

PAUL EICHENBERG



STRATEGIC CONSULTING





# e-Mobility

## What are We Waiting For? Overcoming Obstacles for Mass Adoption



**PAUL EICHENBERG**  
strategic consulting

### Session framework

January 17, 2019



# Overcoming obstacles for mass adoption – framework

<b>Perspective</b> ↓	<b>Growth obstacles</b> ← Obstacles that slow growth	→ <b>Growth drivers</b> Trends that accelerate growth
<b>Availability</b>	Few EV/PHEV models available today	<ul style="list-style-type: none"><li>• Increasing stringency of regulations:<ul style="list-style-type: none"><li>– Fuel economy/GHG</li><li>– ZEV</li></ul></li><li>• Shifting OEM corporate strategy:<ul style="list-style-type: none"><li>– Divert from ICE to EV</li><li>– New EV models/architecture</li></ul></li></ul>
<b>Cost</b>	EV/PHEV's are expensive	<ul style="list-style-type: none"><li>• Gaining economies of scale for:<ul style="list-style-type: none"><li>– Battery cells/packs</li><li>– Power electronics</li></ul></li></ul>
<b>Technology</b>	Lack of technical competency	<ul style="list-style-type: none"><li>• Increasing # of experts in:<ul style="list-style-type: none"><li>– High-voltage electrical engineering</li><li>– Power electronics</li><li>– Powertrain software</li></ul></li></ul>
<b>Infrastructure</b>	Lack of eco-system	<ul style="list-style-type: none"><li>• Growing EV charging infrastructure:<ul style="list-style-type: none"><li>– Public charging</li><li>– Residential charging requirements</li></ul></li><li>• Expanding auto repair/maintenance:<ul style="list-style-type: none"><li>– Diagnostics for collision repair</li><li>– Emergency response</li></ul></li></ul>



# Availability – Regulatory compliance require electrification

## China

- Fuel consumption (l/100km)
- NEV (New Energy Vehicles)

## Europe

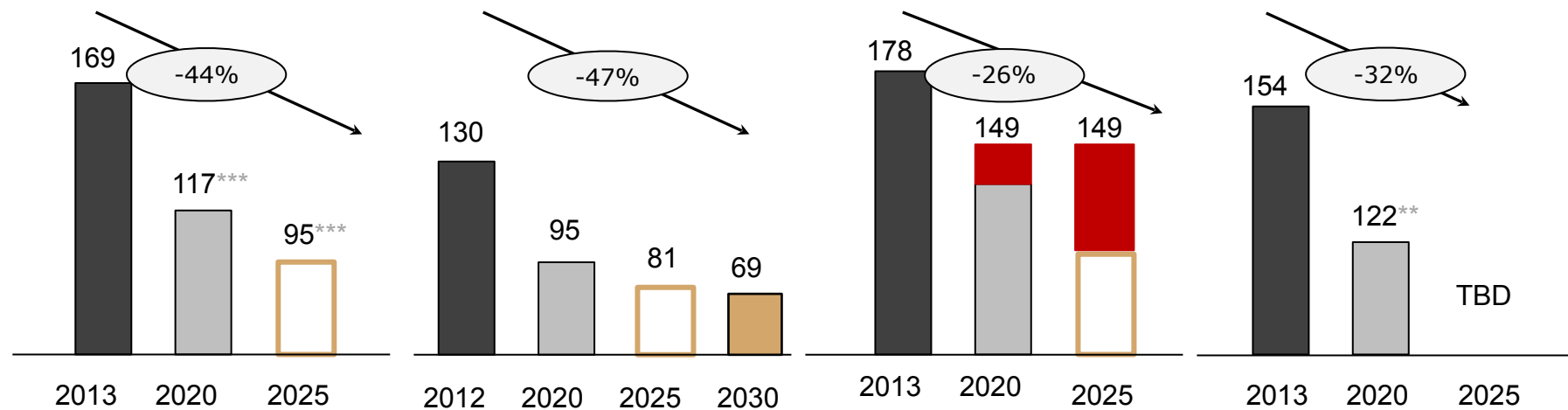
- GHG (g/km)

## U.S.

- CAFE (mpg)
- GHG (g/mi)
- ZEV (Zero Emission Vehicles)

## Japan

- Fuel consumption (km/l)



Sources: ICCT, EPA

Notes: \*Proposed level to be incorporated between 2025-30










\*\* Japan meets this level today

\*\*\*Stated target for major cities, not nationwide

**Trump Proposal  
of August 2018**

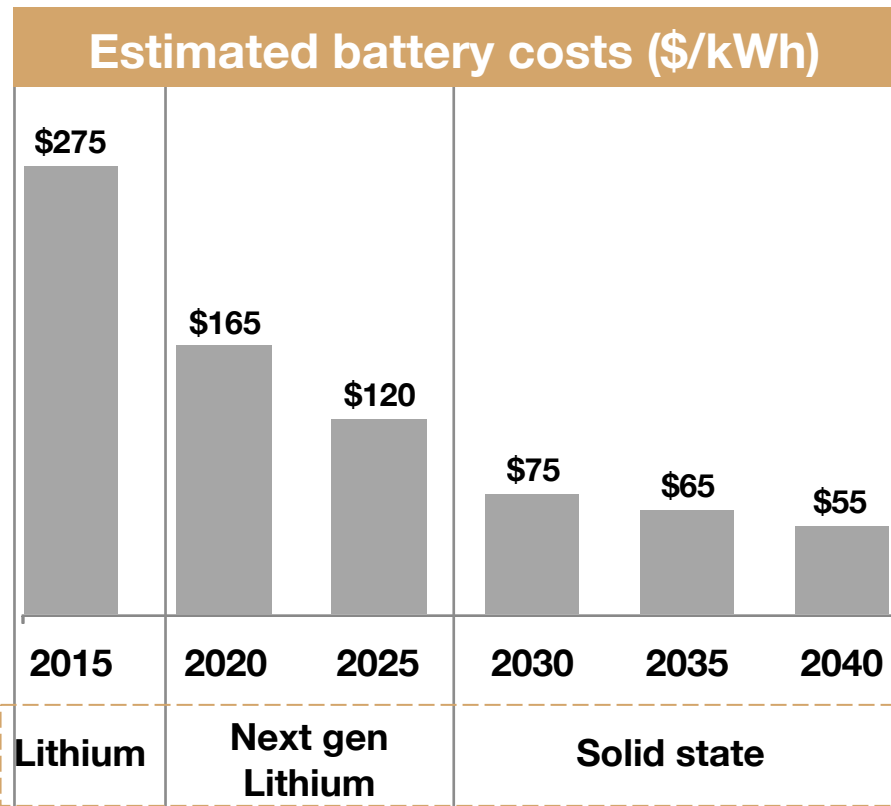


# Availability – OEM’s accelerate supply of electrified vehicles

OEM	Major electrification announcement
	<ul style="list-style-type: none"> <li>• Ford announces that it will launch 7 new EV’s by 2021</li> <li>• It expects 50% of its global sales to be EV by 2032 (~25% by 2025)</li> </ul>
<b>DAIMLER</b>	<ul style="list-style-type: none"> <li>• Daimler announces it will bring 10 new electric vehicles to the market by 2022</li> <li>• It will achieve 15-25% of its global sales by 2022</li> </ul>
	<ul style="list-style-type: none"> <li>• VW Group targets 2-3Mill EV’s/year by 2025 (~25%)</li> <li>• VW brand announced “TRANSFORM 2025+”: 1 mill VW branded EV’s/year globally (~15%) by 2025</li> <li>• Porsche plans 50% of its total sales to be EV by 2023</li> <li>• Audi plans 30% EV/HEV of U.S. sales by 2025 – June 2017</li> </ul>
	<ul style="list-style-type: none"> <li>• BMW announced that their new car architectures will enable “electrification of every model series”</li> <li>• EV/PHEV will be 15-25% of their sales by 2025</li> </ul>
	<ul style="list-style-type: none"> <li>• Volvo Cars announces that by 2019, all its vehicles will be sold as HEV or full EV – none of its vehicles will be solely driven by gasoline or diesel</li> </ul>
	<ul style="list-style-type: none"> <li>• Renault, Nissan, &amp; Mitsubishi to accelerate collaboration on common EV platforms</li> <li>• 12 new EV’s to be launched by 2022</li> </ul>
	<ul style="list-style-type: none"> <li>• Honda to electrify two-thirds (2/3) of new cars in Europe by 2025</li> </ul>
	<ul style="list-style-type: none"> <li>• In addition to the Bolt/Volt, GM will launch 2 more EV’s in ‘19</li> <li>• GM announced that it will have at least 20 EV models by ‘23</li> </ul>
	<ul style="list-style-type: none"> <li>• Toyota will launch 10 new EV’s by 2022 and will have an electric option for its entire lineup of cars by 2025</li> </ul>
	<ul style="list-style-type: none"> <li>• Hyundai/Kia to launch 38 new green vehicles by 2025 with many of them being full EV’s</li> </ul>



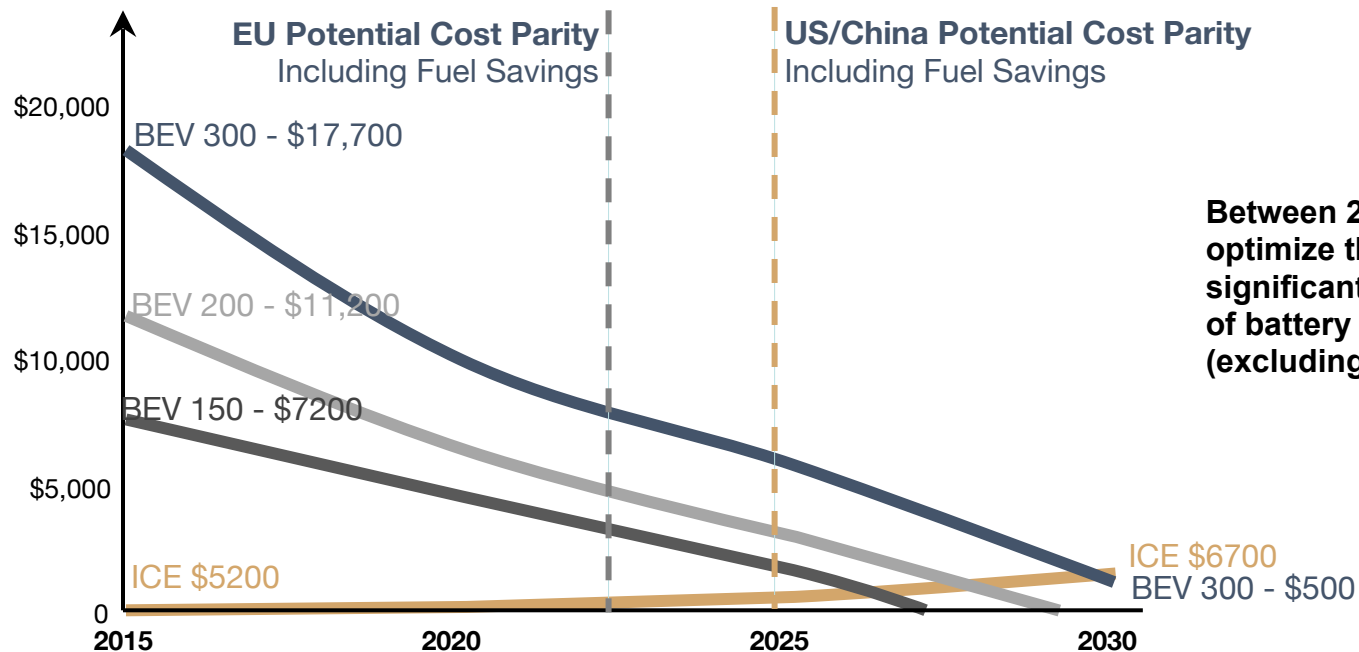
## Cost – Battery costs are decreasing



- As battery technology advance and gain economies of scale, EV batteries are expected to drop by:
  - ~50% by 2025
  - ~75% by 2030 –
- \$100/kWh achieved between 2025-2030



# Cost – Cost differential between EV and ICE is disappearing

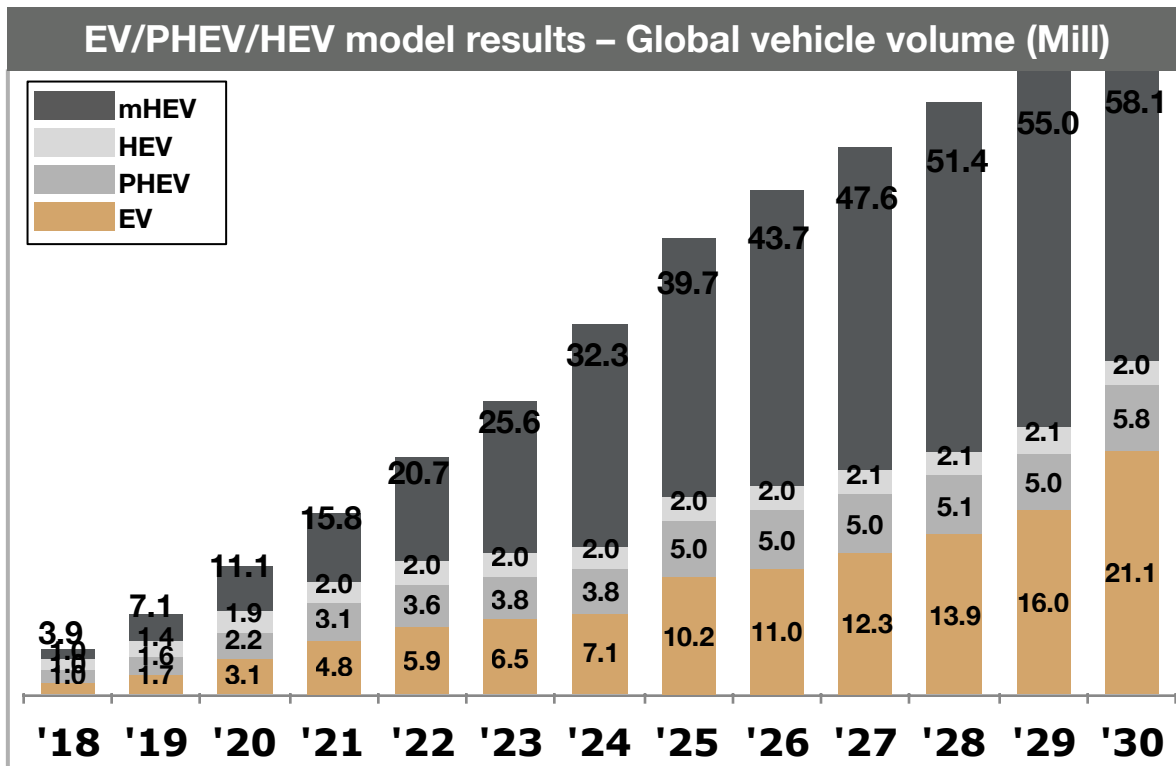


**Between 2020 and 2030 the cost to optimize the ICE will increase significantly as technology and cost of battery packs sharply decrease (excluding subsidies).**

Sources: ICCT November 2016 Battery Technology Forecast - 2015 \$270 USD, 2030 \$110 USD per kWh – battery pack  
Bloomberg News Energy Finance estimates \$270 kwh battery pack = \$74 per pack and \$196 per cell (Tesla acknowledges at \$190 pack and GM at \$145 cell price today).



# Modeling example – 50% electrified vehicles possible by 2030



- Global EV projections are driven by:
  1. China's new NEV regulations
  2. E.U.'s GHG regulations
  3. U.S.'s GHG regulations
- The model results of these 3 regions (~70%) are projected onto the remaining region's volume (~30%) resulting in a global estimate
- Broadly, this model favors EV more than PHEV assuming battery costs decrease and charging infrastructure increases reducing the need for the "dual powertrain" nature of PHEV's

NOTE: NEV = New Energy Vehicle, GHG = Greenhouse Gas, mHEV = mildHEV (48V), HEV = Hybrid Electric Vehicle; PHEV = Plugin Hybrid Electric Vehicle, EV = Electric Vehicle



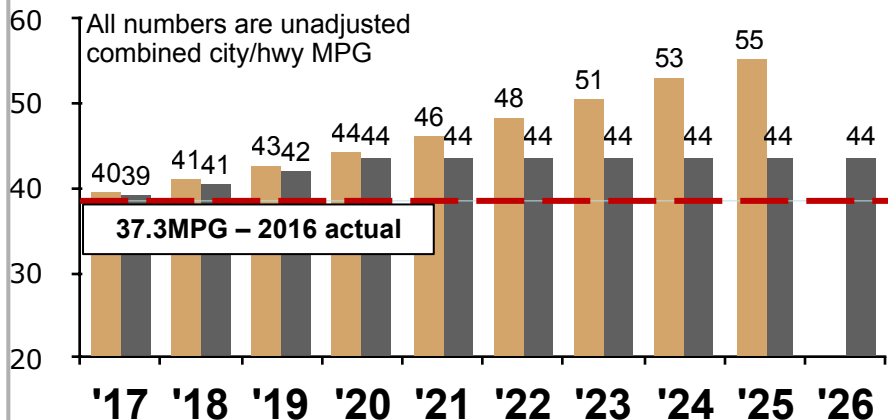


# Modeling example – potential changes in the U.S.

In August, 2018, NHTSA/EPA has announced new proposed regulations covering 2021-2026MY regulations on CAFE/GHG substantially easing current standards – the new proposal is 3X less difficult to comply with

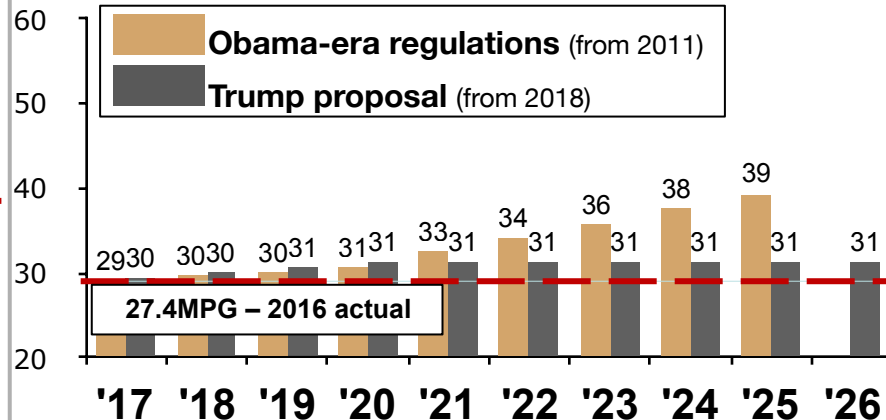
## Corporate Average Fuel Economy – CAFE targets (MPG – miles per gallon)

### Passenger Car



16MY gap to 25MY target:  
18MPG (Obama) vs. 6MPG (Trump) – 3X difference

### Light Truck



16MY gap to 25MY target:  
12MPG (Obama) vs. 4MPG (Trump) – 3X difference

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