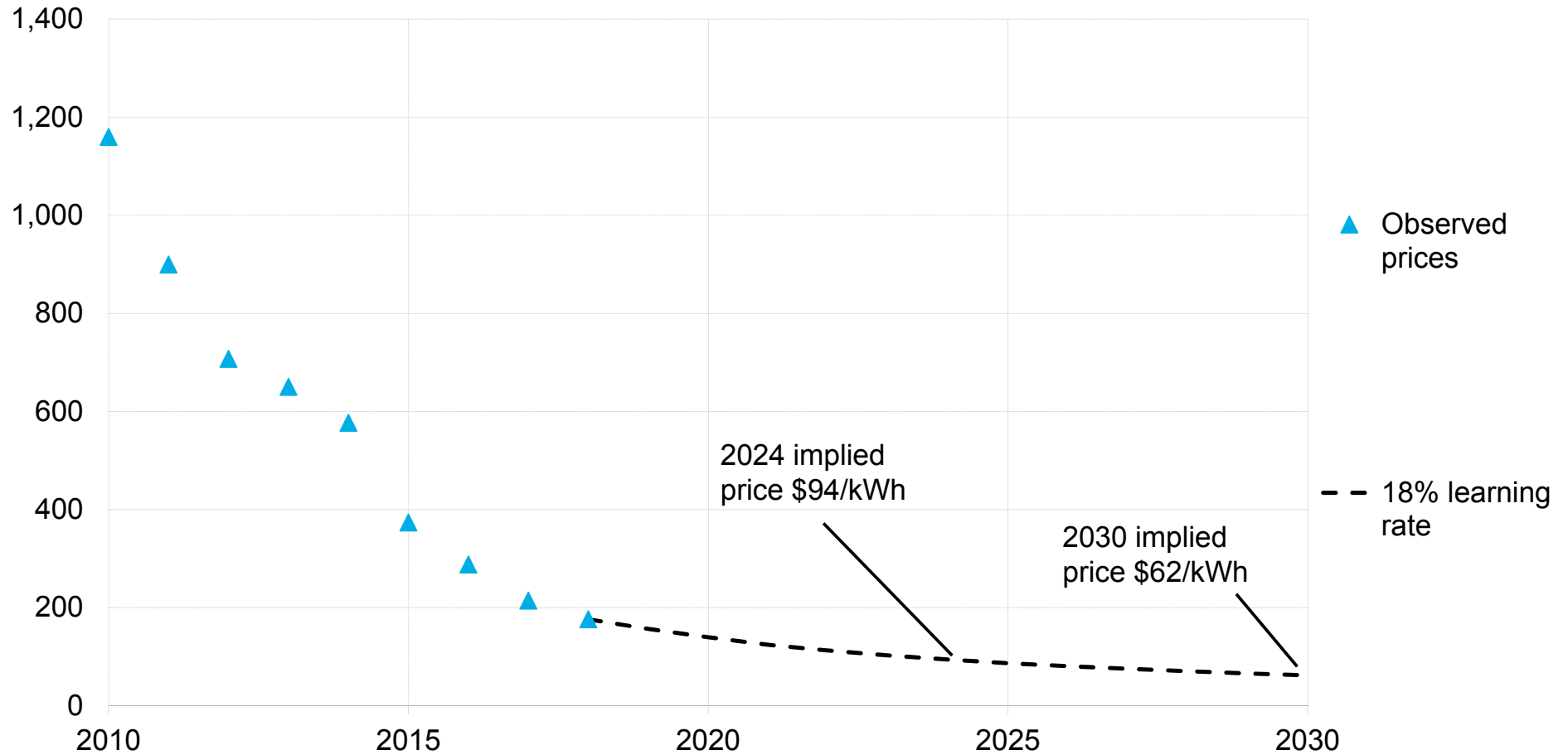
Cells make up roughly 70% of the total cost



Source: BloombergNEF Note: numbers may not add exactly due to rounding. The data in this chart has been adjusted to show real 2018 dollars

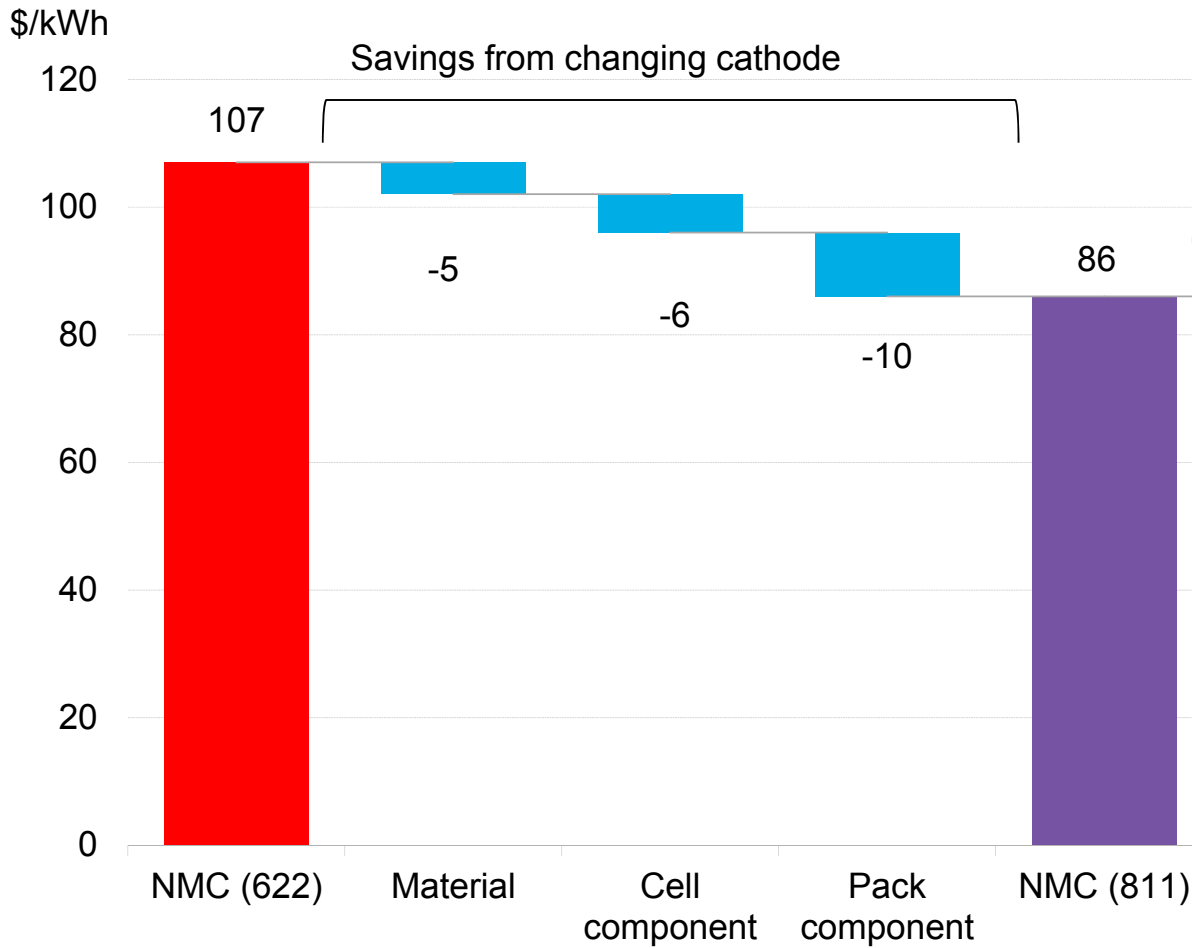
BloombergNEF expects battery pack prices to continue to fall

Lithium-ion battery pack price (real 2018 \$/kWh)



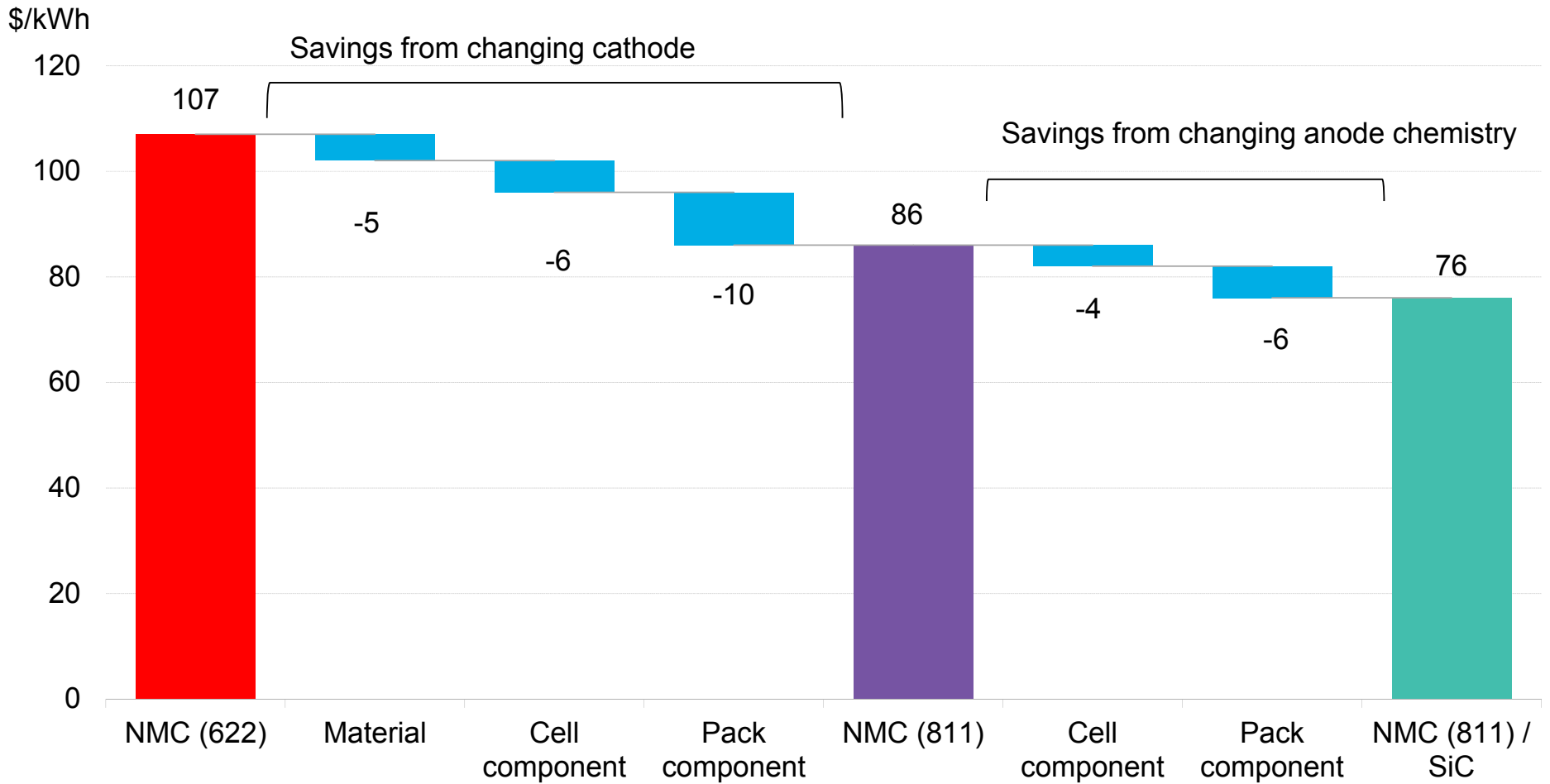
Source: BloombergNEF Note: Prices are an average of BEV and PHEV batteries and include both cell and pack costs. Cell costs alone will be lower. Historical prices are nominal, future ones are in real 2016 U.S. dollars.

Ongoing cathode advancements will help achieve these costs reductions



Source: BloombergNEF

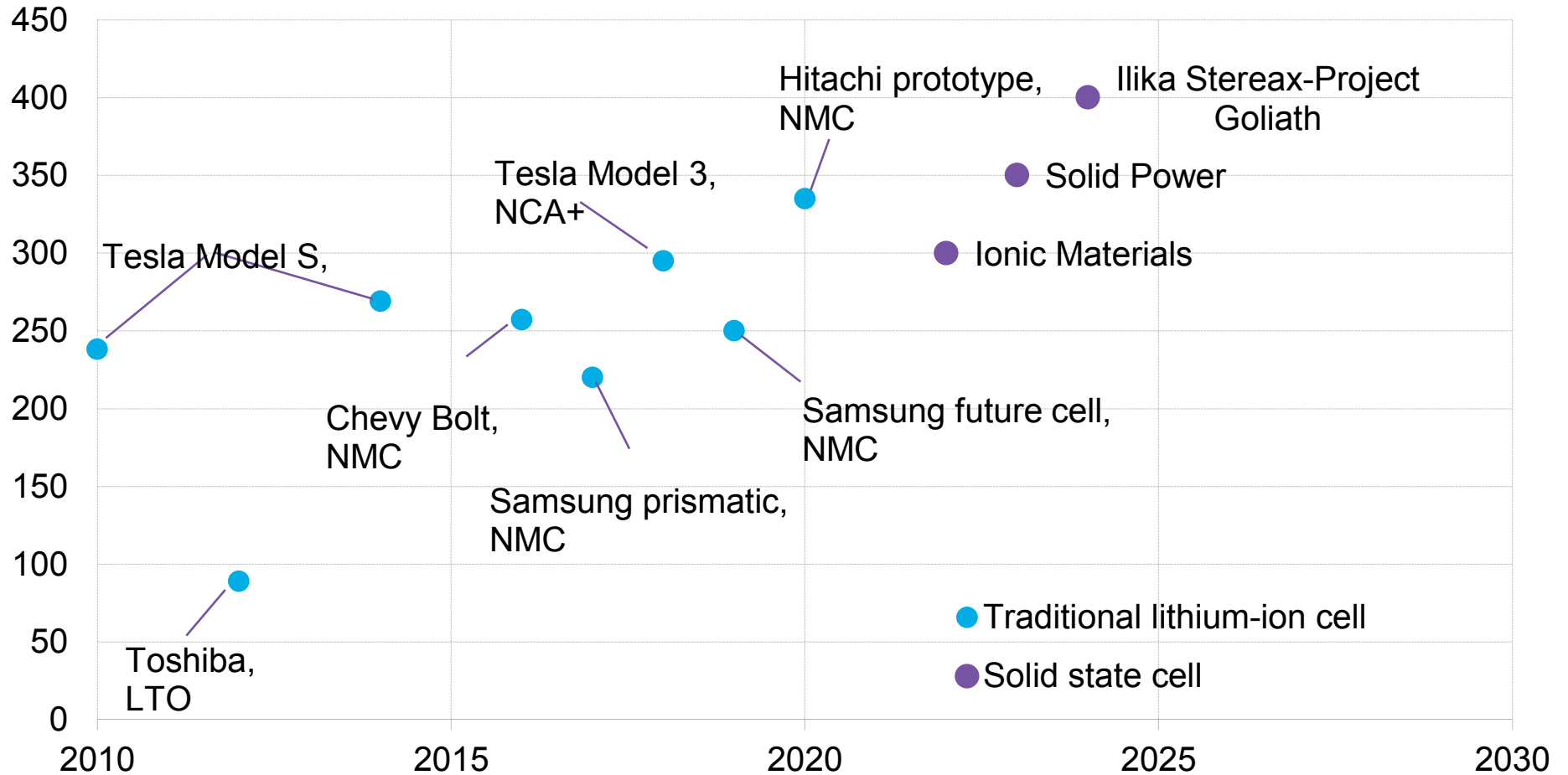
New anode designs will also help



Source: BloombergNEF

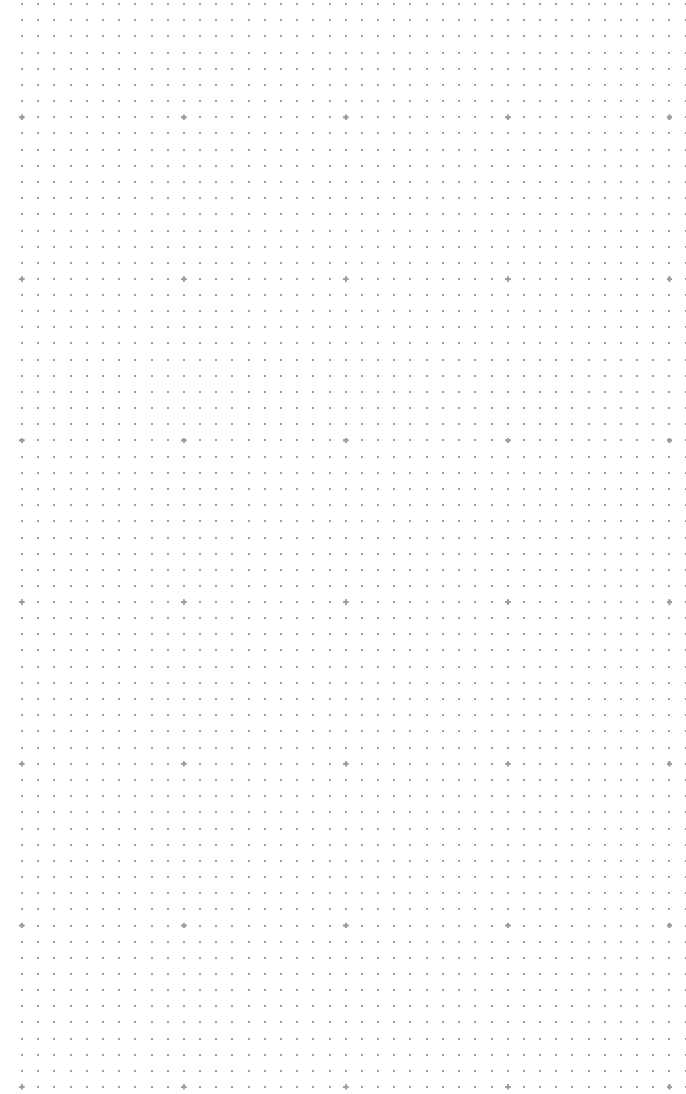
Battery energy density is also improving rapidly

Cell energy density (Wh/kg)

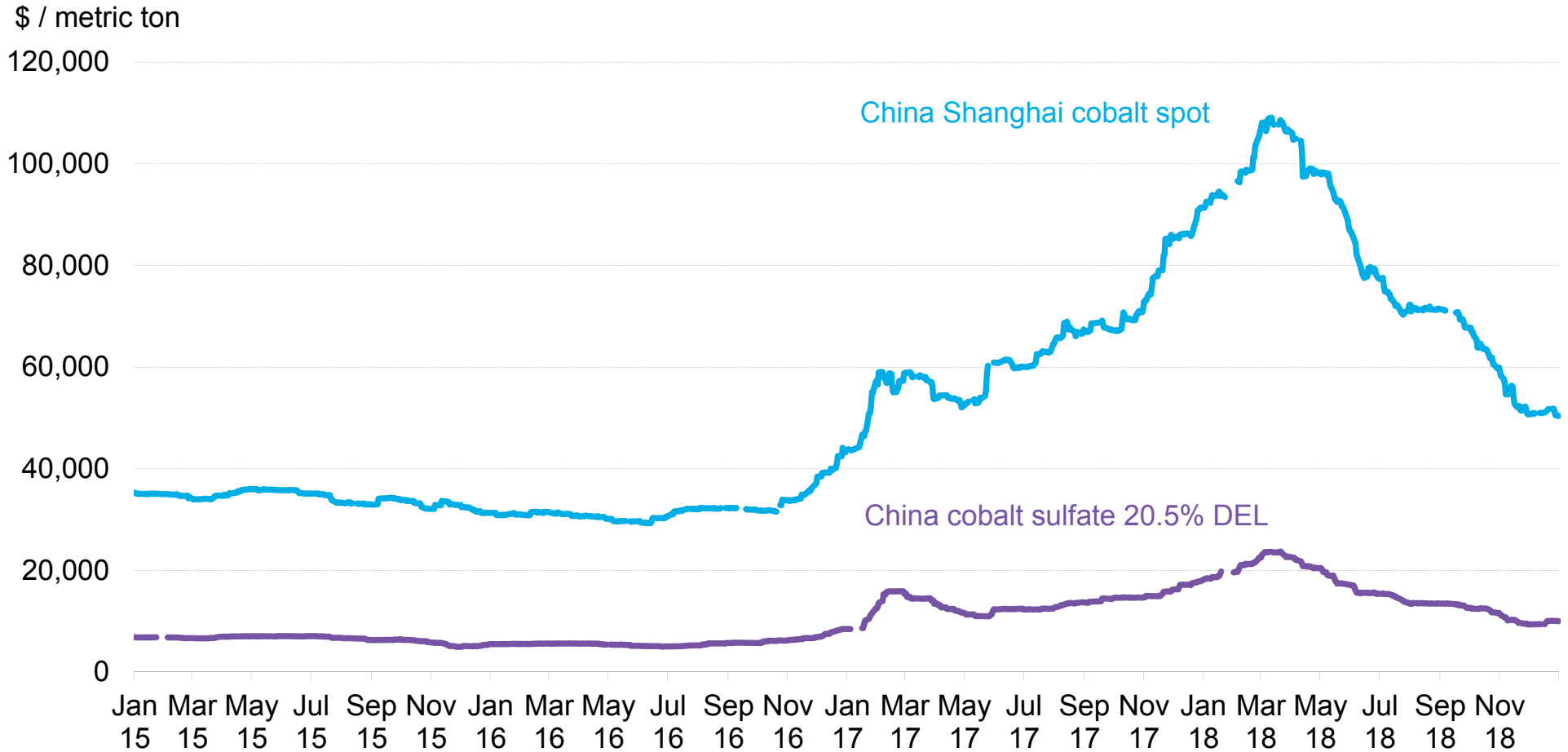


Source: BloombergNEF, public announcements

Battery components & pack price sensitivity

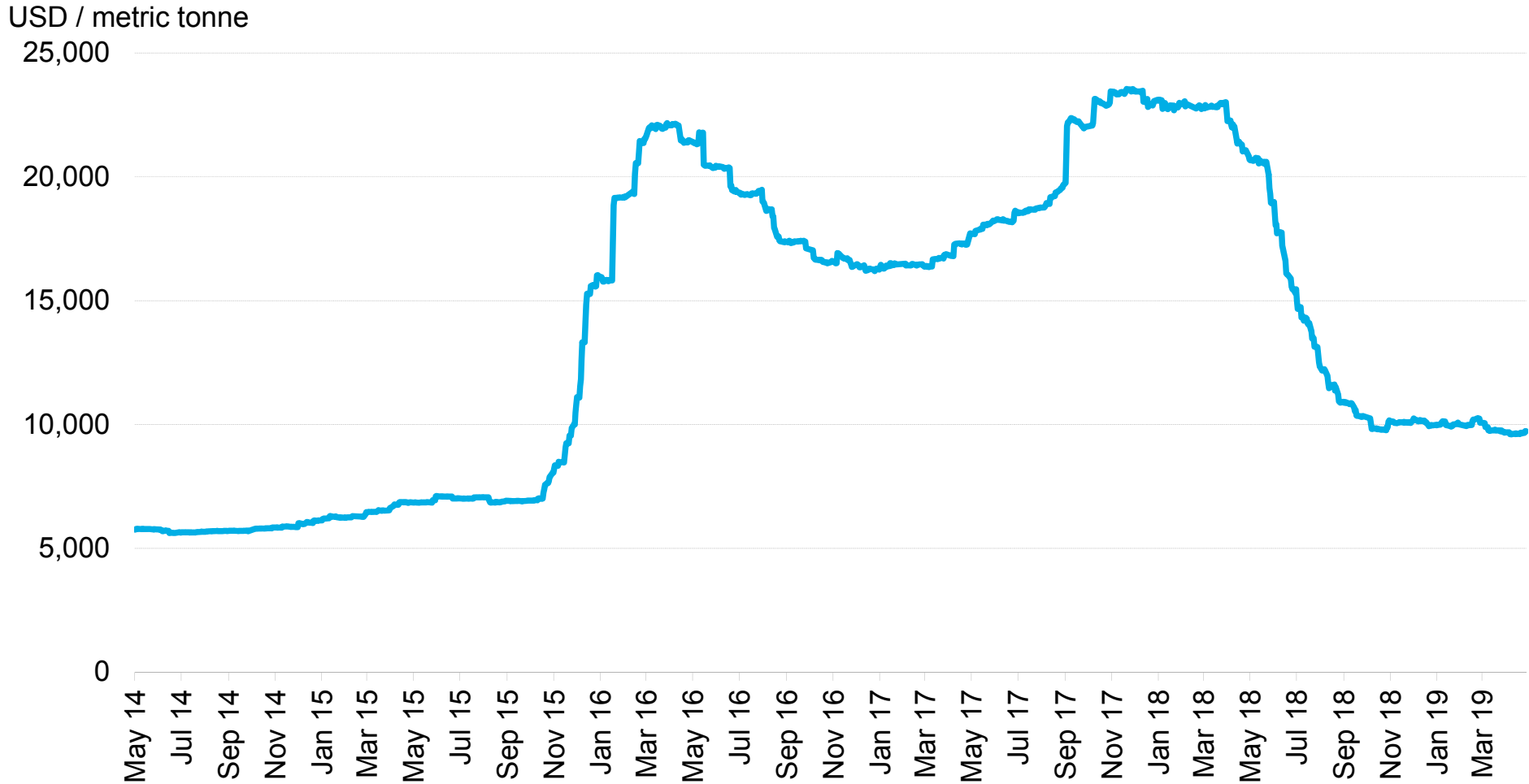


Price rise and subsequent collapse of cobalt highlights market volatility



Source: Antaike Information Development Co, Asian Metals Inc, BloombergNEF

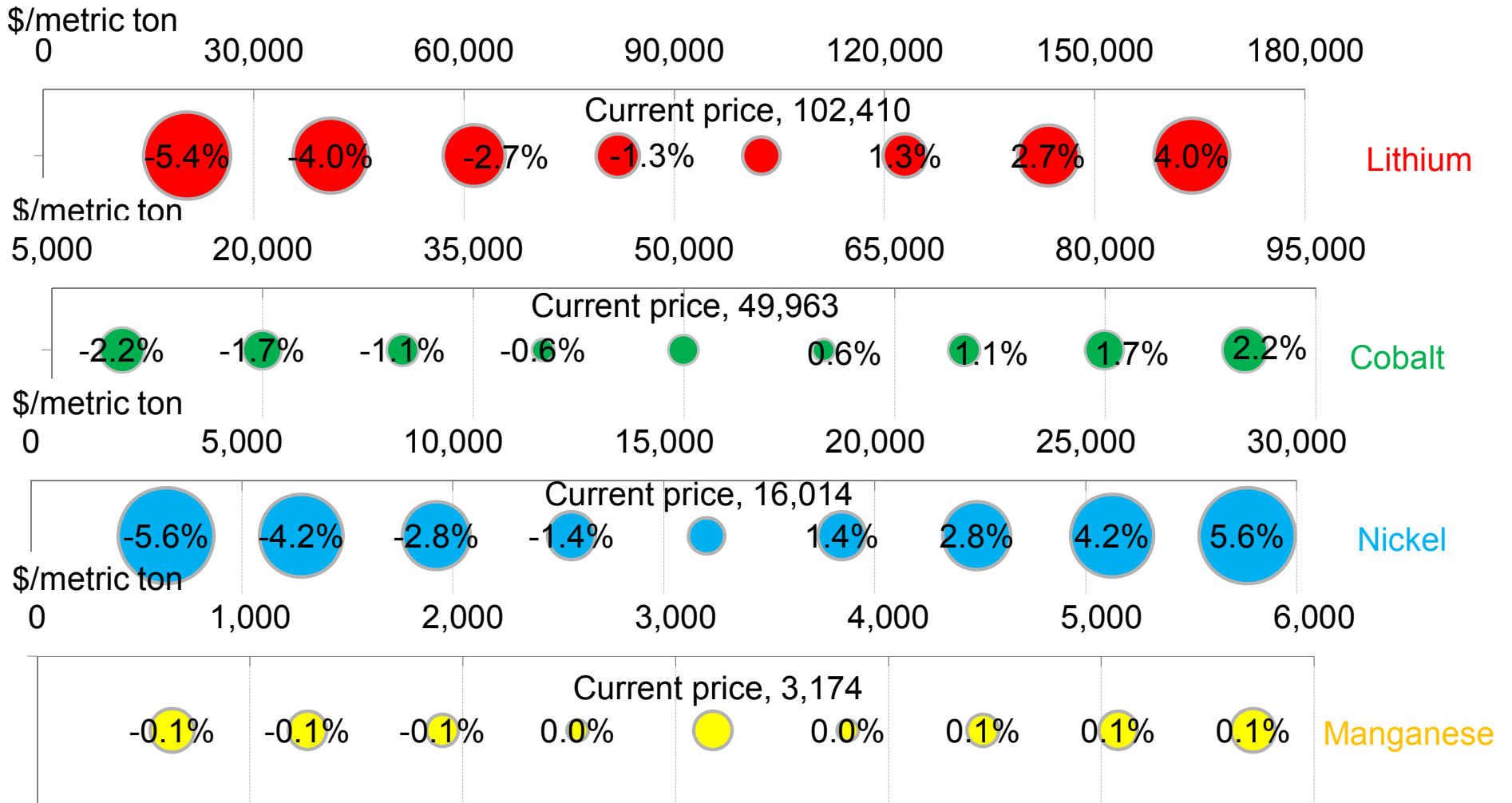
Lithium prices have also fallen in recent months



Source: Asian Metals Inc, BloombergNEF Note: This applies to China Lithium Carbonate 99% DEL

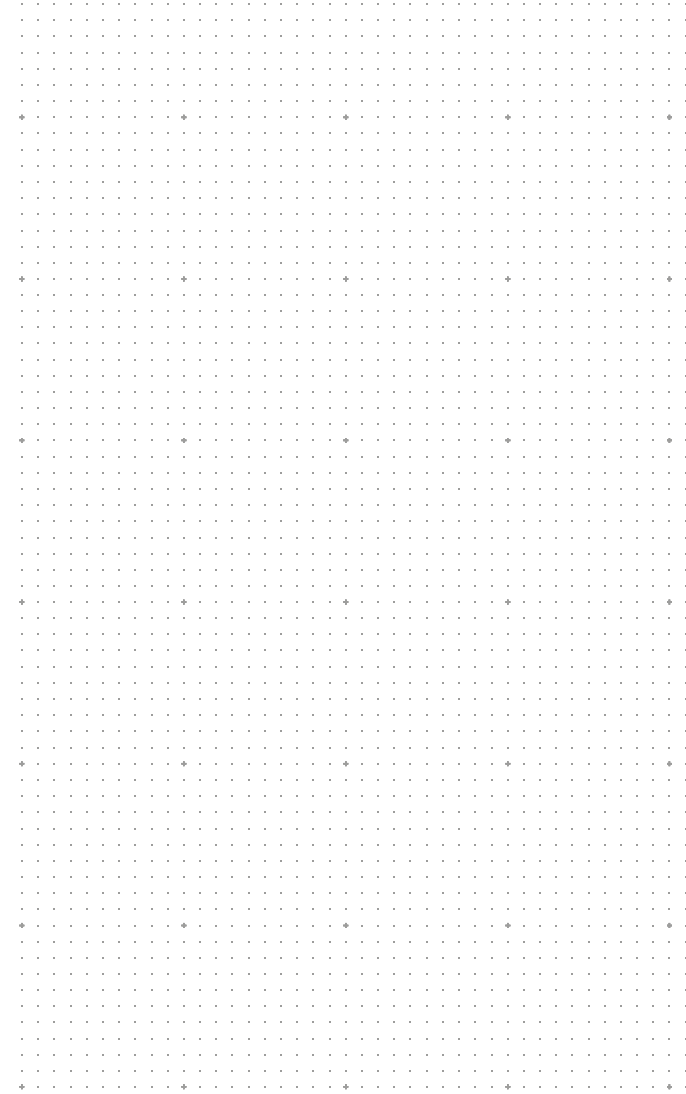
Commodity swings are unlikely to derail lower costs

NMC (811) battery pack price sensitivity



Source: BloombergNEF Note: Prices true as of December 3, 2018. Size of bubbles denote % change in pack price. Central bubble is an arbitrary size

Implications for electric vehicle uptake

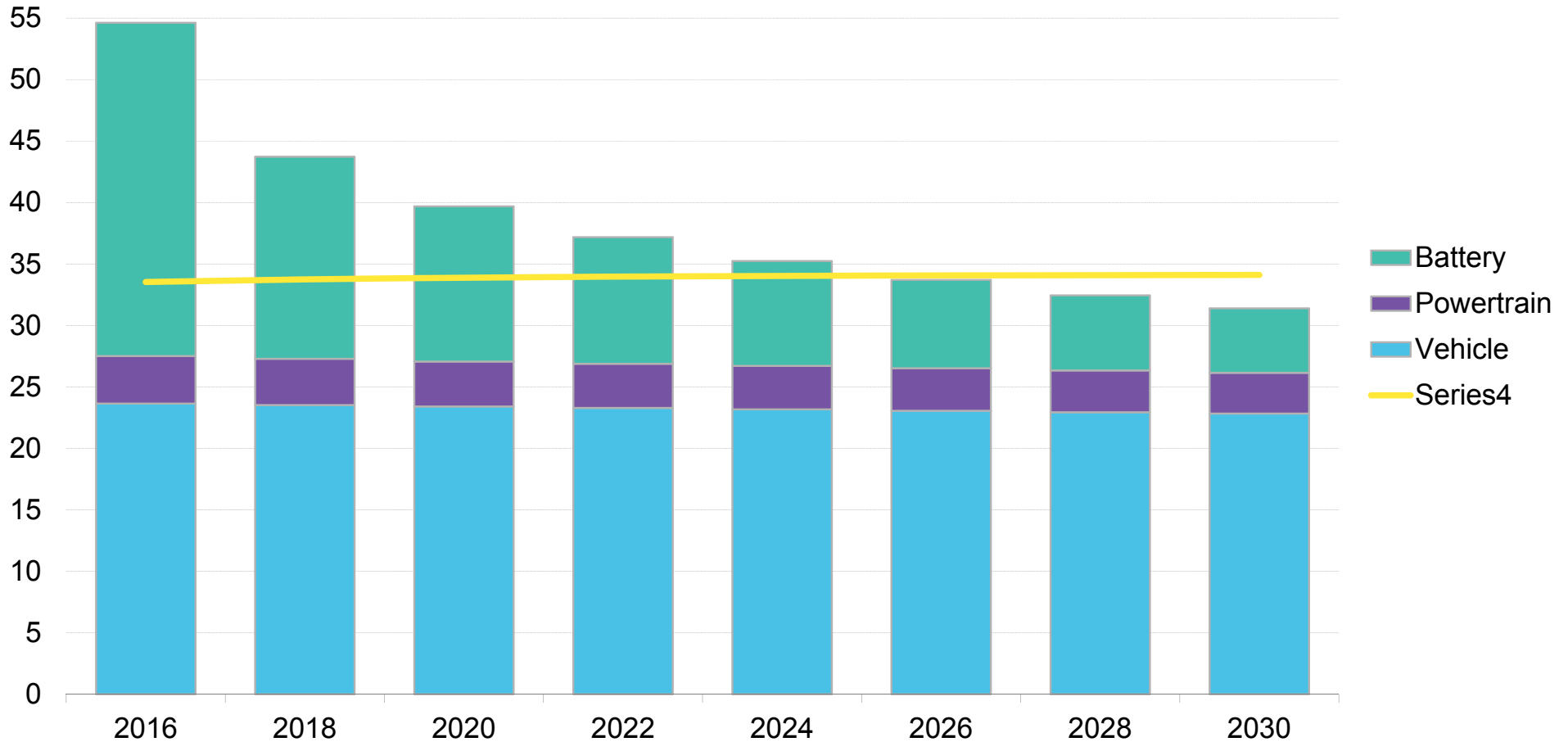


Falling battery prices ensure that EVs will be cheaper than ICE in the mid-2020s

Updated 2019 analysis available to BloombergNEF clients

Projection of ICE and BEV pre-tax retail prices in the U.S. for large vehicle segment

2016 \$ (thousand) and %



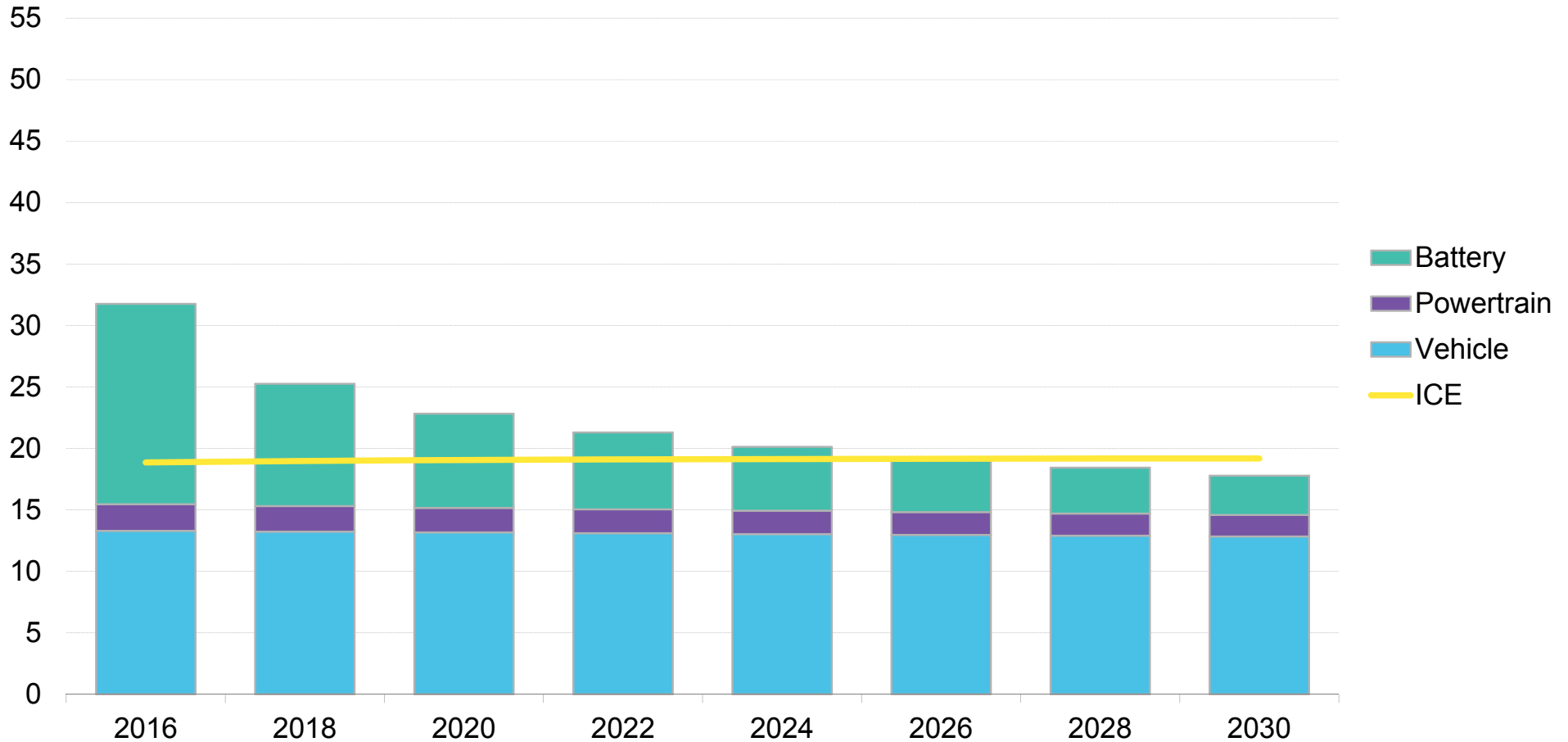
Source: BloombergNEF, EPA, ICCT, FEV, ONRL, IDL

Smaller vehicles are harder to electrify, cheaply

Updated 2019 analysis available to BloombergNEF clients

Projection of ICE and BEV pre-tax retail prices in the U.S. for small vehicle segment

2016 \$ (thousand) and %



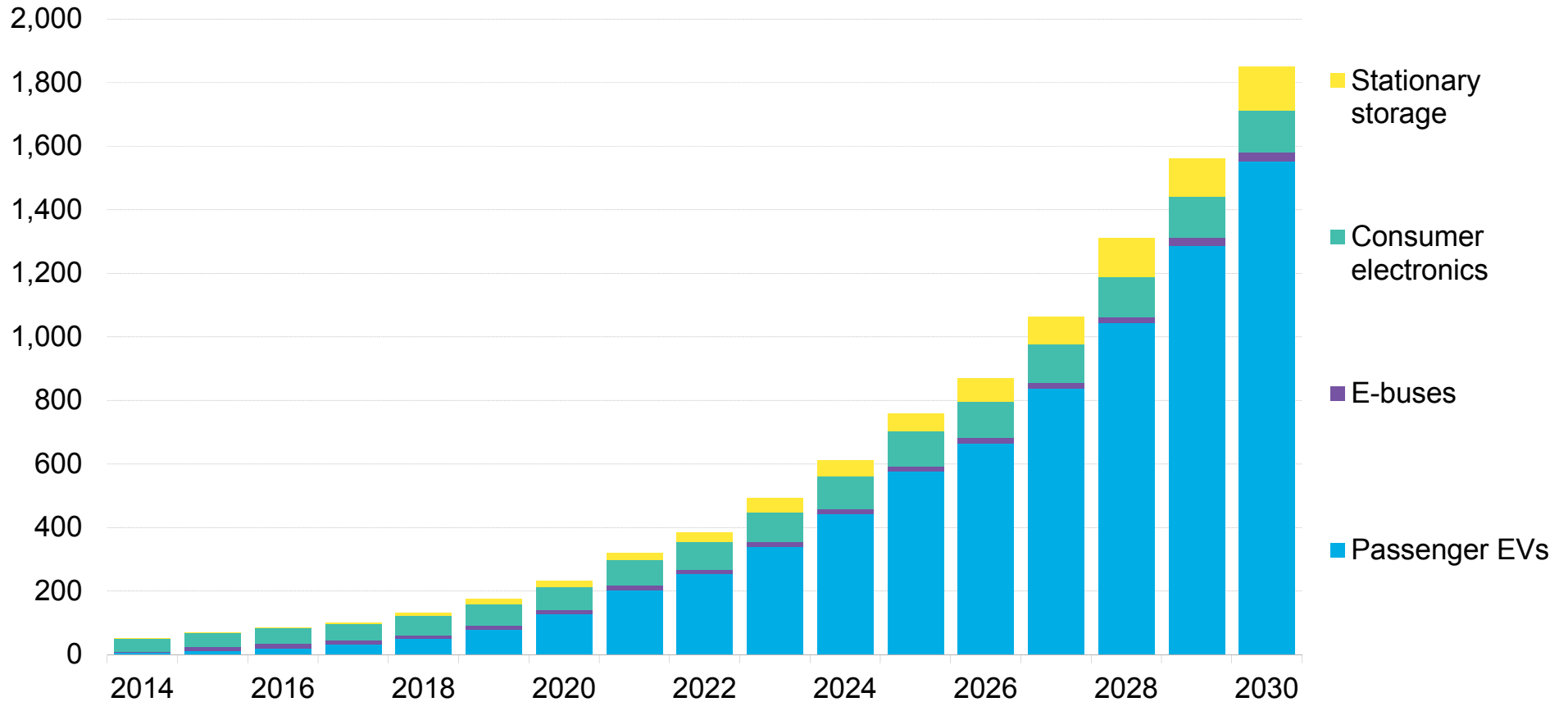
Source: BloombergNEF, EPA, ICCT, FEV, ONRL, IDL

Implications for electric vehicle uptake

Lower prices, better performing technologies underpin increasing battery demand

Updated 2019 analysis available to BloombergNEF clients from mid-May 2019, including Commercial vehicles outlook

Annual GWh demand



Source: BloombergNEF

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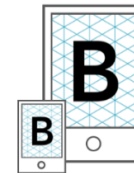
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