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Docket Number:	17-IEPR-07
Project Title:	Integrated Resource Planning
TN #:	217132
Document Title:	Global EV trends and forecast
Description:	4.18.17 Presentation by Alejandro Zamorano of Bloomberg
Filer:	Raquel Kravitz
Organization:	Bloomberg
Submitter Role:	Public
Submission Date:	4/17/2017 4:45:58 PM
Docketed Date:	4/17/2017

Global EV trends and forecast

IEPR workshop on Light Duty Vehicle Transportation Electrification

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April 18, 2017

Bloomberg New Energy Finance

Agenda

- 2017 forecast
- Drivers of transport electrification: the role of mobility

North America selected EV model sales, Q1,Q2 2015 – 2016 (thousand units, % change)

	Chevrolet Volt	Tesla Model S	Tesla Model X	Nissan Leaf	Ford Fusion Energi	Ford C-max Energi	Toyota Prius Prime	BMW i3
Q4 2016 (units)	9,338	8,825	6,485	5,058	4,309	2,635	2,422	1,947
Q3–Q4 2016 (%)	20%	-10%	0%	29%	-3%	20%		-35%
Q4 ’15 – Q4 ’16 (%)	39%	-6%		26%	50%	36%		-40%
2016 (units)	28,208	32,037	20,148	15,381	16,055	8,140	2,422	8,081
2015 – 16 (%)	67%	11%		-17%	64%	5%		-30%

Source: Bloomberg New Energy Finance, automakers, vehicles registration agencies

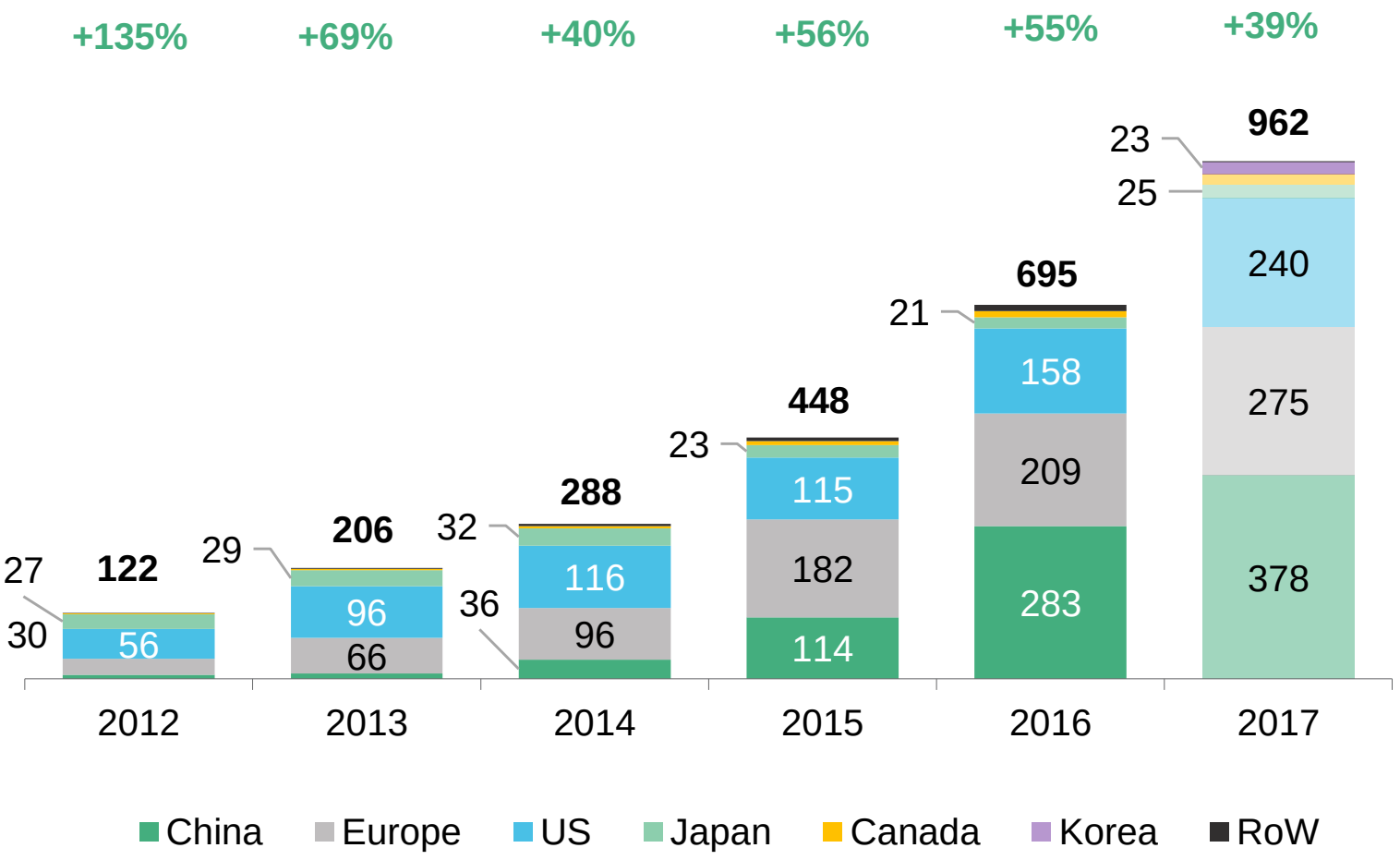
Global EV sales, 2012 – 2017e (thousand units)

Cumulative global EV sales hit one million in Q4 2015

We expect the next million to be hit by Q2 2017

Regional 2017 totals:

APAC - 426k units
AMER - 259k units
Europe - 275k units
RoW - 2k units



EV sales trends – Changing growth patterns

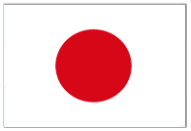
	North America		Europe		China		Japan	
	Q3 – Q4 2016	Q4 ’15 – Q4 ’16	Q3 – Q4 2016	Q4 ’15 – Q4 ’16	Q3 – Q4 2016	Q4 ’15 – Q4 ’16	Q3 – Q4 2016	Q4 ’15 – Q4 ’16
EV sales	8%	47%	29%	-6%	48%	122%	18%	-12%

Looking Up

Europe: up 15% year-on-year Driven by: Strong policy support in: Norway, UK, France. Germany recently introduced incentives. But growth is slowing from last 18 months.

China EV sales up 148% year-on-year. Driven by: strong domestic policy support, new models and strong growth in BEVs.

Moving sideways



Japanese EV sales dropped 12% year-on year. Driven by: shrinking market, restricted model availability.

North America EV sales up 39% year-on year. Driven by: refreshed versions of current models. Welcomed change from 2015. Fuel prices and consumers awaiting longer range BEVs inhibiting broader uptake.

Source: Bloomberg New Energy Finance

Agenda

2016 end of year update

Drivers of transport electrification: the role of mobility

drivers

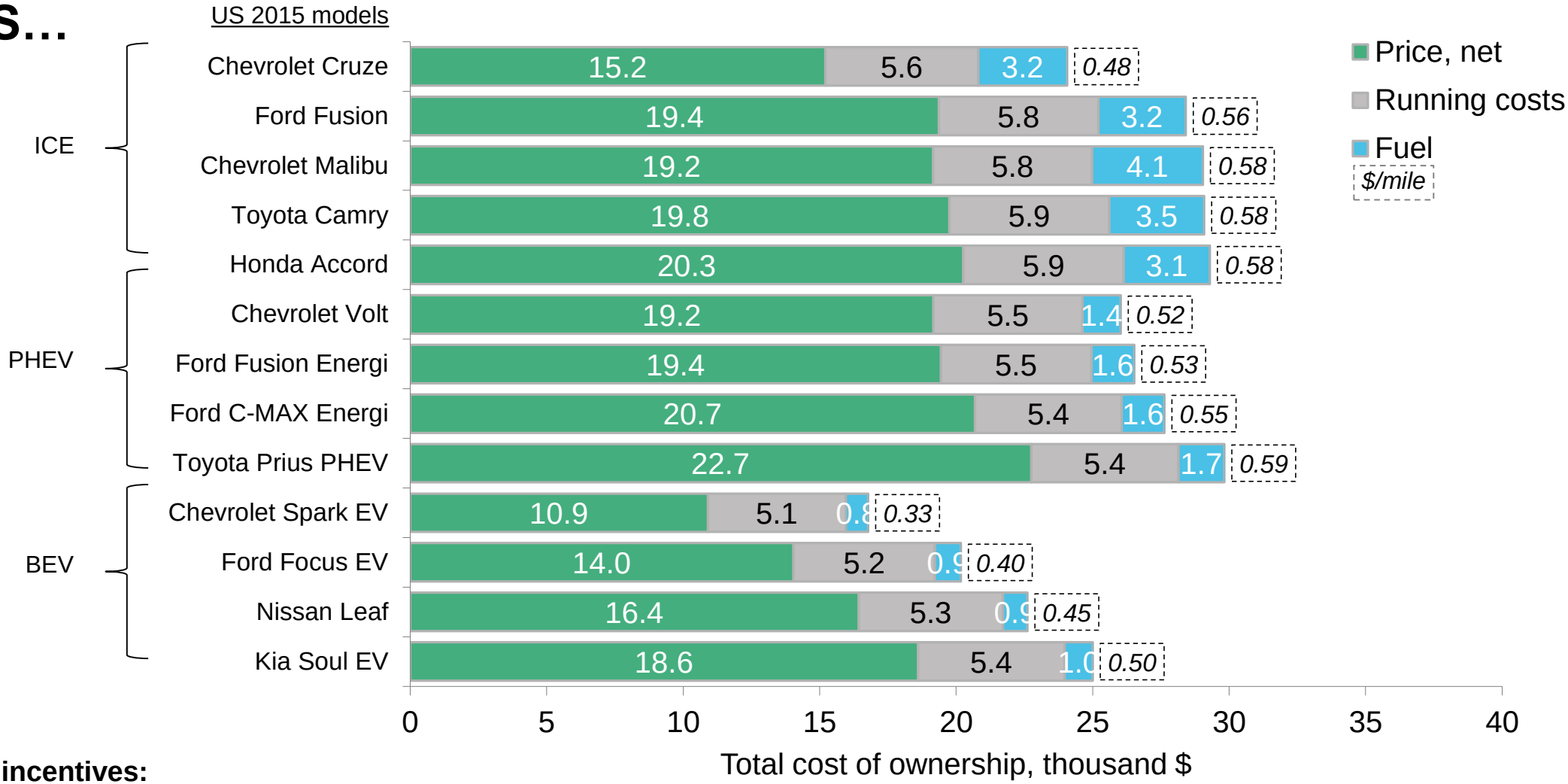
1 Technology development

2 Mobility

1 Technology development

2 Mobility

With incentives, the TCO of BEVs is lower than all but the cheapest ICE vehicles in the US…



With incentives:

The TCO of a BEV is up to 25% lower than an average midsize gasoline vehicles

PHEVs cost the same as midsize gasoline vehicles: higher purchase price, lower incentives

Labels in italics are $/mile; Price includes down payment, financing and sales tax and is net of incentives and resale value; running costs consist of road tax, insurance and maintenance. Based on $0.125/kWh electricity and $2.50/gal fuel prices. 10,100 miles driven per year, TCO is calculated over the first 5 years of ownership

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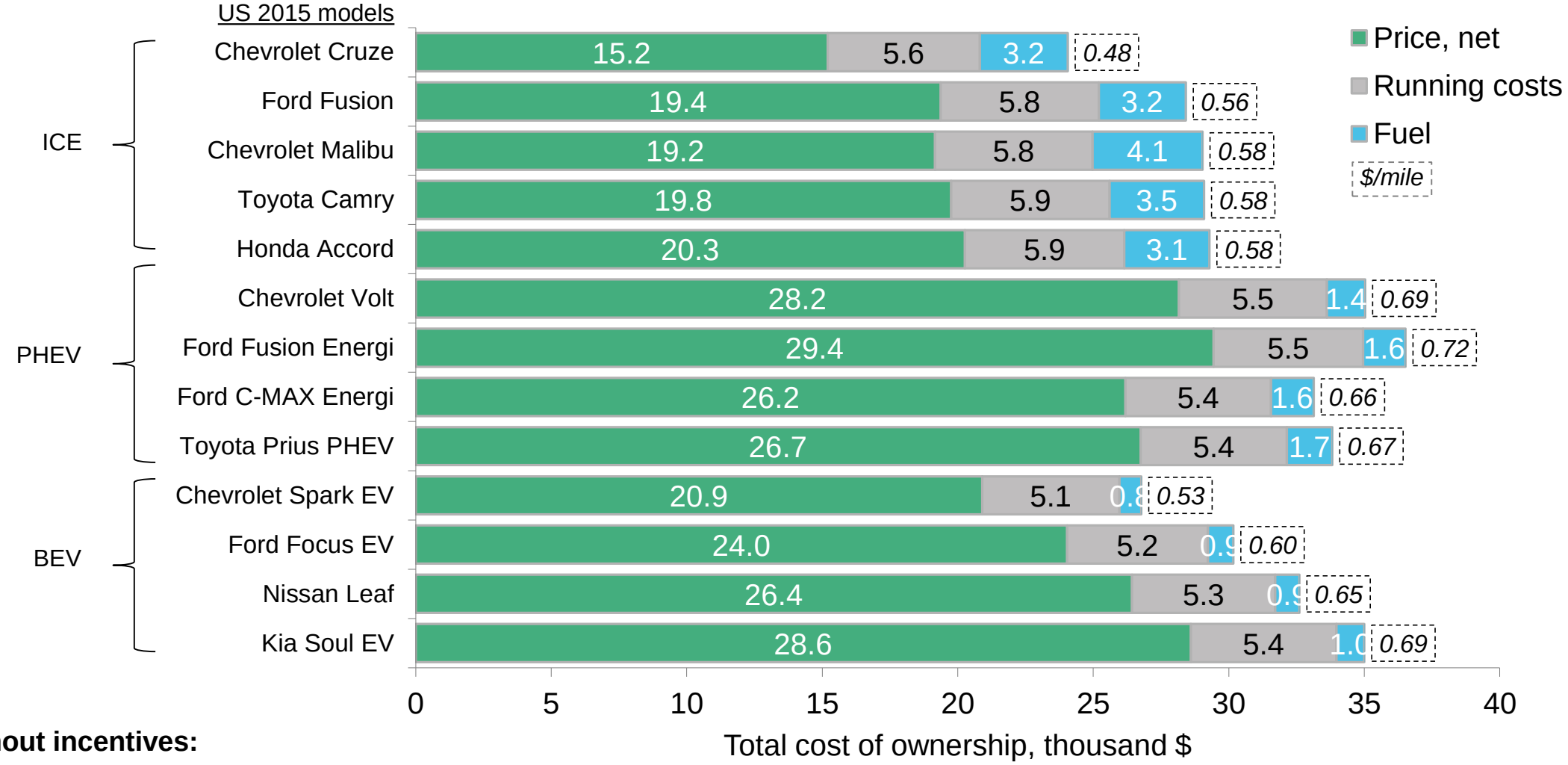
…but BEVS/PHEVS are still more expensive without purchase incentives



Without incentives:

Current BEV models are more expensive than midsize gasoline cars by ~13%, PHEVs by 15%

The Chevrolet Spark EV is still cheaper due to its low upfront price (~$25k)

Labels in italics are $/mile; Price includes down payment, financing and sales tax and is net of incentives and resale value; running costs consist of road tax, insurance and maintenance. Based on $0.125/kWh electricity and $2.50/gal fuel prices. 10,100 miles driven per year, TCO is calculated over the first 5 years of ownership

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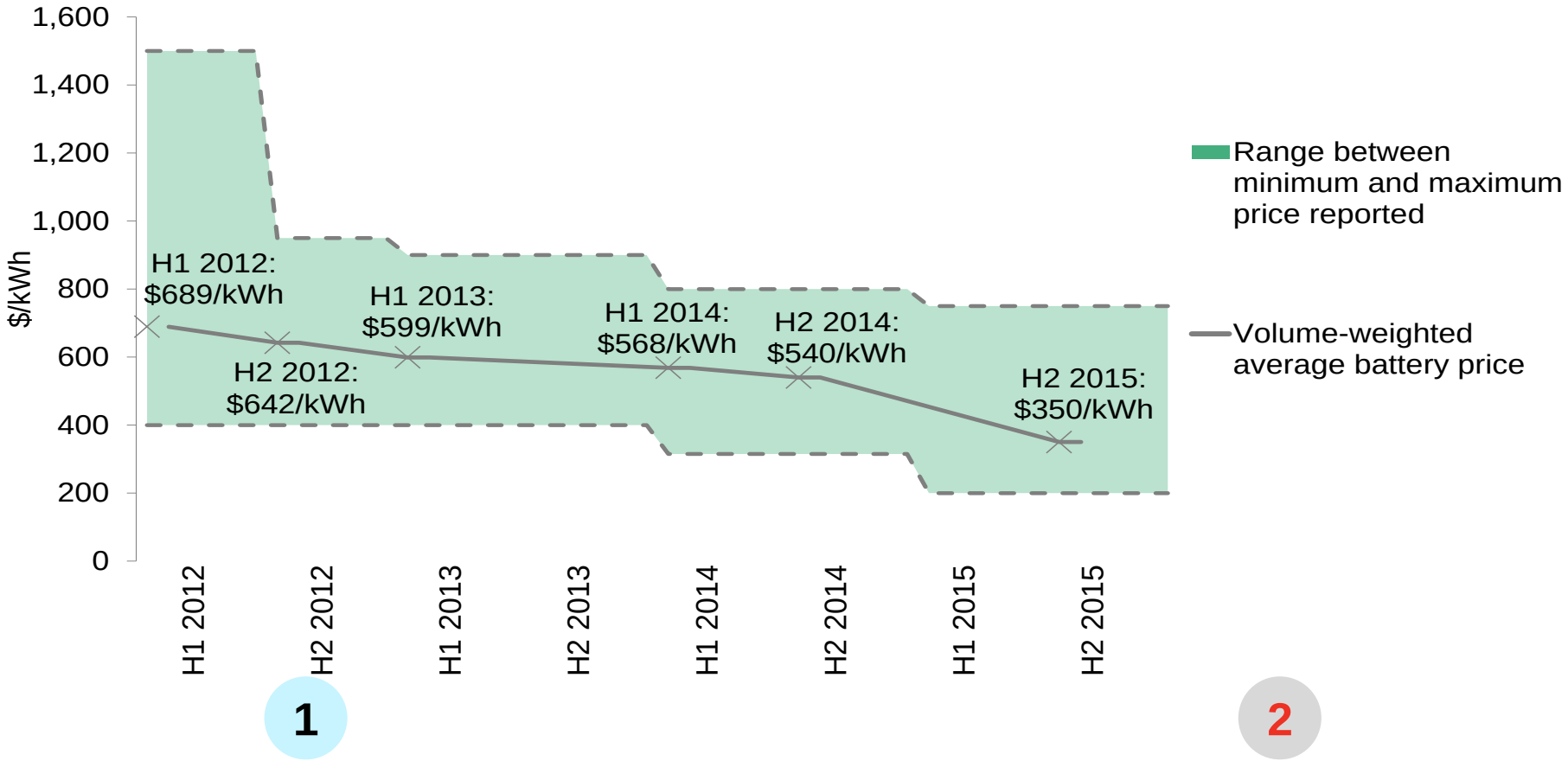
Vehicle lithium-ion battery prices and monthly volumes of lithium-ion batteries sold in new EV sales, 2012-2015 ($/KWh and MWh)



The decline in price is partly due to technology improvements, increased plant utilization and aggressive pricing strategy by large players

The five largest battery manufacturers control 64% of li-ion battery capacity for EVs

Panasonic supplies batteries to at least 18 models, LG Chem to 12, Samsung to 6

Note: Prices include both pack and cell costs

Source: Bloomberg New Energy Finance

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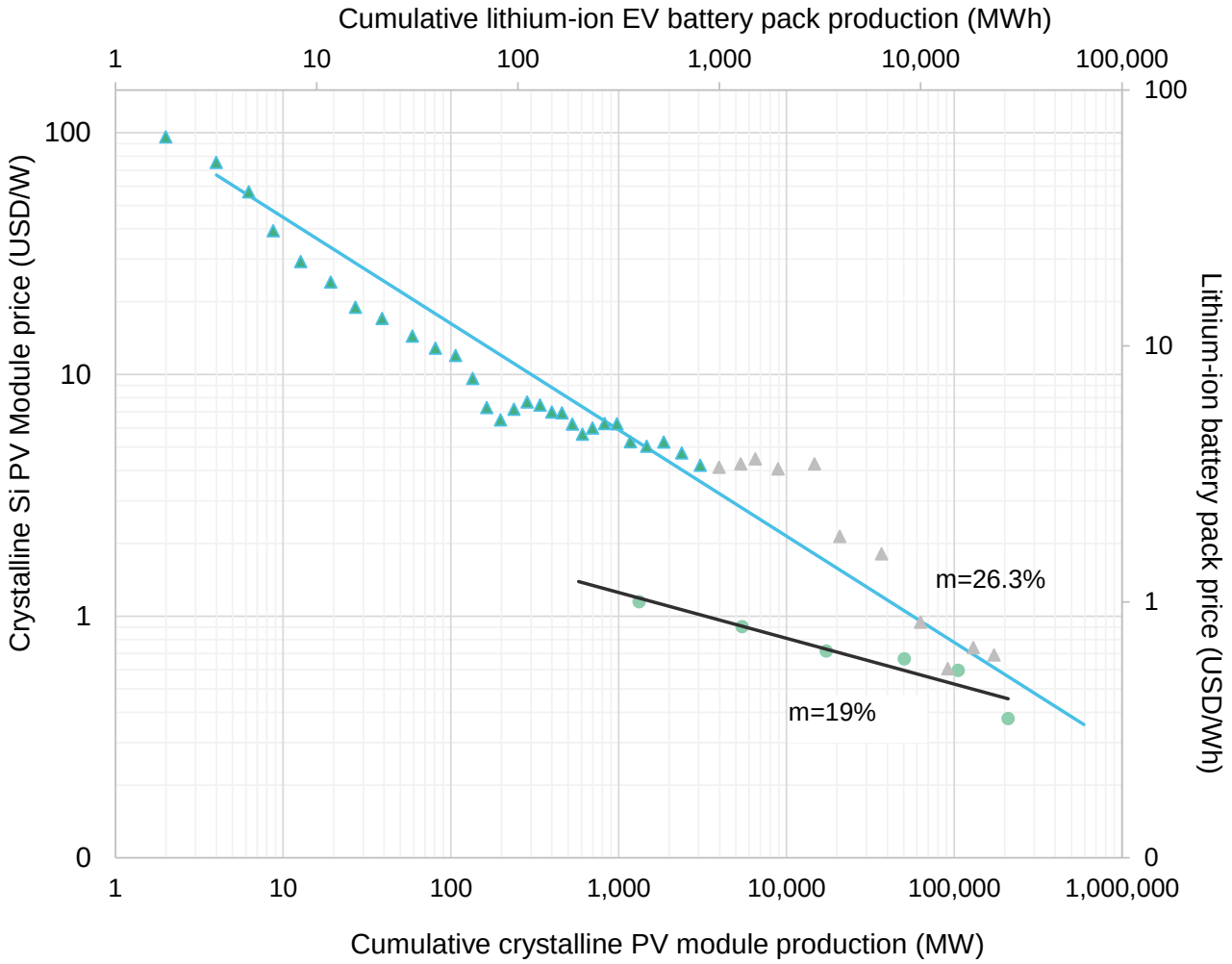
Bloomberg New Energy Finance recorded learning rate of SI PV modules and Li-ion battery packs 2004 – 16 (multiple units)



1

Crystalline Si PV module prices have fallen 26.3% on average for every doubling of cumulative production capacity in 2004 – 15

2

Li-ion battery pack prices have fallen 19% on average for every doubling of cumulative production capacity in 2010 – 16

Source: Bloomberg New Energy Finance

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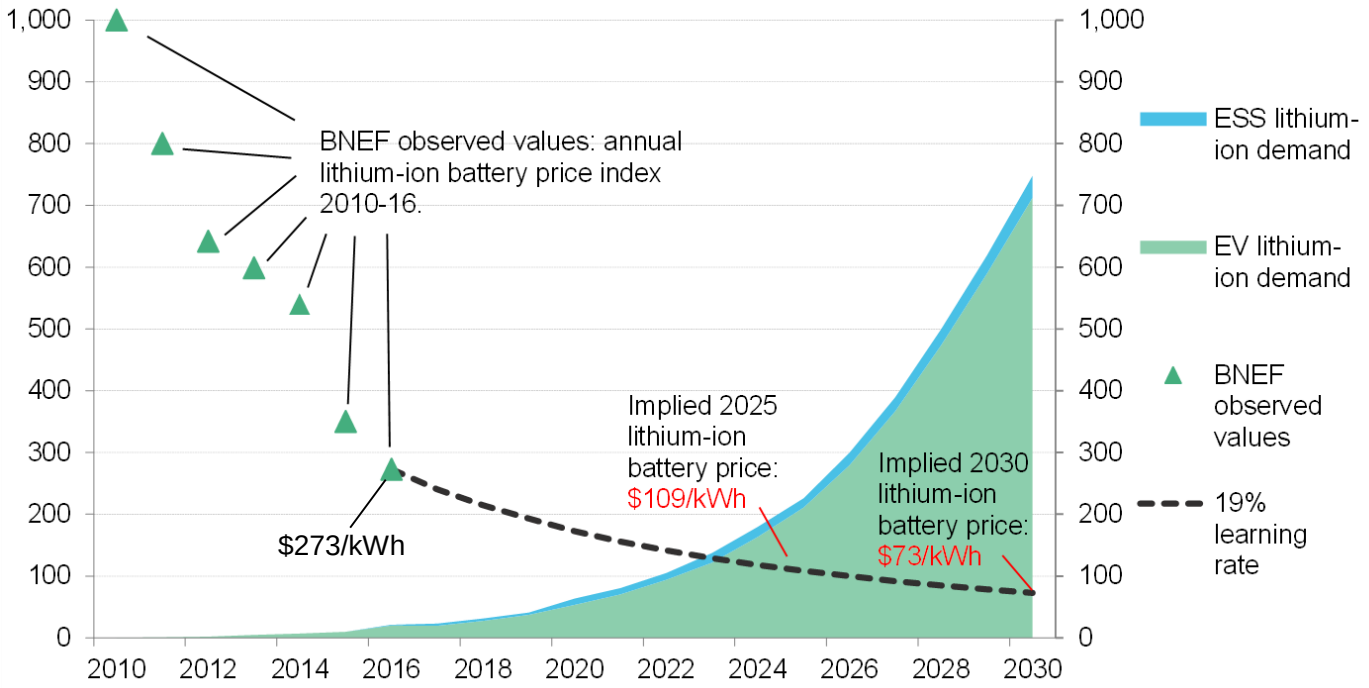
Observed and forecast EV lithium-ion battery prices
2010-30 ($/KWH)



1

The weighted average battery price in 2016 was **$273/kWh**. Based on a learning rate of 19%, we anticipate battery prices will reach $73/kWh by 2030

2

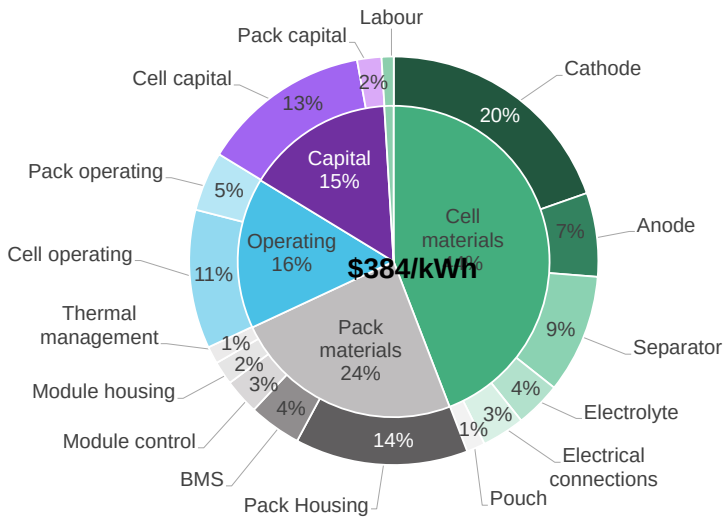
The decline of battery pack prices has accelerated since 2014 due to improvements in energy density and pack design, and large contracts as mass market EVs such as the Bolt and the Model 3 are introduced.

Note: values shown are taken from BNEF's annual EV lithium-ion battery price survey. Forecast is based on a learning rate of 14-20%. EV cost parity is calculated on an unsubsidised total cost of ownership (TCO) basis. The date range reflects cross over with different vehicle classes in the US.

Source: Bloomberg New Energy Finance

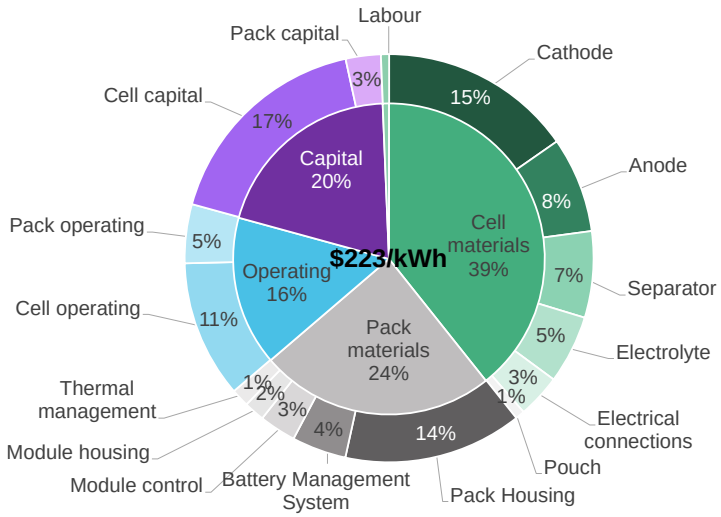
Lithium-ion battery cost breakdown for a US plant, by component, BEV pack 2015 – 16 ($/kWh)

2015: $384/kWh



Source: Bloomberg New Energy Finance

2016: $223/kWh



Source: Bloomberg New Energy Finance, Note: 40 kWh NMC/graphite pack

1

$384/kWh: production costs of a 1GWh output plant, in the US, with a 12% WACC, 10 year lifetime

2

High volume US plants can produce batteries below the average market price ($273/kWh), despite high capital costs.

3

$223/kWh is our indicative 2016 battery pack price for a large (3GWh), US based plant that is optimized for high volume production.

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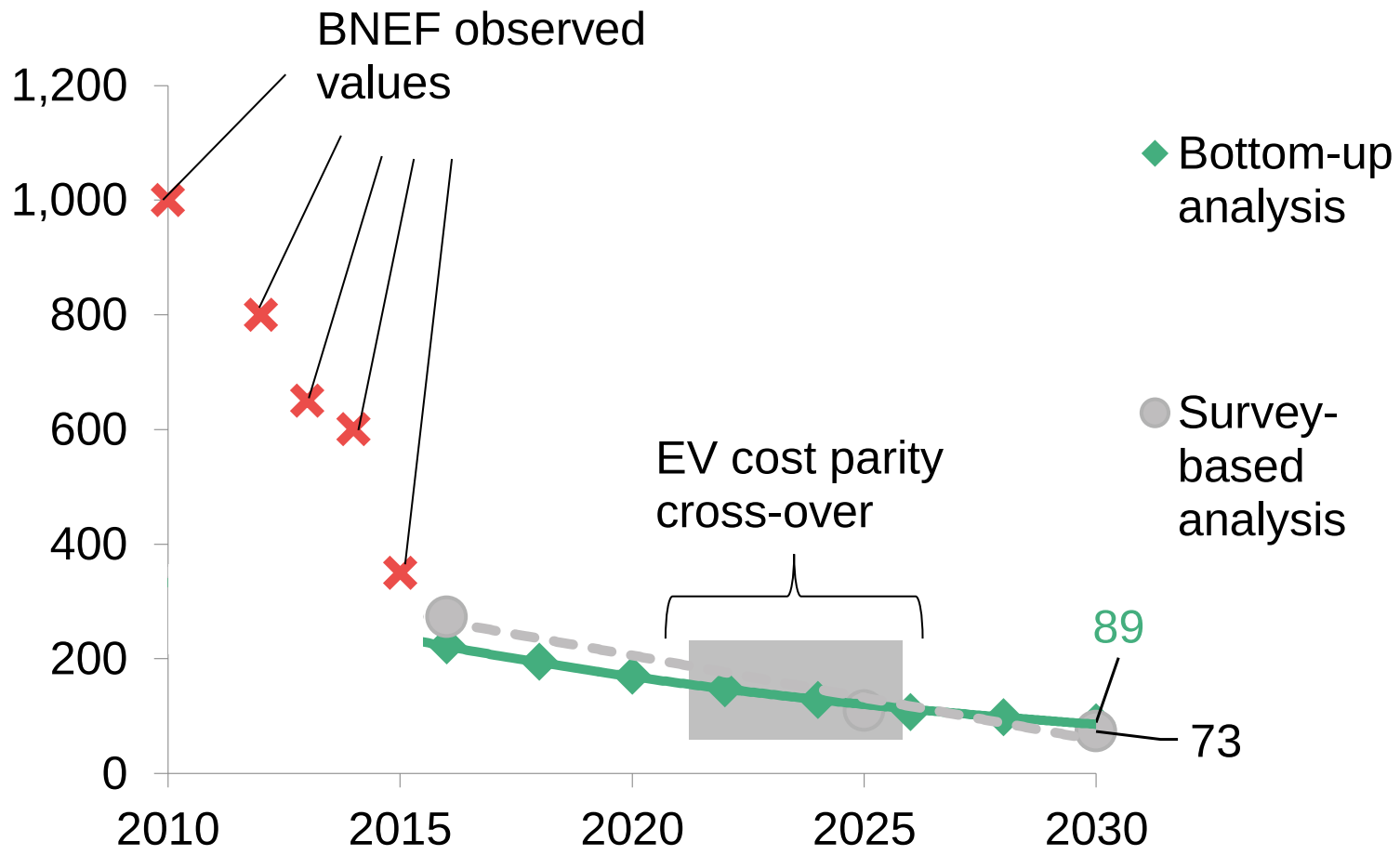
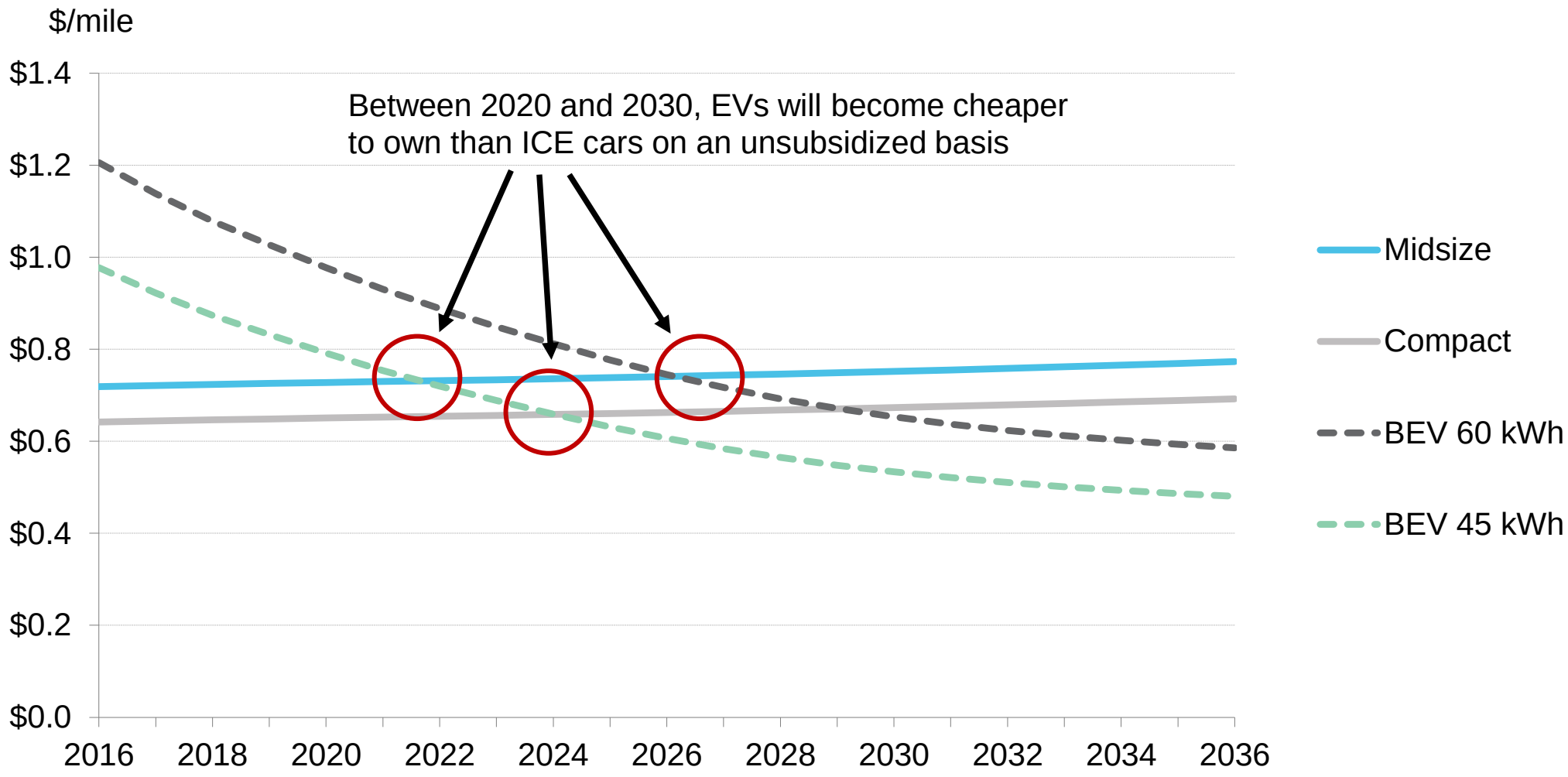
BNEF battery price survey 2016 and experience curve forecast 2010-30, ($/KWh)



Source: Bloomberg New Energy Finance. Note: values shown are taken from BNEF's annual EV lithium-ion battery price survey. Forecast is based on a learning rate of 19%. EV cost parity is calculated on an unsubsidised total cost of ownership (TCO) basis. The date range reflects cross over with different vehicle classes in the US.

Unsubsidized total cost of ownership of EVs will reach parity with ICE in the mid-2020's



Note: 10,100 miles per year, 5-year ownership. Gasoline and electricity prices from EIA's 2015 Annual Energy Outlook 'Low Oil Price' scenario (ranging from $50 to $65 between 2015 and 2025). The fuel economy of an internal combustion engine vehicle increases by 3.5% per year and its price increases by 1% per year. The purchase price of a battery electric vehicle is based on the battery pack price, using an adjustment factor of 3-to-4 between 2015 and 2030, plus a profit margin of 7%. All other costs remain constant in 2015 dollars.

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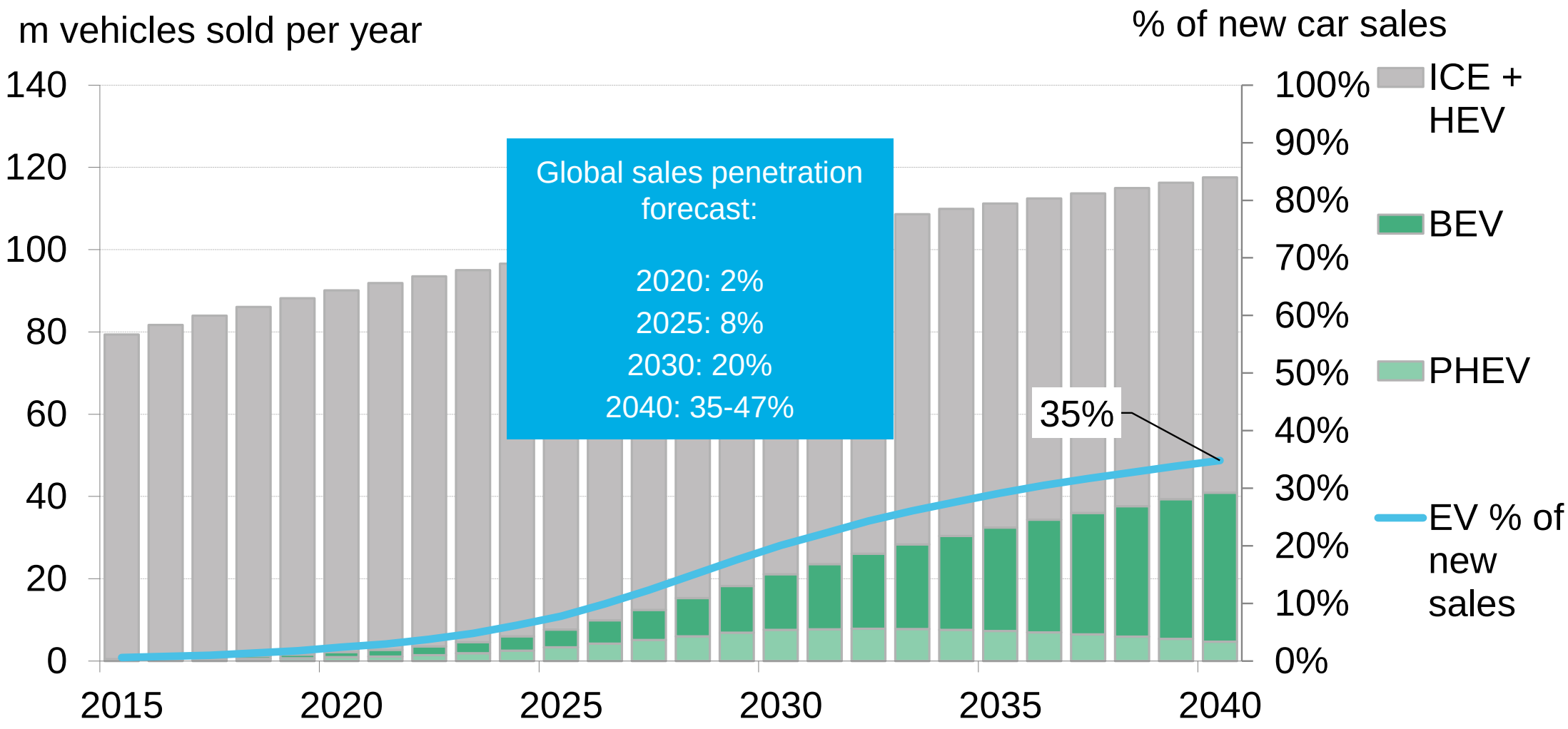
Global LDV and EV yearly sales, 2015 – 2040 (million vehicles sold per year, %)



Bloomberg New Energy Finance Note: ICE+HEV = internal combustion engine and hybrid vehicles, BEV = battery electric vehicles, PHEV = plug-in hybrid electric vehicles.

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1 Fuel efficiency

2 Technology development

3 Mobility

The rise of shared services and new mobility business models

Peer-to-peer car sharing

easyCar club The social way to hire

FlightCar

Peer-to-peer ride sharing

Bla Bla Car

scoop

On-demand ride-hailing

UBER

DiDi More than a journey

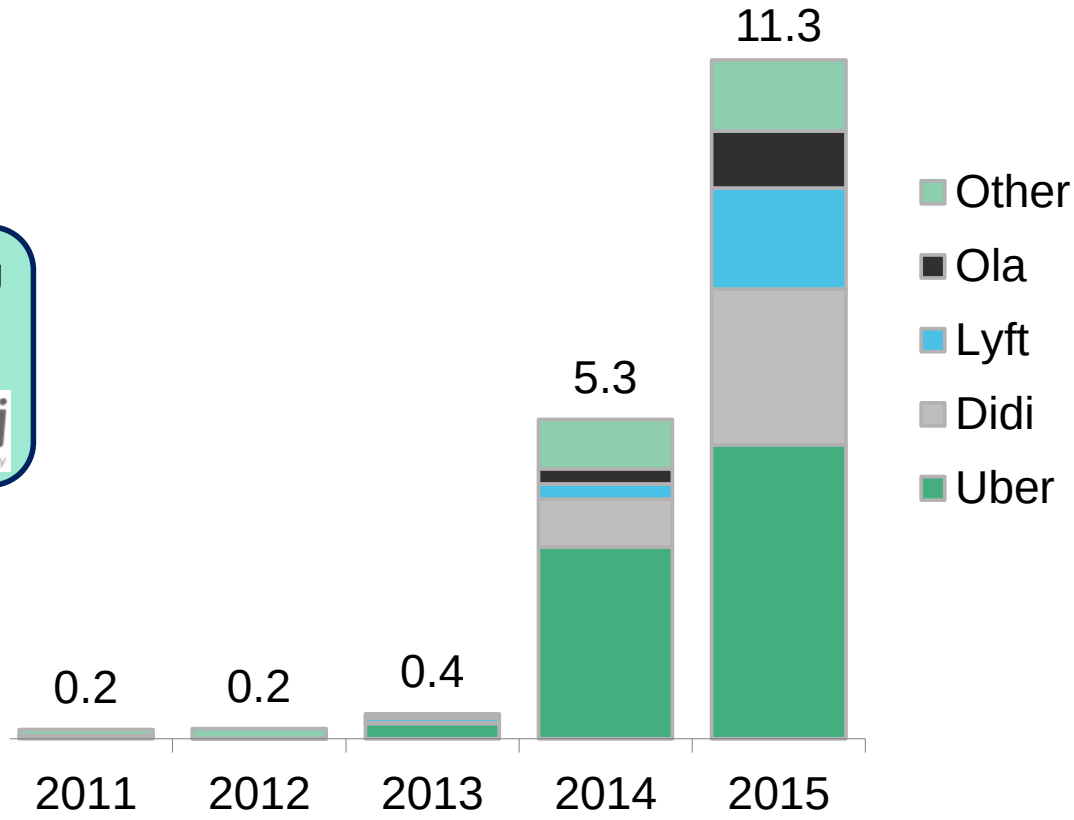
Operator car sharing

zipcar

康迪 KANDI

CAR2GO

Investments in ride-hailing companies, 2011-15 ($ billion)



Source: Bloomberg New Energy Finance

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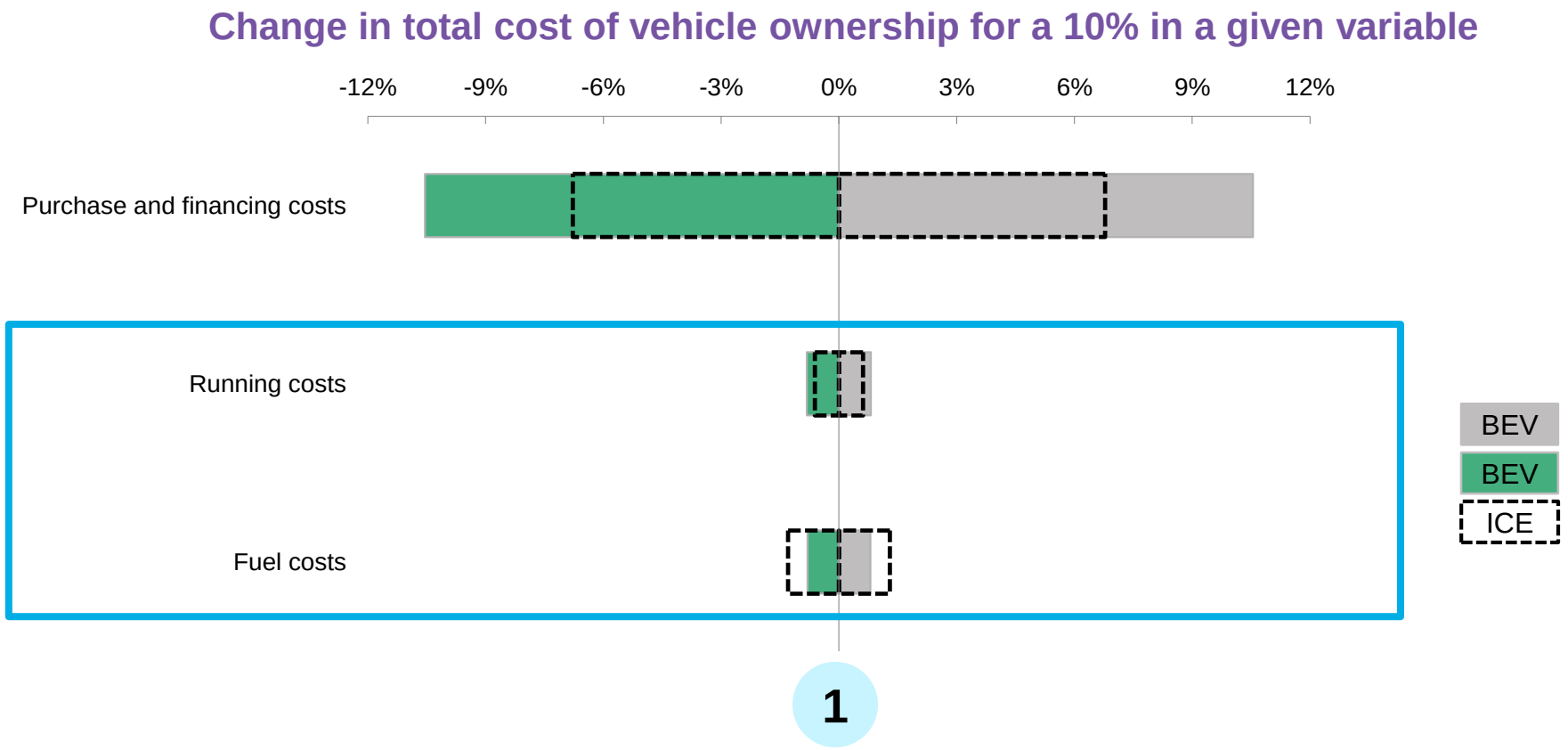
Sensitivity of the TCO of BEVS to changes in costs, using purchasing incentives

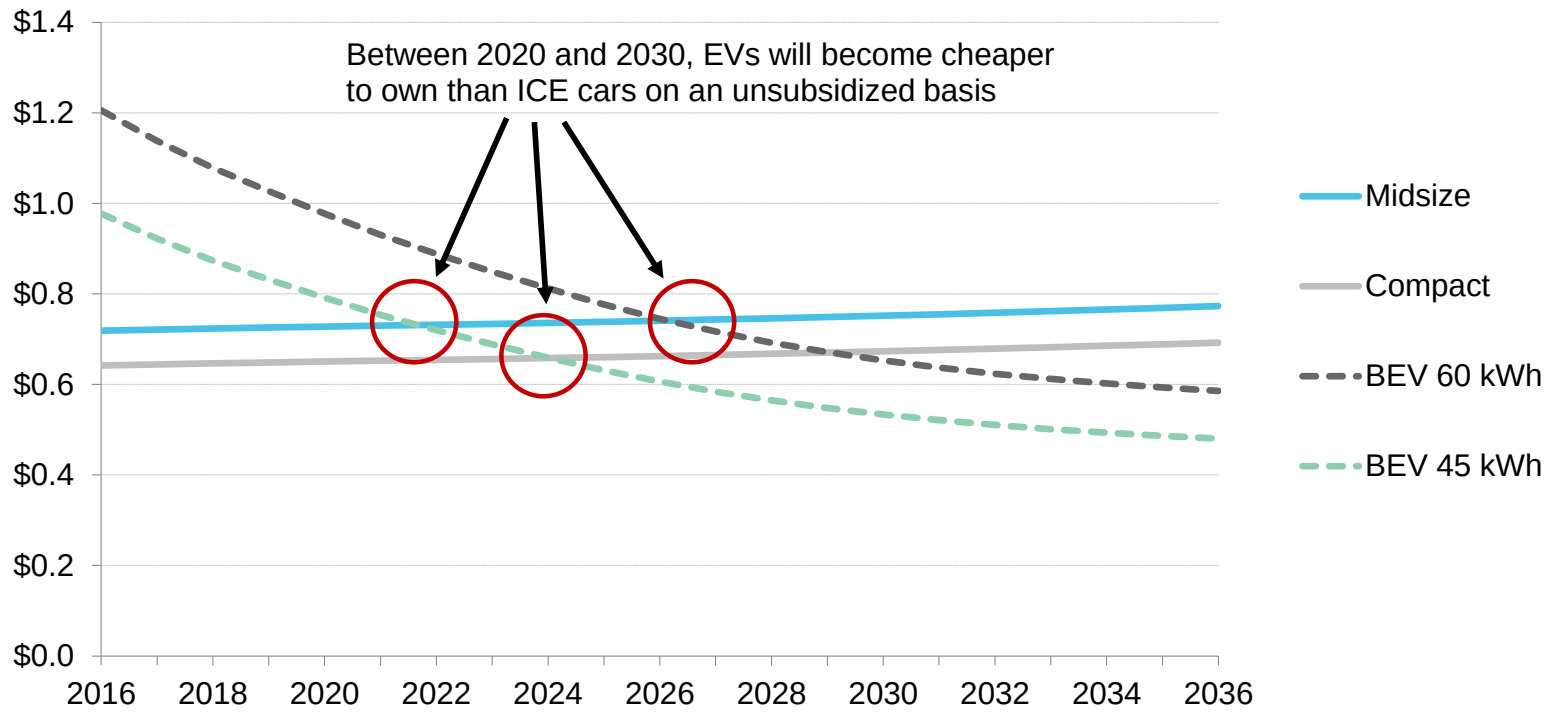


Running and fuel costs have a smaller impact on BEV's total cost of ownership…

…but vehicle utilization rates important factors in determining competitiveness of EVs relative to gasoline cars…

…specially in a scenario where the global vehicle fleet is utilized around 5% of the time.

Global average unsubsidized total cost of ownership outlook of BEVs compared with internal combustion engine vehicles 2016 – 2036 ($/mile)



1

Any mass adoption of EVs – over 5% of new vehicle sales – needs to be supported by competitive TCO.

Economics are not the only factor, but they are the leading indicator of future EV adoption.

2

Using EIA's "low" reference crude oil price to 2040 ($50-$75/barrel) – and our battery cost forecast – BEVs will not be competitive on a TCO-basis with ICEs until 2022

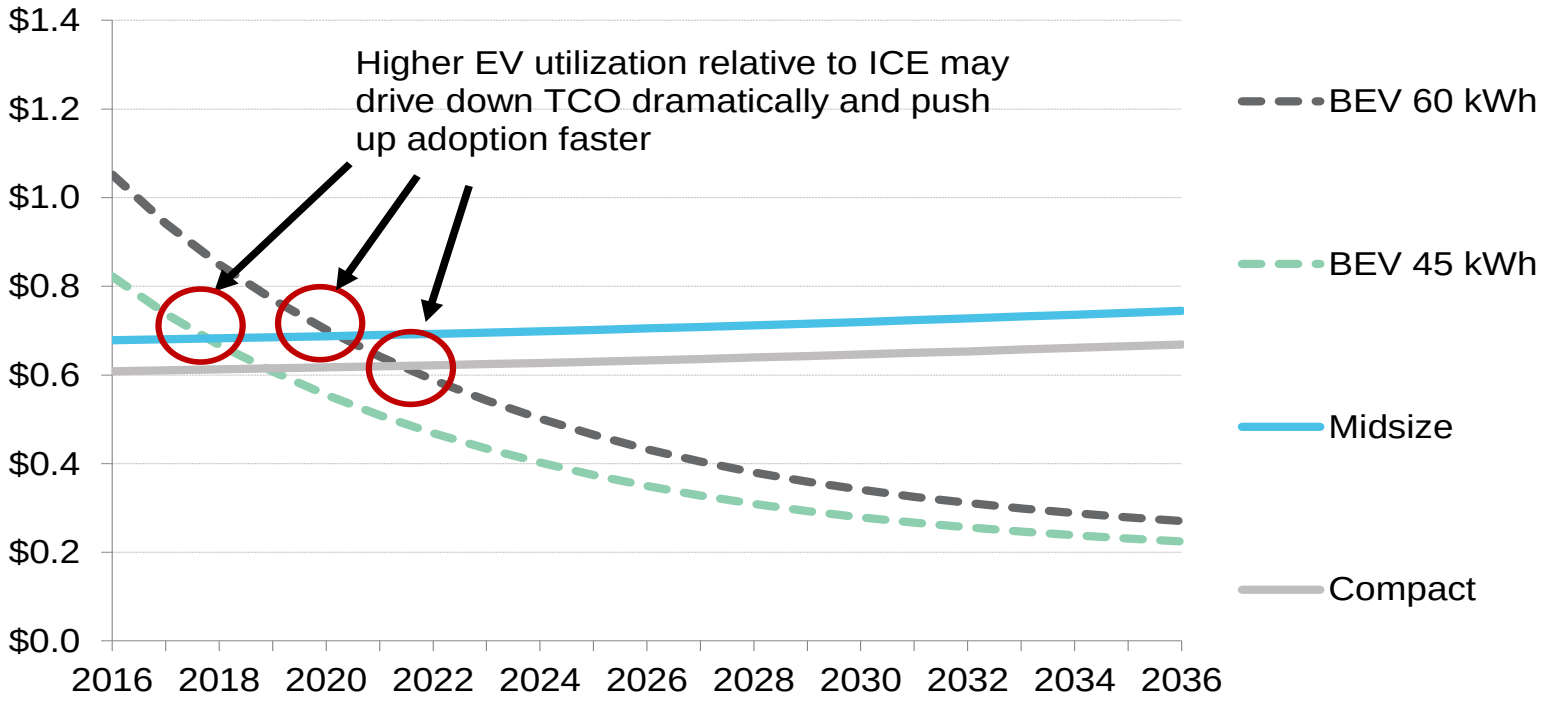
3

We project that a long-range 60kWh BEV can be competitively priced at $21,500 by 2040 (2015 dollars).

At that point, the total addressable market could exceed 50% of new sales for most markets

Source: Bloomberg New Energy Finance

TCO scenario where EV utilization doubles relative to ICE vehicles
2016 – 2036 ($/mile)



1

If ICE vehicle miles travelled are held constant in 2014 – 40, and BEV miles are doubled, TCO falls dramatically

2

The effect on ownership economics is sharp and in 2025 the per-mile cost of owning and operating an EV falls by about 40%

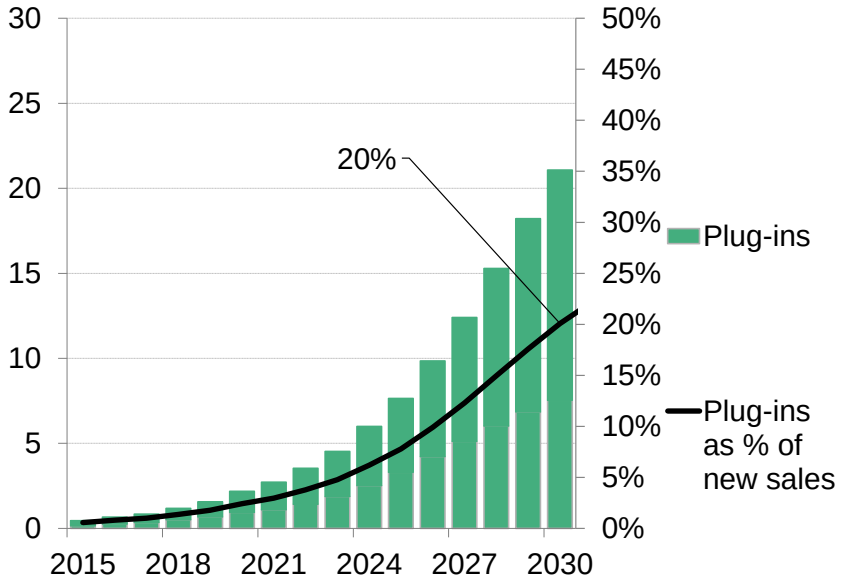
3

The additional electricity and maintenance costs are small and spread over a large number of miles driven.

Source: Bloomberg New Energy Finance

BNEF global NEW EV sales forecast by geography, 2015–2040 (million vehicles per year)

EQUAL NUMBER OF MILES TRAVELLED

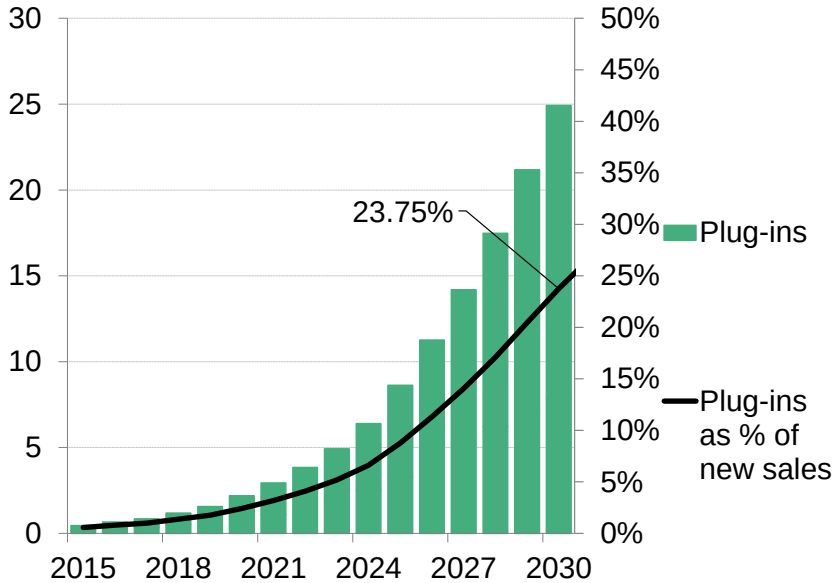


1

Under equal vehicle miles travelled the number of new EVs sold in 2030 globally is about 22m

The inclusion rate of EVs that year is 20% of new vehicles sold

DOUBLED THE EV MILES TRAVELLED



2

When doubling the utilization rate of plug-ins, the number of new EVs sold in 2030 increases to 25m

The penetration rate of new vehicle sales in 2030 increases to close to 24%

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