



Electrified Transportation Challenges

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Electrified Powertrain Engineering

Ford Motor Co.

An Industry Session

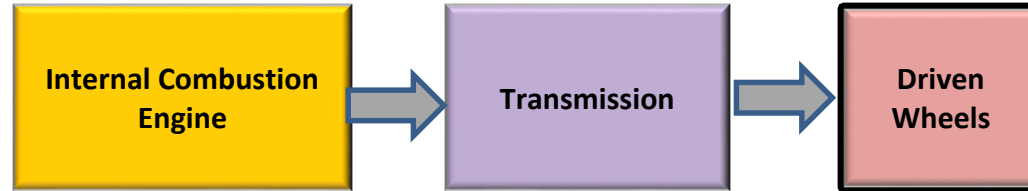
APEC 2017

- ❖ At the end of the 19th century, big cities such as New York, Boston, and Philadelphia welcomed clean electric vehicles to replace polluting horse-drawn carriages.
- ❖ And now more than a century later, it seems that we have come full circle since regulatory, environmental, and economic concerns are driving the world to electrify transportation.
- ❖ Although, such move poses numerous challenges due to a fully articulated infrastructure; and a society, economy, and culture tightly bound to ICE.
- ❖ That is why effective solutions and proper implementations are required in order to make the electrified vehicle an acceptable and even desirable choice to the customers.
- ❖ This presentation attempts to address some of the key challenges facing the electrification of passenger vehicles, although, the same challenges could apply to other types of road transportation.

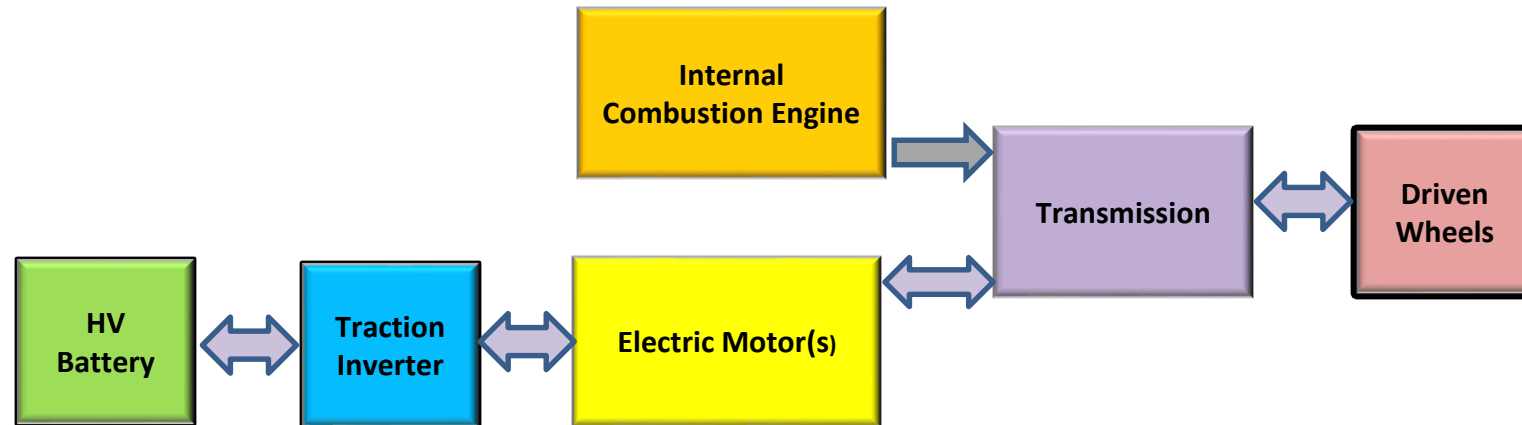
Powertrain Topologies



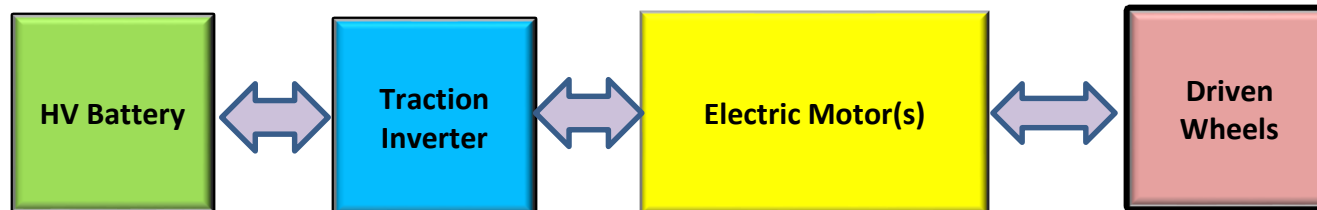
Conventional Vehicle Powertrain



Plug-in Hybrid Electric Vehicle Powertrain



Battery Electric Vehicle Powertrain

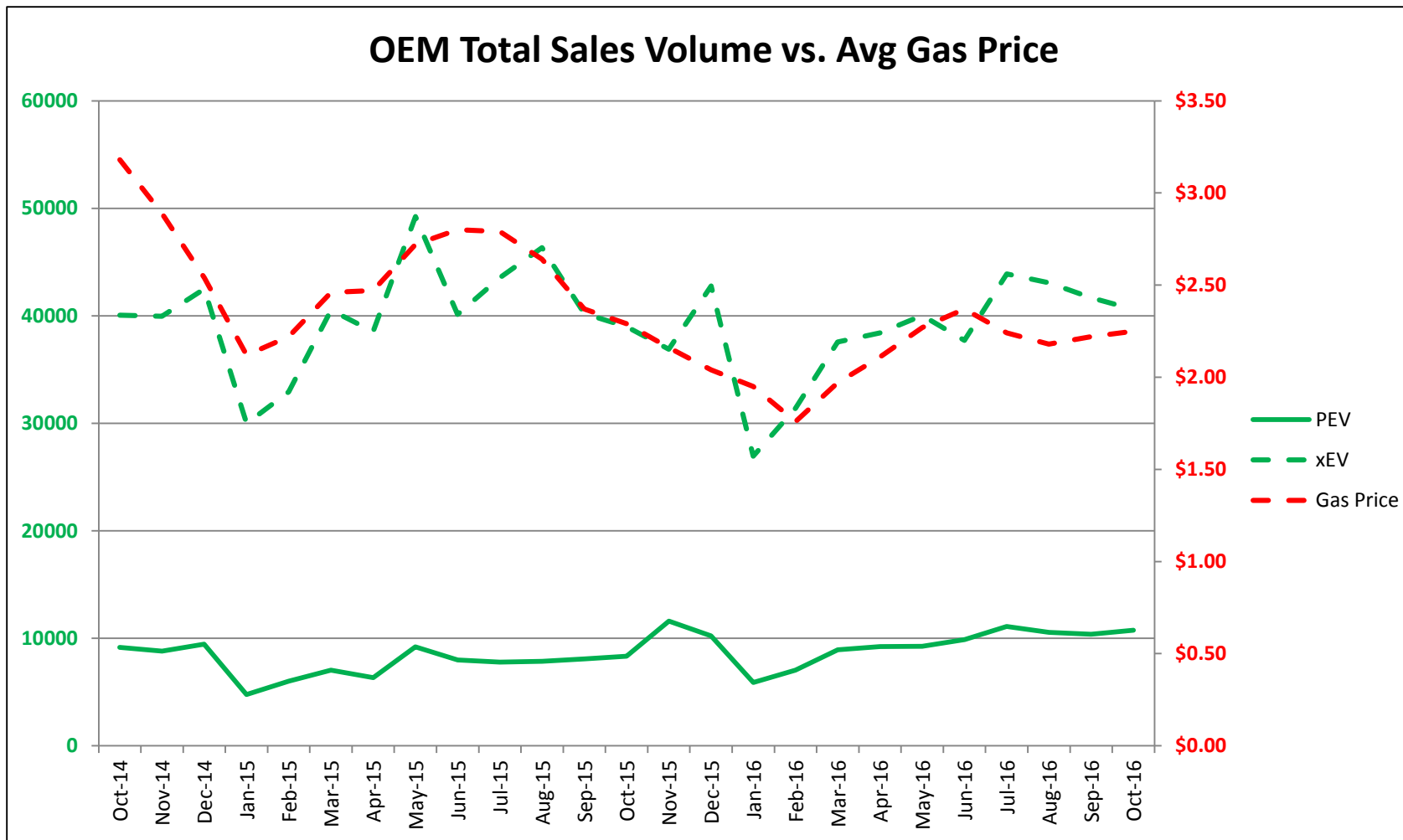


PEV

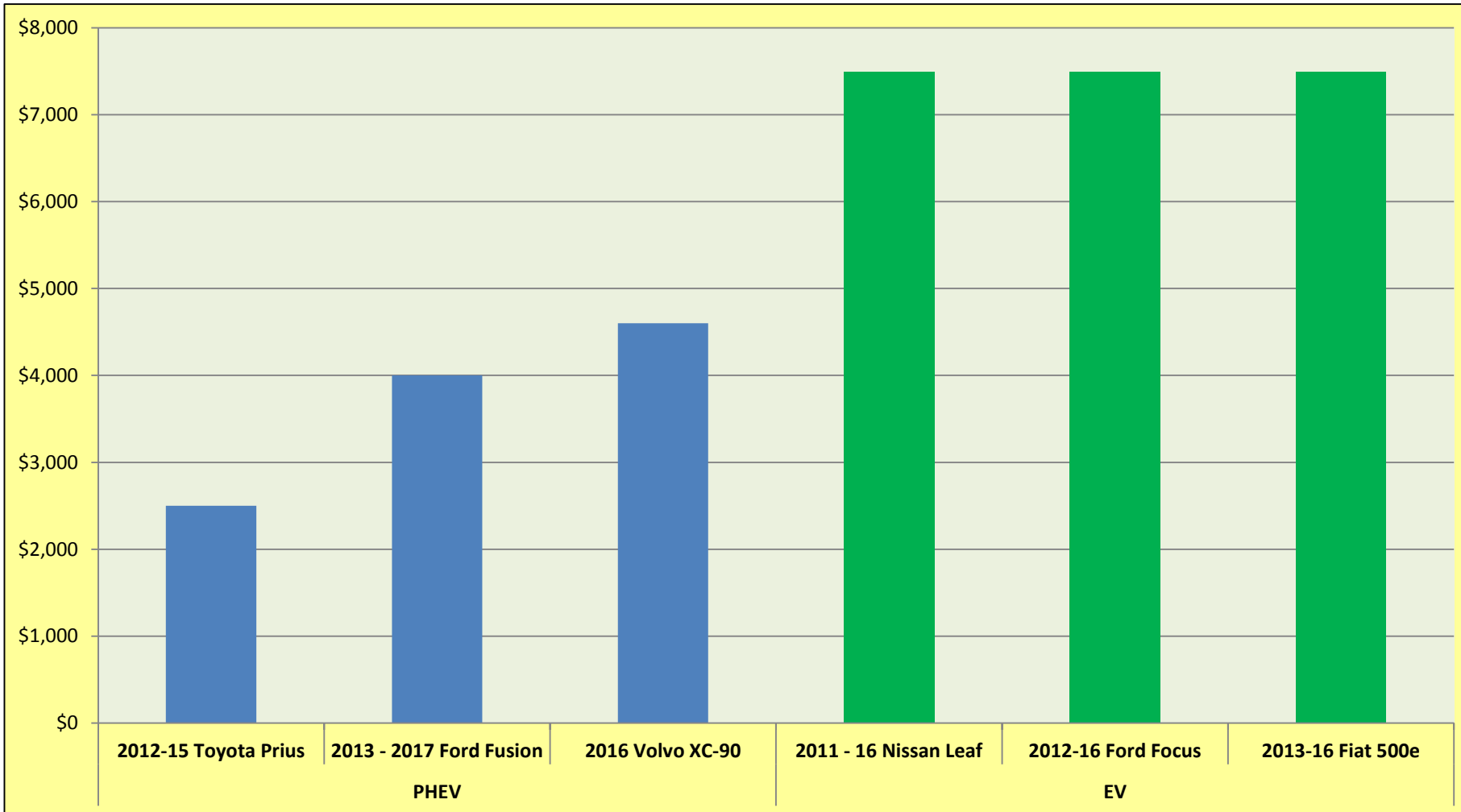
Challenges: Customer Expectations



TCO (Total Cost of Ownership) – More attractive cost equation



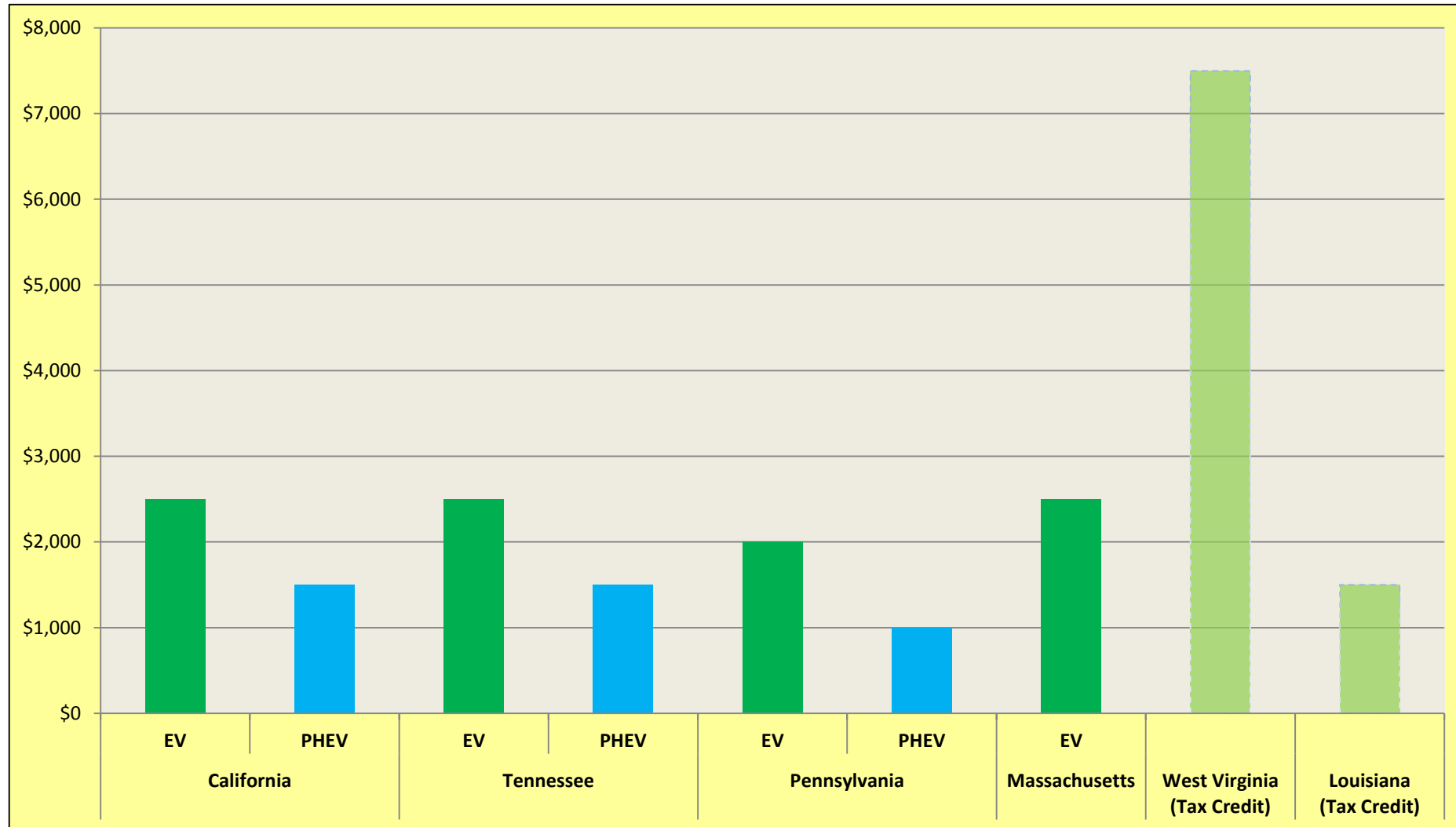
2016 Incentives for Electrified Vehicles – US (Federal)



Additional Incentives:

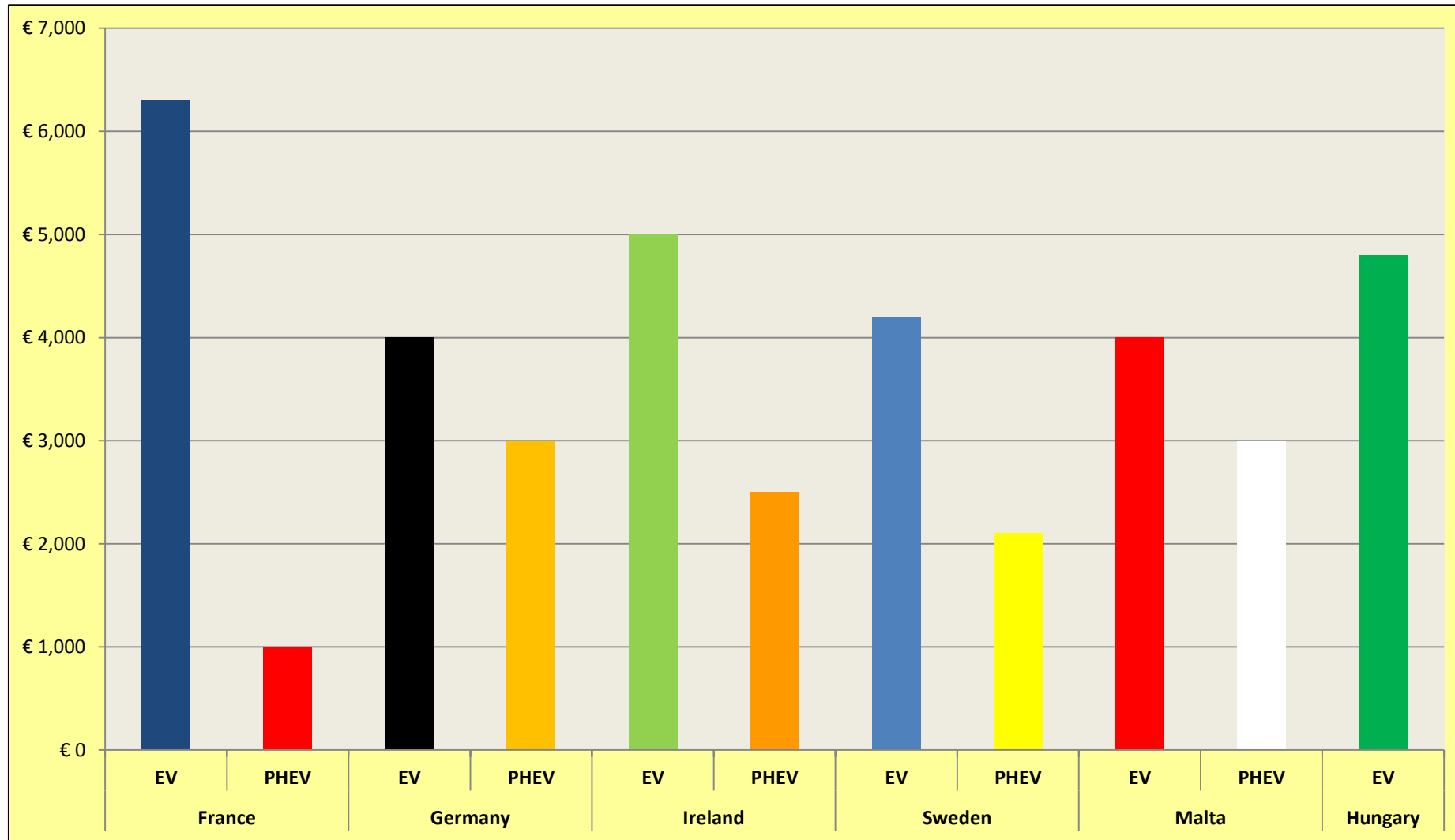
- Tax credit up to \$1,000 for consumers and \$30,000 for businesses toward purchasing and installing charging stations.

2016 Incentives for Electrified Vehicles – US (States)



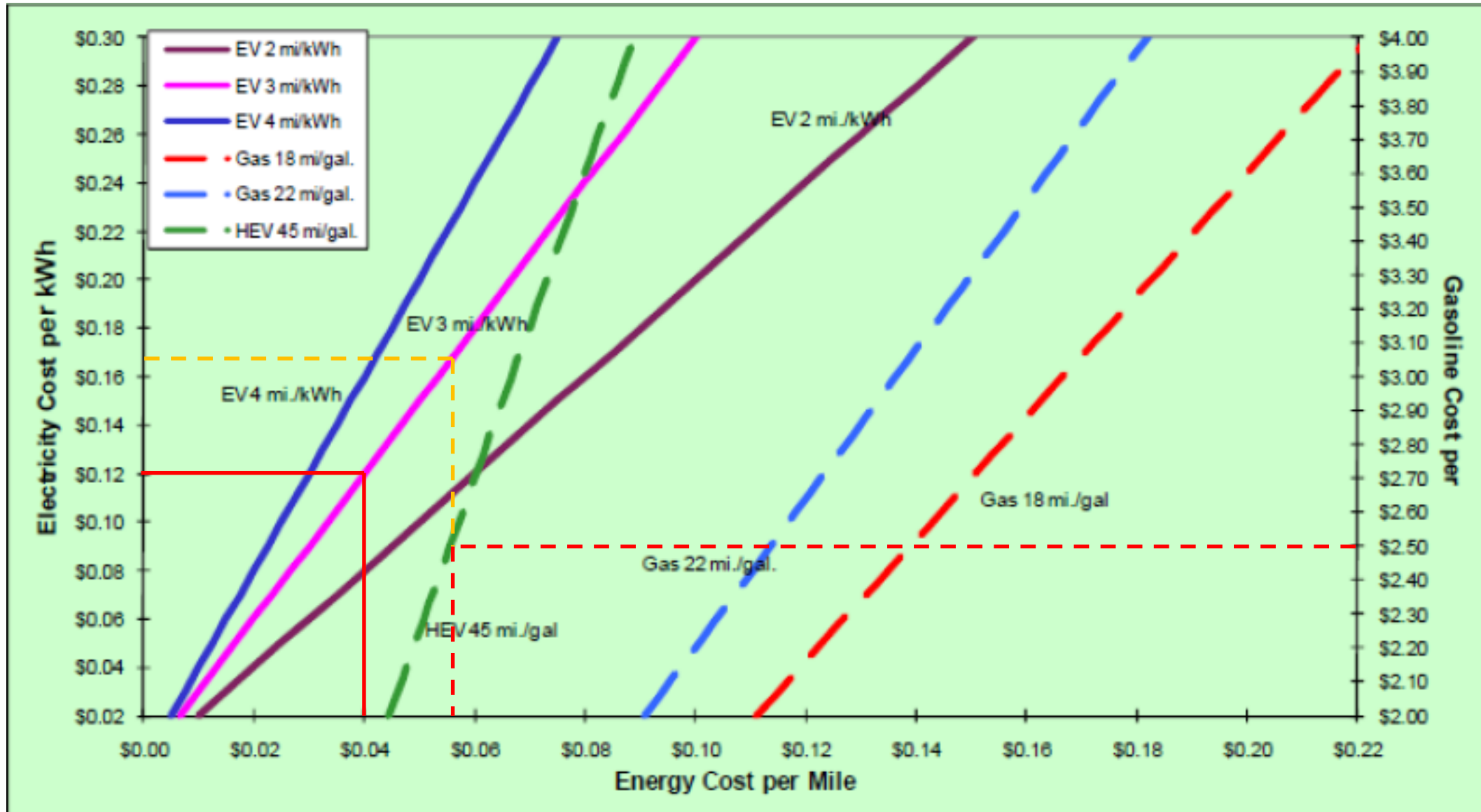
Ohio provides funding for 80% of purchasing and installing charging stations.

2016 Incentives for Electrified Vehicles - Europe



Denmark, Netherlands, and Norway have vehicle registration tax exemptions.

Energy Cost Comparison (xEV vs Conventional)*



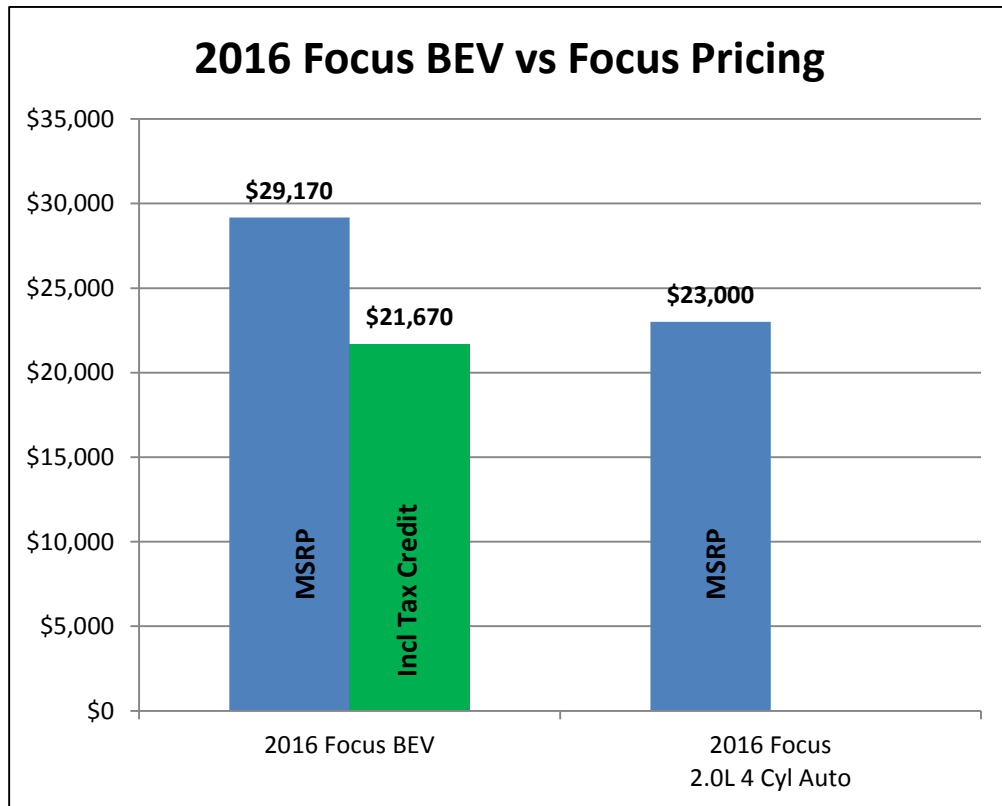
* Source: Idaho National Laboratory

Challenges: Customer Expectations

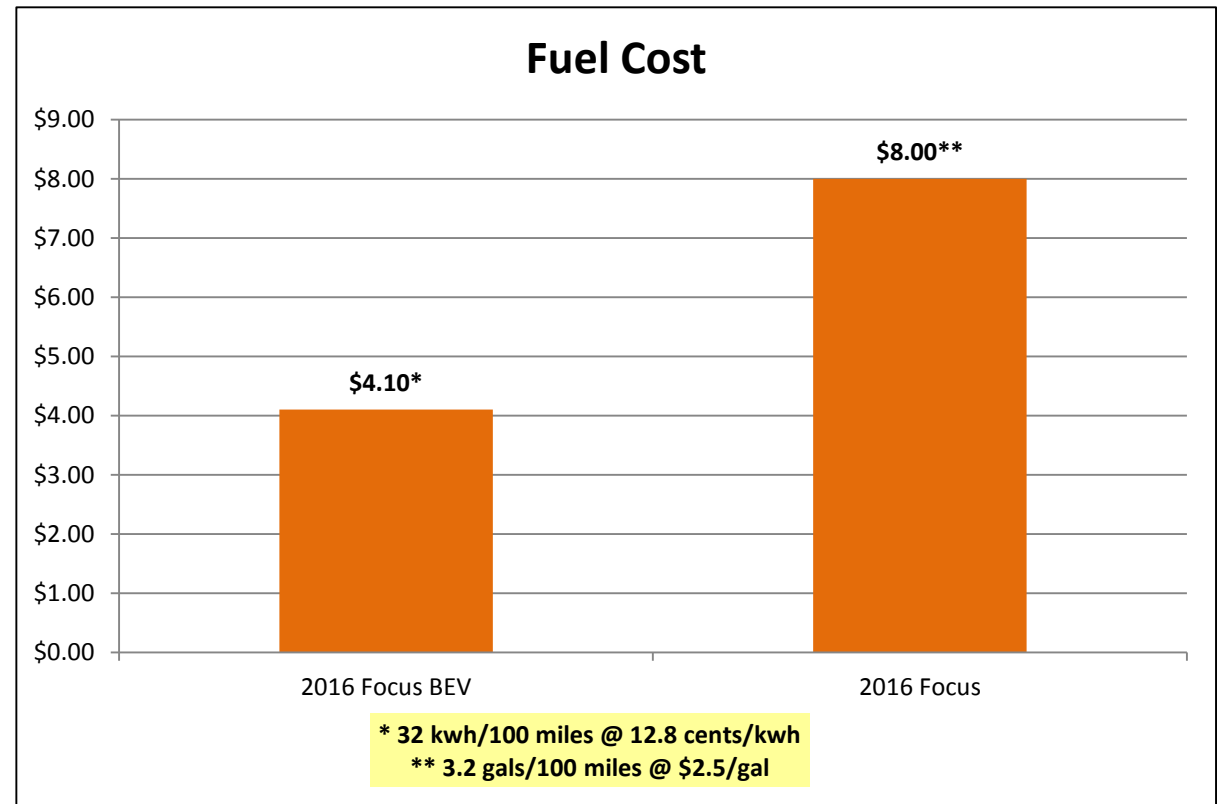


TCO (Total Cost of Ownership) – More attractive cost equation

❖ Price



❖ Operating cost



* Source: www.fueleconomy.gov

No Compromises – At least same vehicle attributes

- ❖ Performance
 - *Demand for higher vehicle acceleration and max speed*

- ❖ Electric Driving Range
 - *Bigger battery pack*

- ❖ Cargo Capacity
 - *Available cargo space for larger battery pack*

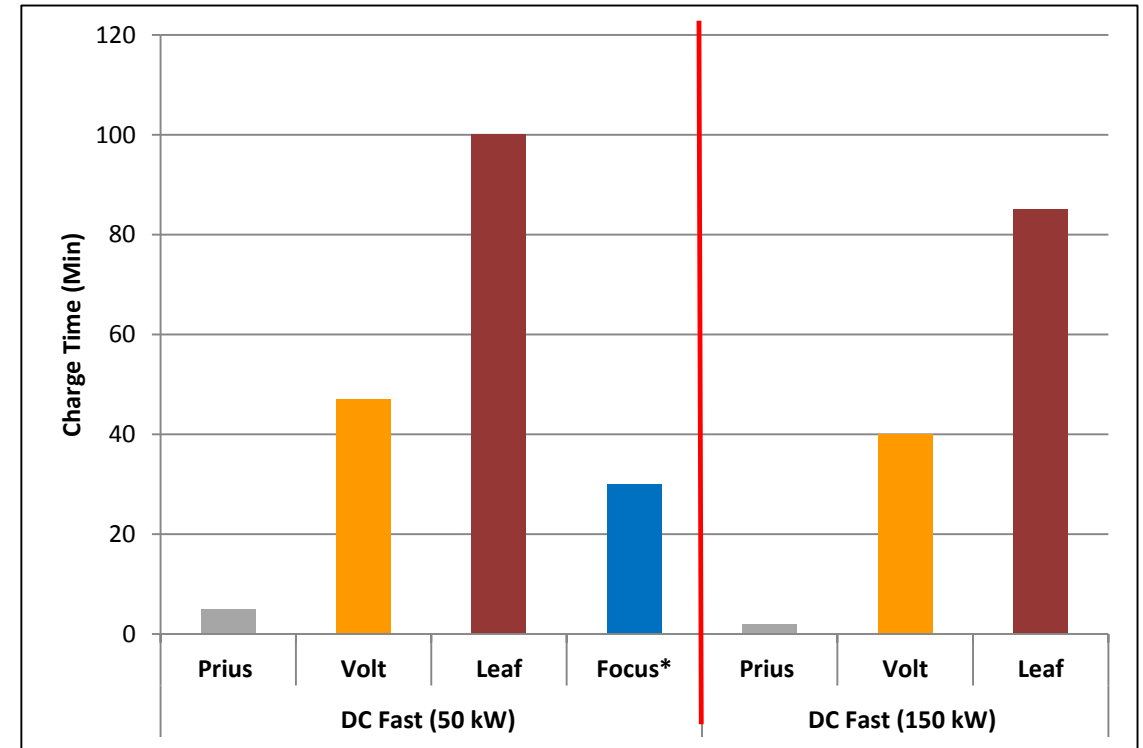
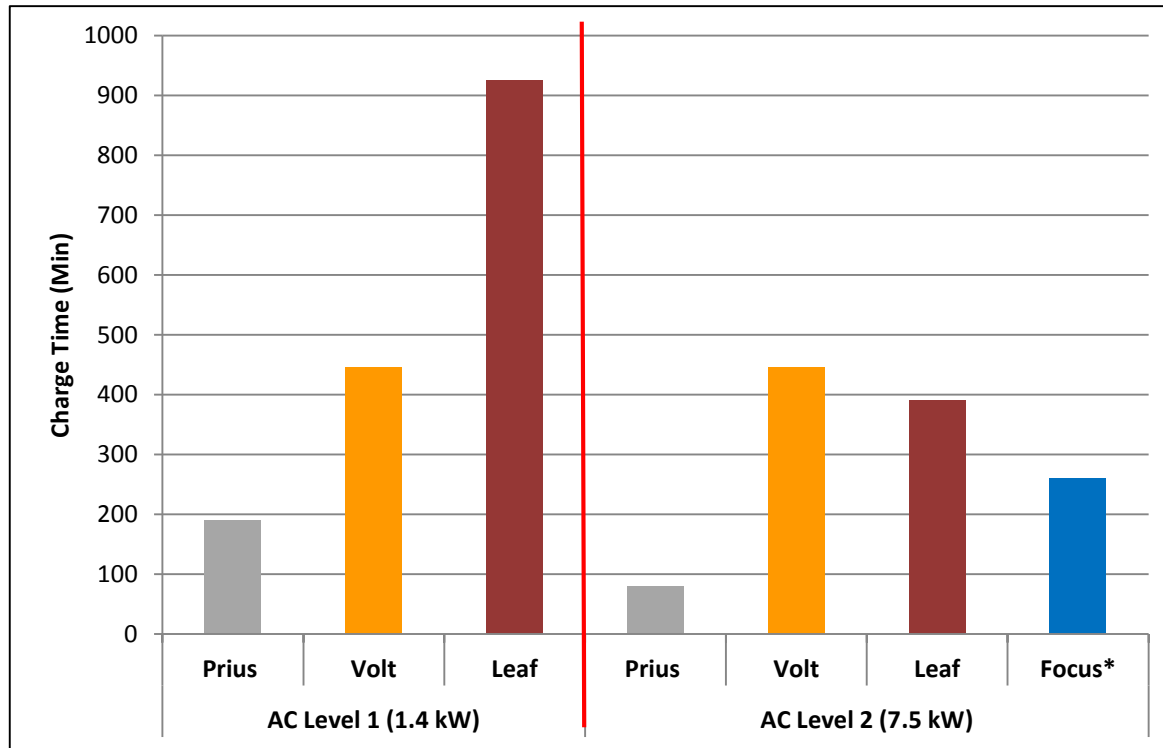
There are inter-dependencies and possible conflicts exist between vehicle attributes expected by customers which, of course, needs to be resolved thru technical solution(s).



Charging Stations – Convenient and fast

❖ Charging Time

- *Fast DC charger best suited for “en-route” charging*

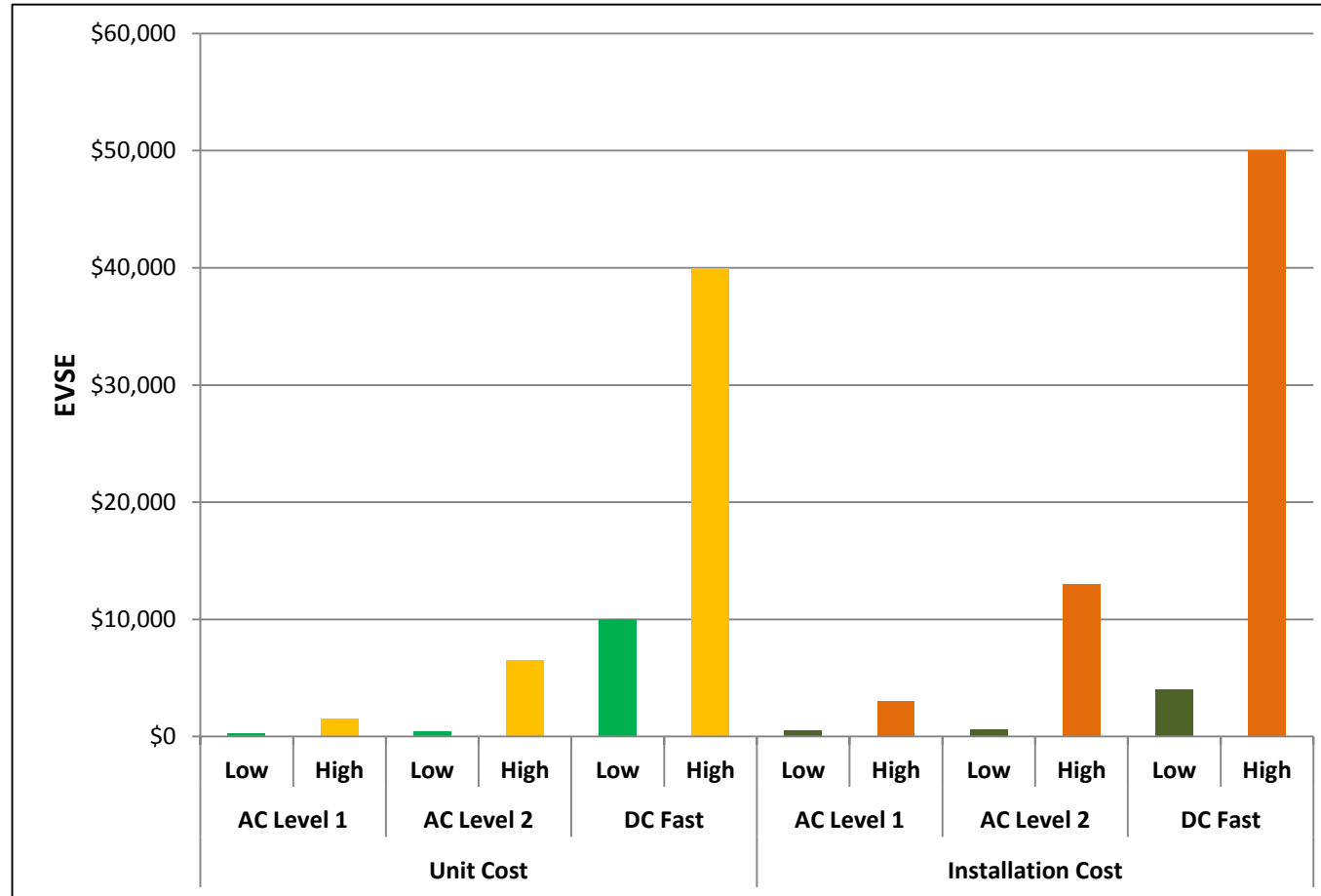


- **Source:** Bay Area Plug-in Electric Vehicle Readiness Plan – Dec. 2013
(* Ford data: 2017 Focus BEV)

Challenges: Charging Infrastructure



- ❖ Upfront Infrastructure Cost of EVSE
 - *Significant investment for charging stations network*

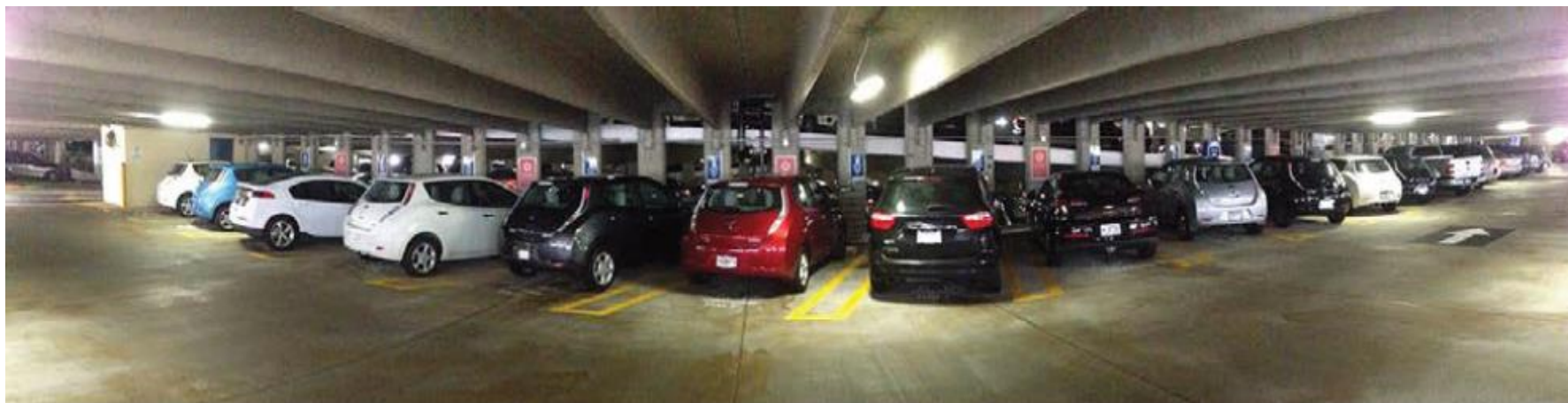


• **Source:** U.S. Department of Energy– Nov. 2015
EVSE -> Electric Vehicle Supply Equipment

Challenges: Charging Infrastructure



- ❖ Impact on Electrical Grid and Cost of Charging
 - *Infrastructure needs to match the demand*



❖ Optimal System Functionality

- Understanding of global customer usage and expectations

❖ Packaging

- Modular and common design vs. vehicle packaging constraints

❖ Reliability

- Highly reliable and durable electrified vehicles

❖ Homologation

- Ever increasing regulatory standards

- ❖ Although fuel economy and CO₂ improvements required by global regulations do point to electrified road transportation as the only practical solution, consumer's willingness to widely accept that will require other key factors beyond consideration of ecological impact.
- ❖ Numerous studies and publications have concluded that such key factors include price, operating cost, performance, functionality, and driving range.
- ❖ Even though hybrid and plug-in hybrid electric vehicles do offer acceptable key attributes such as performance and functionality without driving range compromise, more emphasis is given globally to the adaption of electric vehicles.
- ❖ If electric vehicles are to claim a substantial share of the electrified vehicle market, reduction in total cost of ownership would be required as well as convenient and fast charging infrastructure would need to be developed.

Thank you



for your attention!

Questions???



2005
Ford
Escape
Hybrid



2013
Ford
Fusion
Hybrid



2006
Mercury
Mariner



2013
Ford
CMAX
Hybrid



2010
Ford
Fusion
Hybrid



2013
Lincoln
MKZ
Hybrid



2010
Mercury
Milan
Hybrid



2011
Lincoln
MKZ
Hybrid