Energy Week
University of Texas - Austin
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Advanced Technology Vehicle Tipping Point(s)

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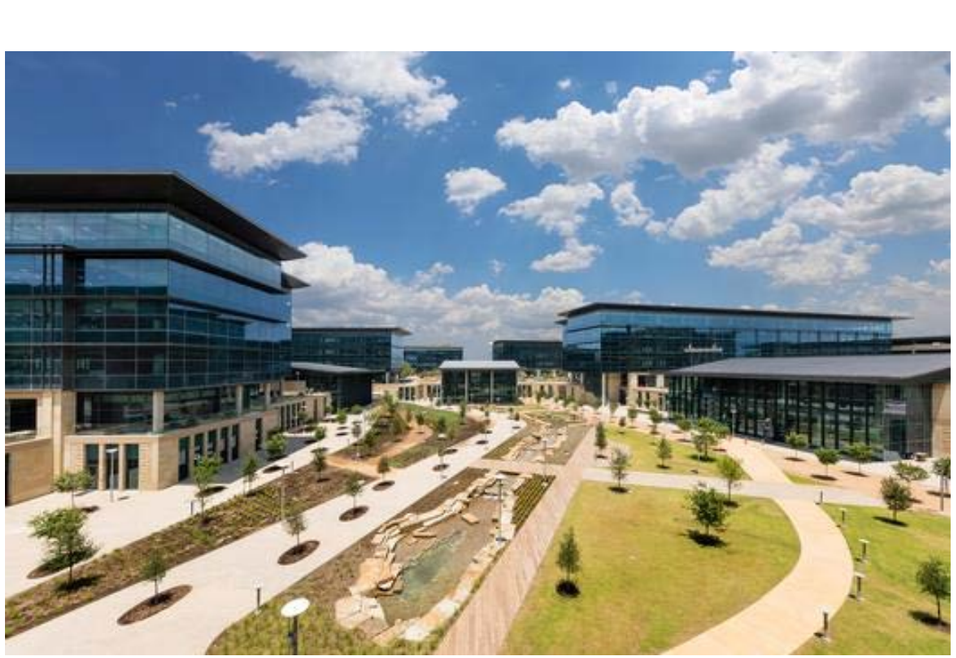
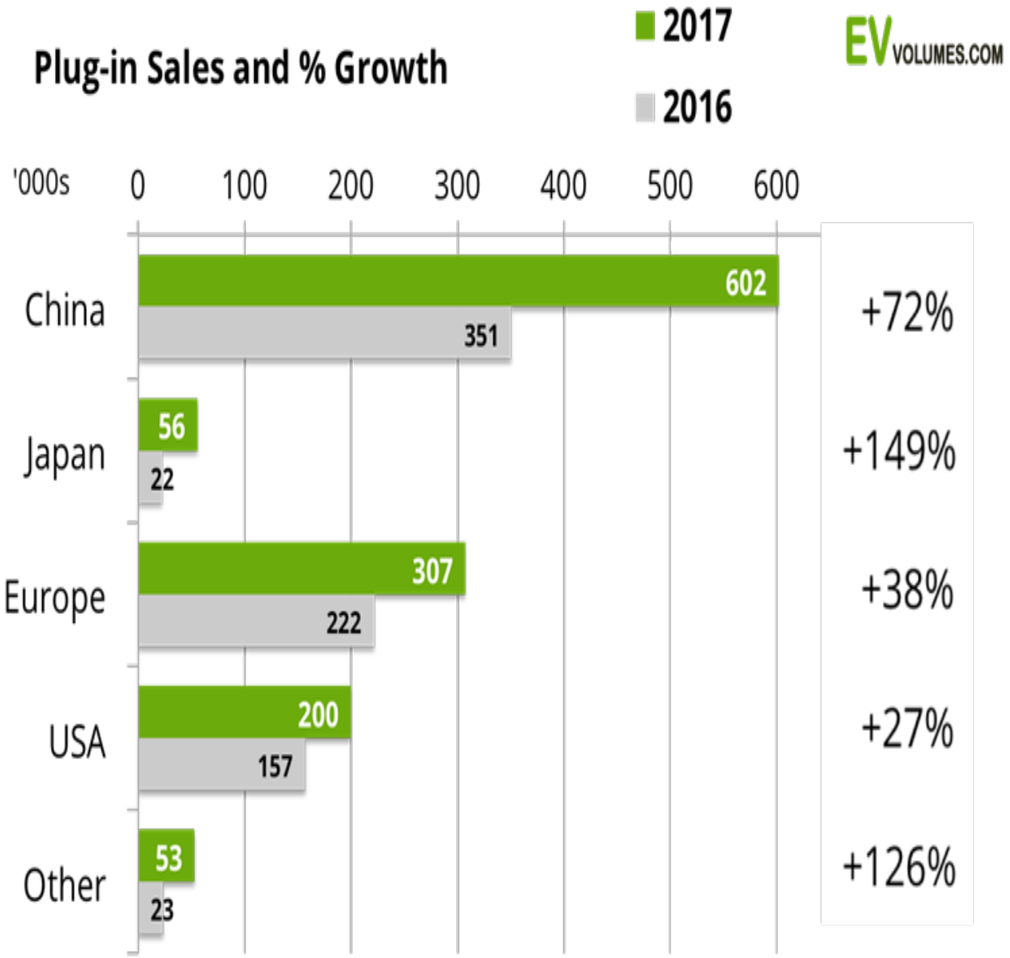
Corporate Strategy and Planning Division
Toyota Motor North America, Inc.
Plano, Texas

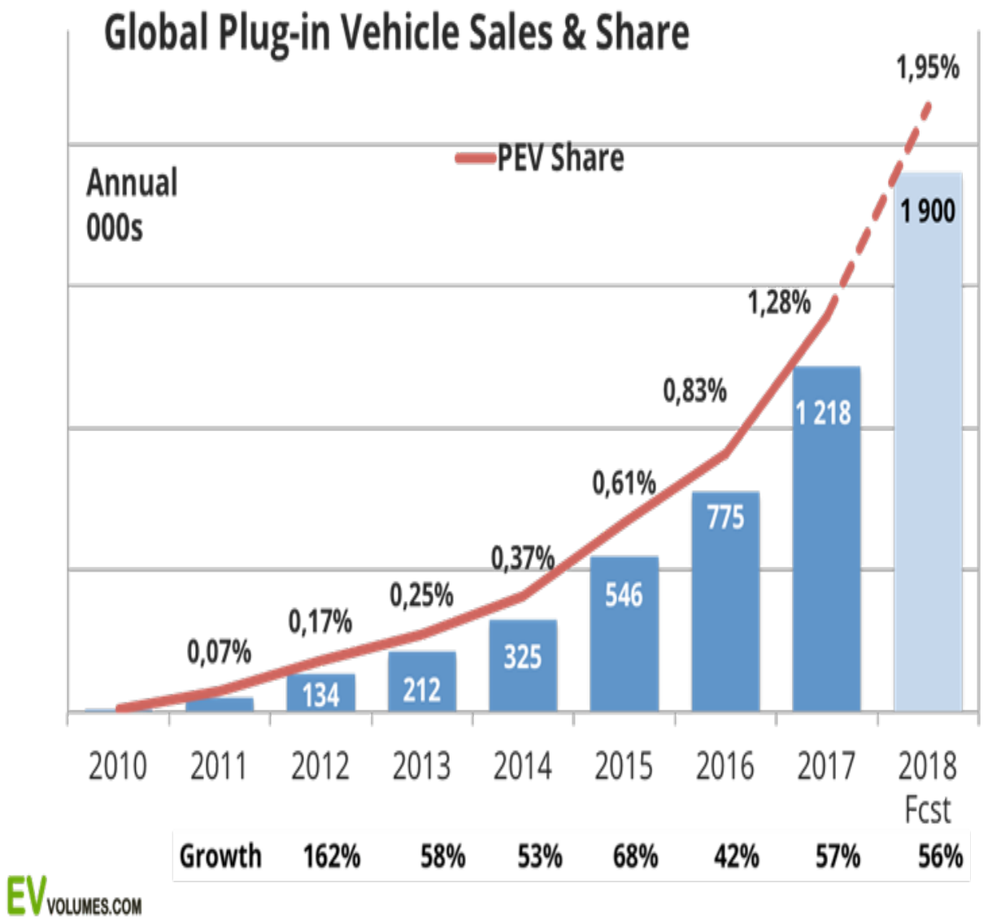
TOYOTA MOTOR NORTH AMERICA

It's really great to be in Texas!!!!

- 4,000+ employees on Plano campus
- Exterior landscaping reflects the native habitat, with drought resistant plants
- A Texas-sized 8.79-megawatt array of more than 20,000 solar panels
- Commitment to use only renewable energy, purchasing all electricity not generated by the solar panels from wind generated by Texas farms
- A rainwater harvesting system, up to 400,000 gallons, to use in irrigation




Plug-in Sales and % Growth
2017
2016
EVVOLUMES.COM
'000s
0
100
200
300
400
500
600
China
602
351
+72%
Japan
56
22
+149%
Europe
307
222
+38%
USA
200
157
+27%
Other
53
23
+126%

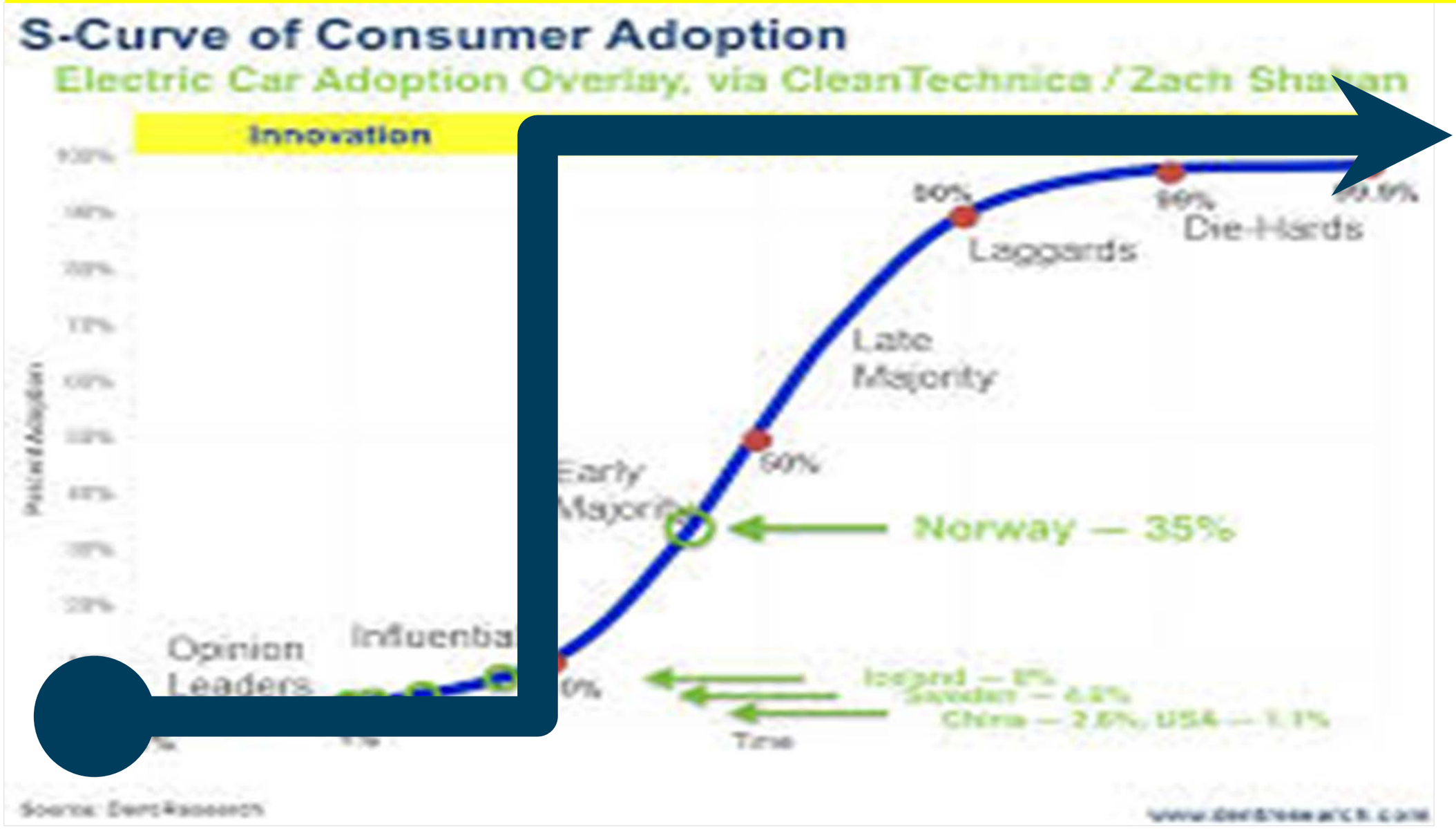

Global Plug-in Vehicle Sales & Share
Annual
000s
PEV Share
1,95%
1,28%
0,83%
0,61%
0,37%
0,25%
0,17%
0,07%
1 900
1 218
775
546
325
212
134
2010
2011
2012
2013
2014
2015
2016
2017
2018
Fcst
Growth
162%
58%
53%
68%
42%
57%
56%
EVVOLUMES.COM

Collective Will – Can Public Policy Stimulate or Foster Development?

Many Links in Chain of Collective Will – ***Weakest Link(s)*** Will Cause Market Failure

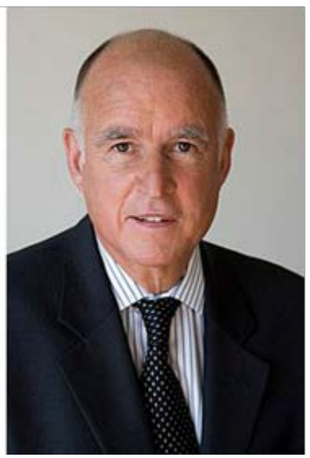
- Product Performance Relative to Existing Products
- Product Image
- Manufacturing Feasibility and Cost
- Quality Control and Production Consistency
- Product Cost and Perceived Benefit or Return on Investment
- Residual (Resale) Value
- Consumer Acceptance (Overcoming Aversion to Technology Risk)
- Affordability
- Operational Safety (Perceived and Actual)
- Enabling Infrastructure and Broad Capacity (Refueling and Reliable Service)
- Durability
- Reliability
- Functionality
- Regulatory Compliance Costs and Challenges
- True Environmental Impacts – Well to Wheel
- True fuel savings
- Government Support and Incentives

INNOVATION **GROWTH** **MATURITY**



What Could Be Key Motivator for Tipping Point Today or Near Future?

Regulation (plus important Government Support and Incentives)



“…setting the pace for America”

State of the State Address, January ‘18

New Eight Year $2.5B Initiative (EO B-48-18) (1-26-18)

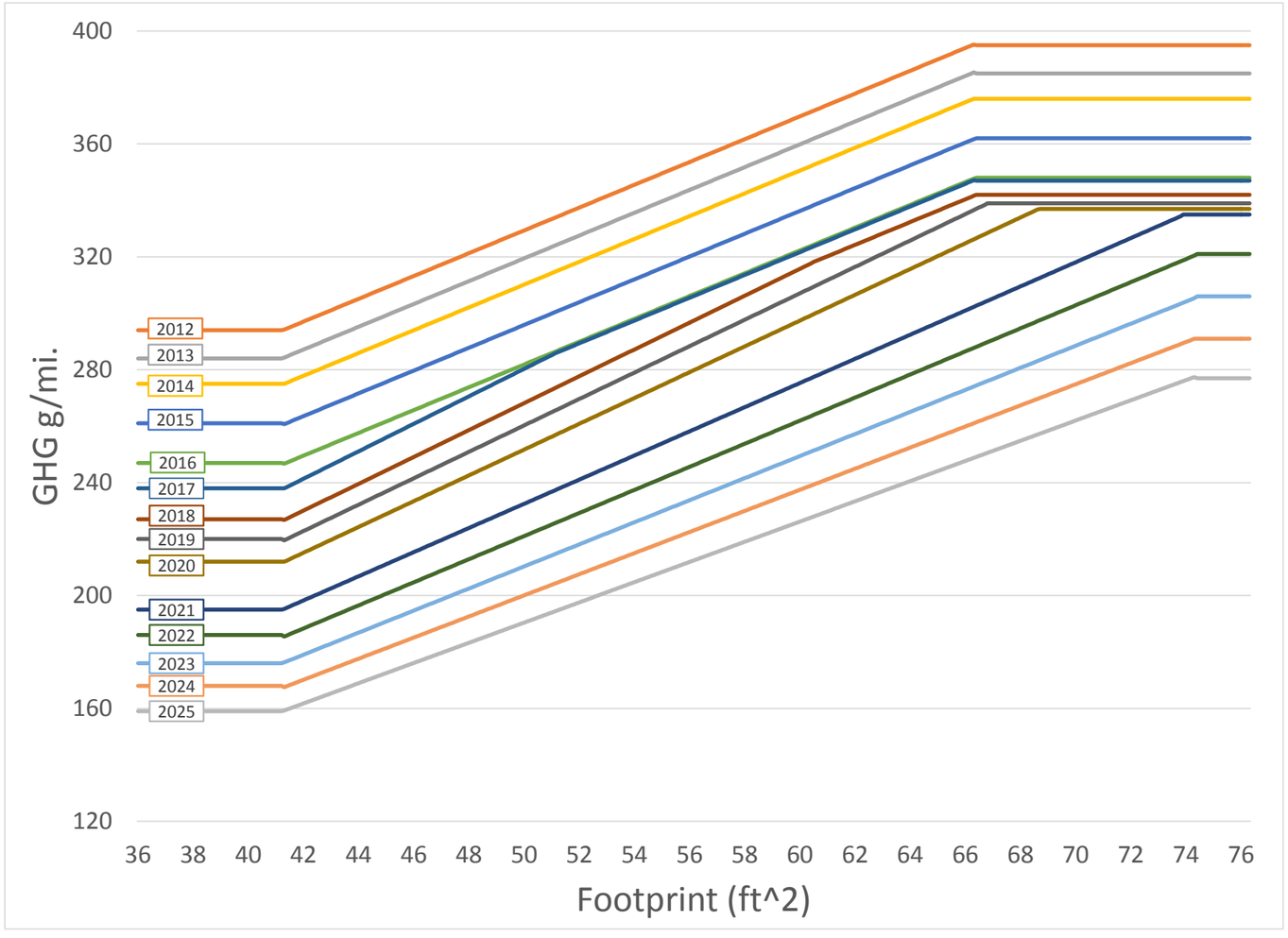
- 250,000 new BEV charging stations (incl 10,000 DC fast chargers)
- 200 new H2 FCV refueling stations
- New plan for $1.25B cap-and-trade program revenue investment
- Supports goal set in 2012 of 1.5M ZEVs on California roads by 2025
- Pursues infrastructure tie-in with LCFS

California ZEV Regulation

- Increased stringency 2018-2025
  - BEV credits do not travel; FCV does
  - TZEV only technology offset
  - IVMs become LVMs
- NE States become significant hurdle
- Offset credit market is drying up
- Post-2025 regulation under discussion

Regulatory “Drivers” for ZEV

U.S. EPA TRUCK GHG REQUIREMENT CURVES



CALIFORNIA

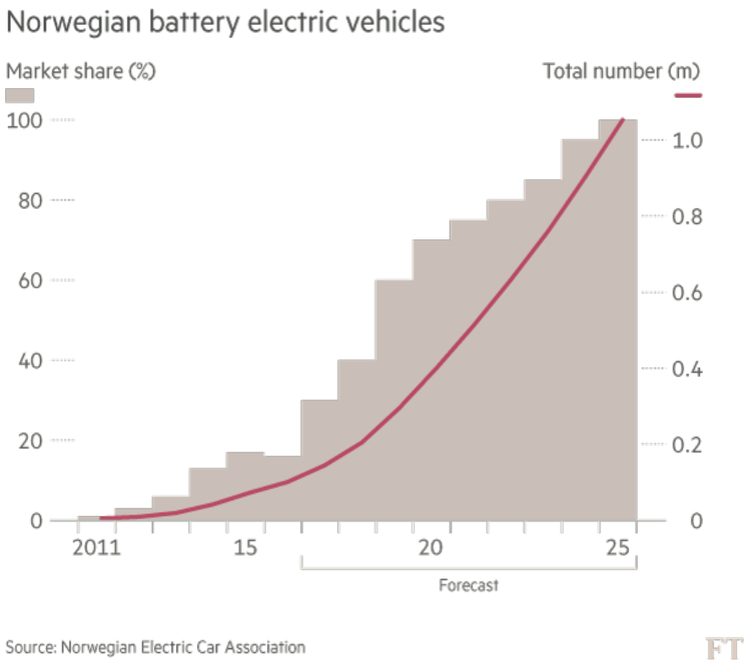
ZEV Mandate Requirement for LVMs Thru 2025

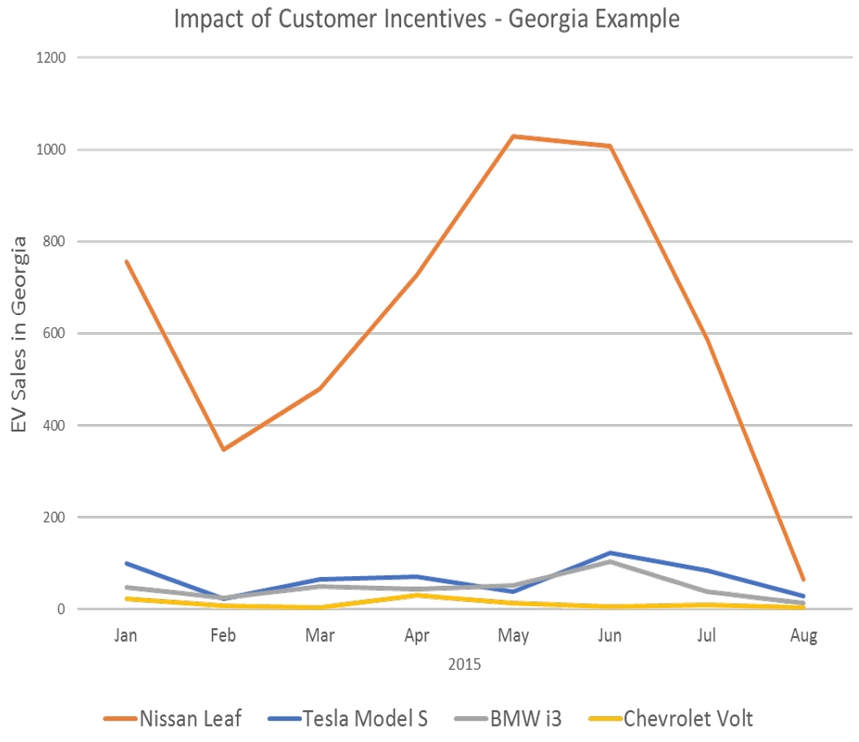
Model Years	Total ZEV Percent Requirement	Minimum ZEV floor	TZEVs
2018	4.5%	2.0%	2.5%
2019	7.0%	4.0%	3.0%
2020	9.5%	6.0%	3.5%
2021	12.0%	8.0%	4.0%
2022	14.5%	10.0%	4.5%
2023	17.0%	12.0%	5.0%
2024	19.5%	14.0%	5.5%
2025	22.0%	16.0%	6.0%

2050 IPCC targets also require significant ZEV market growth

Incentives Are Effective But Sustainability Is Challenging

"What we have proven in Norway is that if you give enough subsidies and impose enough restrictions on fossil fuel vehicles, people will buy electric," says Andreas Halse, the environmental spokesman in Oslo for the opposition Labour party. (Source: Financial Times)

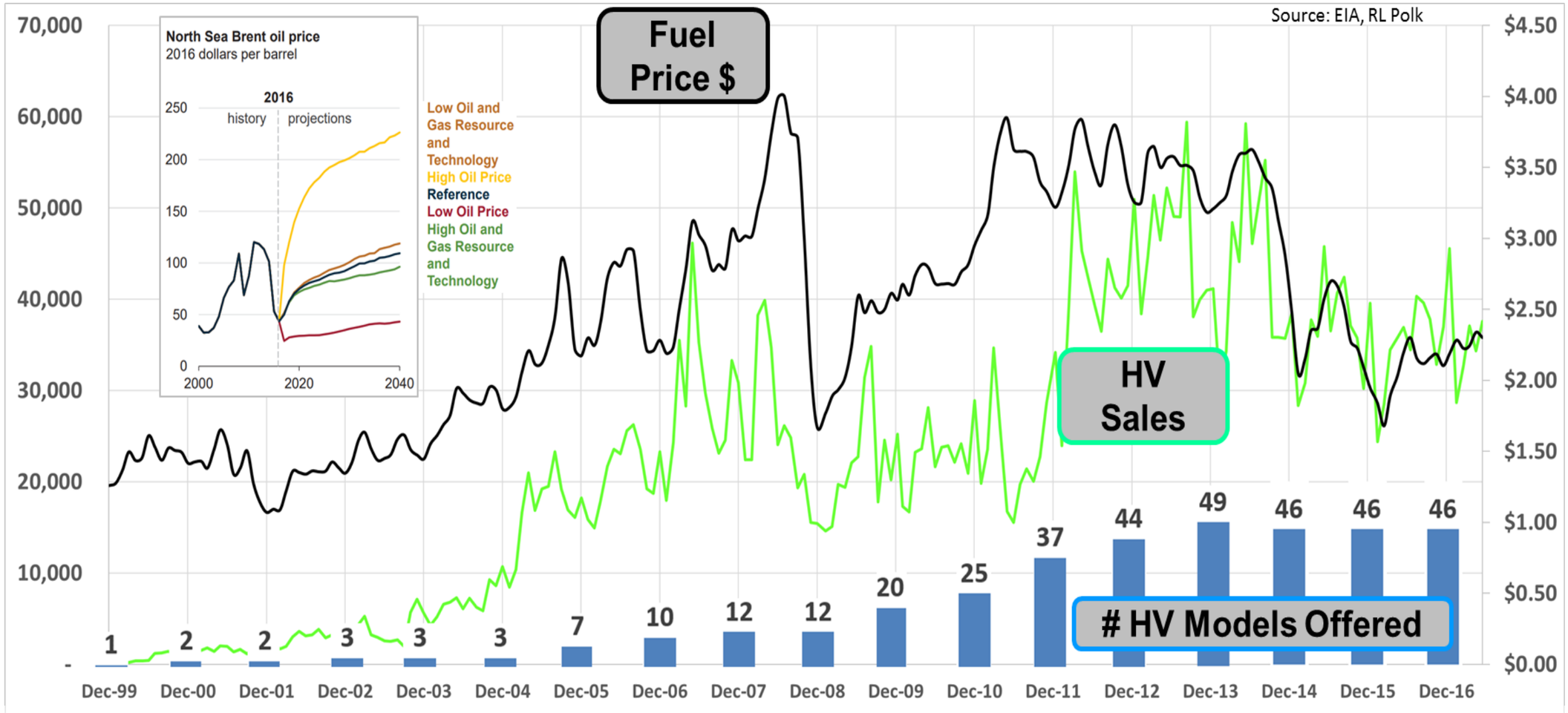




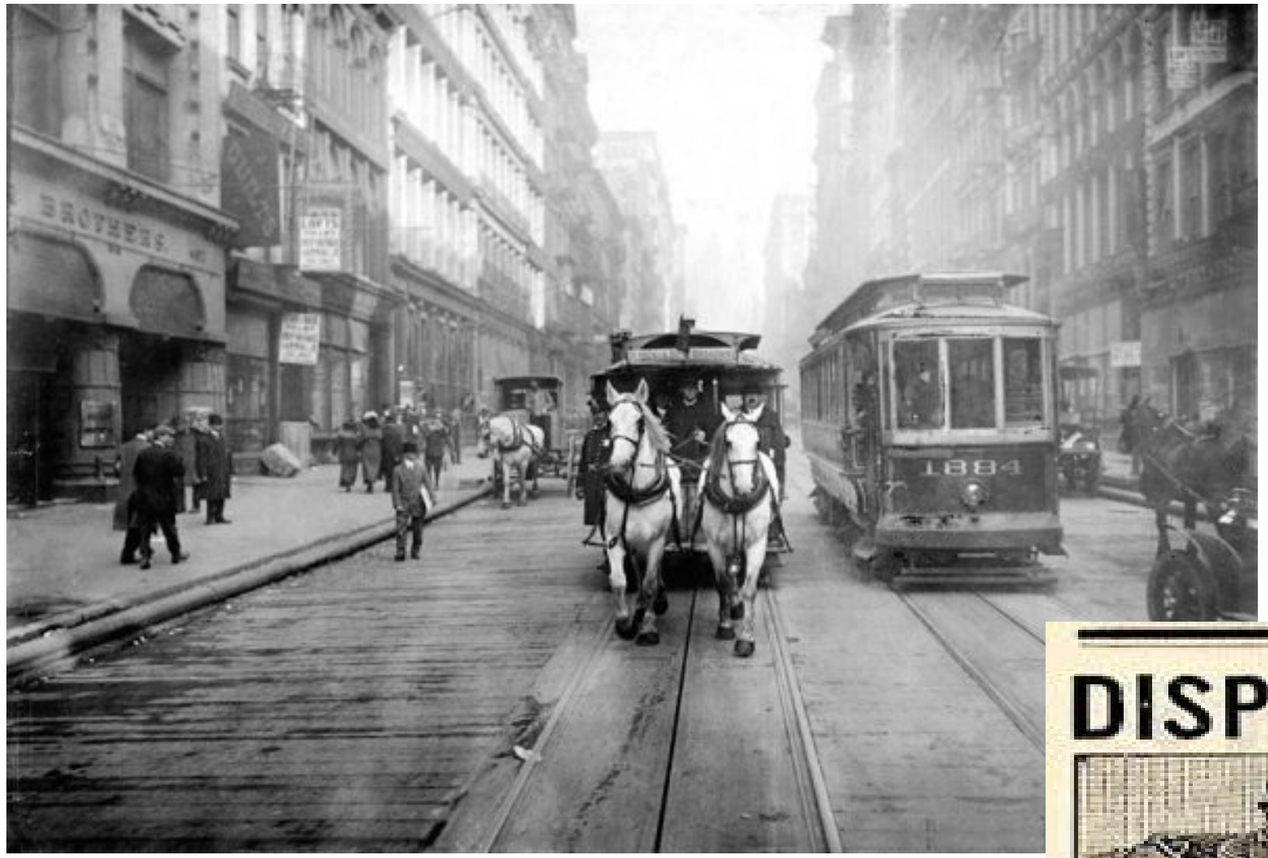
- July 1, 2015, Georgia legislature repealed $5,000 income tax incentive for ZEVs and in parallel imposed a $200 annual registration fee on all ZEVs to make up for lost gas tax revenue.
- New ZEV registration fell 89 percent from June to August 2015.

Fuel price tipping point?

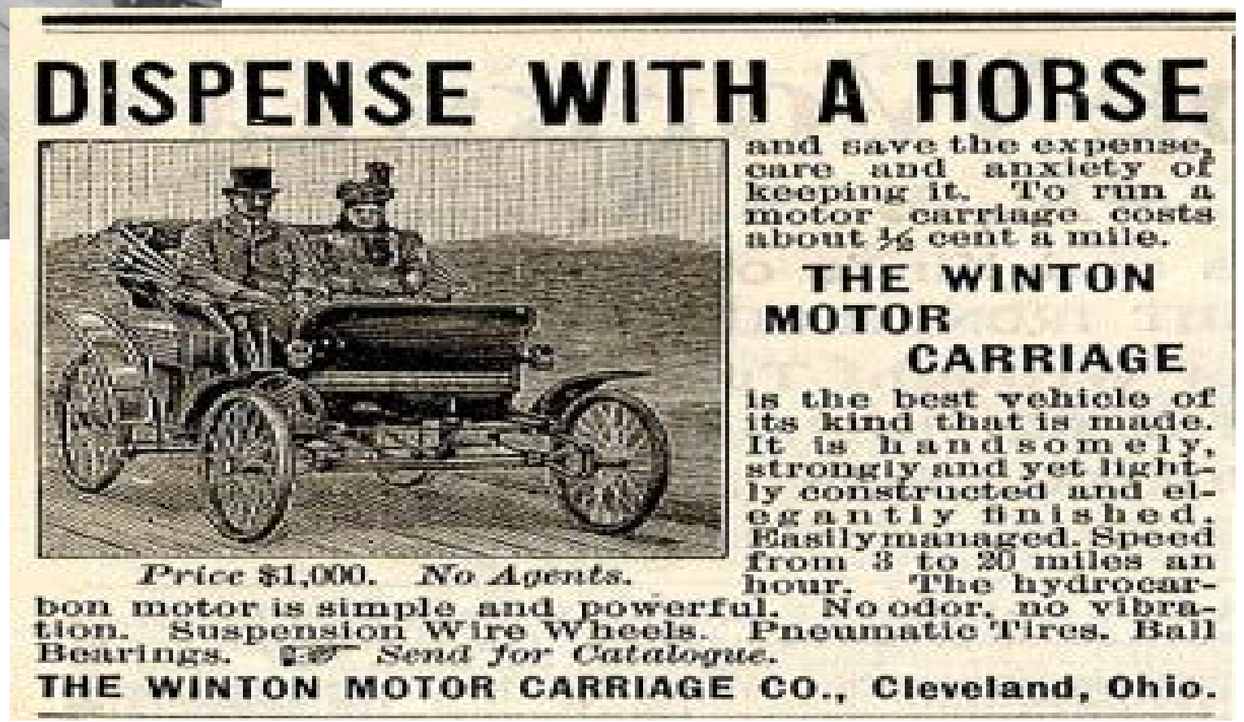
Fuel Price & Hybrid Sales



Catalyst towards electrification?



Year 1900 - 100,000 horses in NYC produced 2.5M pounds of manure/day



DISPENSE WITH A HORSE

and save the expense, care and anxiety of keeping it. To run a motor carriage costs about ½ cent a mile.

THE WINTON MOTOR CARRIAGE

is the best vehicle of its kind that is made. It is handsomely, strongly and yet lightly constructed and elegantly finished. Easily managed. Speed from 3 to 20 miles an hour. The hydrocarbon motor is simple and powerful. No odor, no vibration. Suspension Wire Wheels. Pneumatic Tires. Ball Bearings. *Send for Catalogue.*

Price $1,000. *No Agents.*

THE WINTON MOTOR CARRIAGE CO., Cleveland, Ohio.

Hence, the term “cranky”.

MORTON STREET, CORNER OF BEDFORD, LOOKING TOWARD BLEECKER STREET, MARCH 17, 1893.

The Mother of Invention

1912 Cadillac Touring Edition

Tipping Point for Alternative Fuel - Advanced Tech Vehicles?

- Lots of past attempts since 1980's
  - Methanol
  - E85
  - Battery EV
  - FC EV
  - E85
  - Battery EV
  - PHEV
  - FC EV + Battery EV
- Not Really An Issue Of Technology
- Consumer is Key
- ***No Silver Bullet***

- BEV <u>today</u> presents easier path for consumer convenience
  - Next pathway could be autonomous capability with various levels of "auto pilot"…..life enrichment
  - Longer term feature focuses on infotainment systems such as auto navigation systems
  - Ultimate feature will be 200+mile range or more….need to continue to develop comfort zone around the cars
  - Key is life enrichment
- FC EV also has important pathways, but needs support infrastructure
  - Concept of single power source that can provide mobility as well as powering your house/building
  - Many scalable opportunities in society (Amazon)
  - Key again is life enrichment

What is the life enrichment factor(s) that will represent a tipping point today….for mass market penetration?

Hurdles

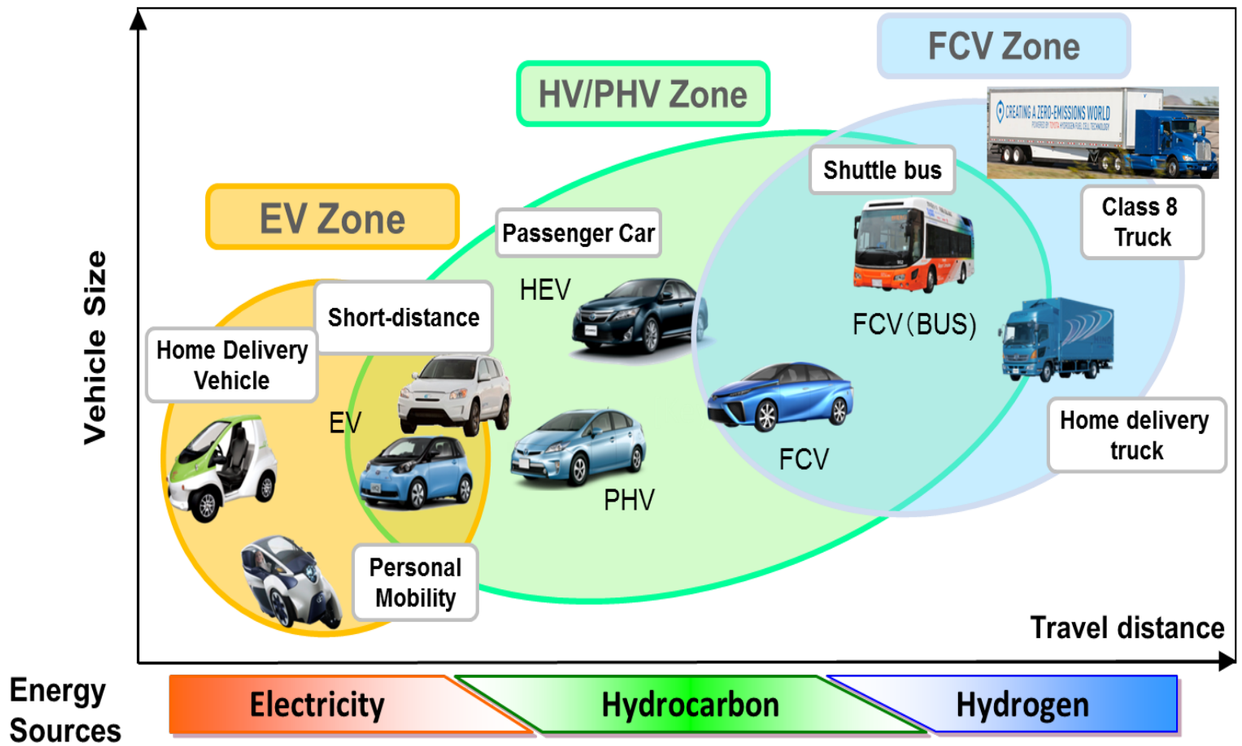
- Consumer debt
- Limited disposable income
- High price of new cars
- New technology aversion
- Life enrichment limitations (range, durability, residual value, infrastructure)

Industry-Wide Portfolio of Technologies Needed and Under Development

- Advanced ICE for light duty and heavy duty commercial (HCCI very important development)
- Lighter weight materials
- More efficient transmissions
- Hybrid drive
- ZEV battery cost
- Synergies between stationary and mobile solutions

ELECTRIFICATION PHILOSOPHY

Toyota's Vision of Mobility Zones



Just like ICE, electrified powertrains are not a "1 size fits all".

Toyota Experience To Date

- Portfolio of 14 HEVs and PHVs in U.S.
- Sold over 11 million electric drive vehicles ranging from sub-compacts to shuttle buses

Toyota Future Commitments

- 5.5M EVs / year globally by 2030
  - 1M ZEV
- By 2022 - 10 new BEV models globally
- Remain fully committed to H2 FCV
- BEV focus is niche market
- H2 refueling infrastructure is key to success long term
- Commercial opportunities for FCV


Shell
Hydrogen
HYDROGEN

FCV Differentiating Features From Other ZEVs

- **Over 300 miles on single “fill” of hydrogen; scalable**
- **Quick refueling…usually less than five minutes**
- **Broader range of buyers; greater ZEV sales**

Mirai Market Experience

- Since Fall, 2015 launch….over 3,000 sold in California and 5,000 globally
- $349/month lease ($57,500 MSRP)
- Three years free fuel plus maintenance and roadside assistance
- 67 EPA mpgge

Toyota Portal Project – Long Beach, Ca
H2 FCV Class 8 Truck
Launched April 2017

Truck Ratings:

- 670 Hp
- 1325 ft-lb torque
- 200+ mile range
- Optimal for Drayage

Hydrogen Supply:

- Currently trucked in SMR H2
- Future (2020), on-site H2 generation from ag biomass
- TriGen carbonate FC (FuelCell Energy) – electrolysis
- 2.3MW …. 1.2 tons H2/day

Hydrogen Council

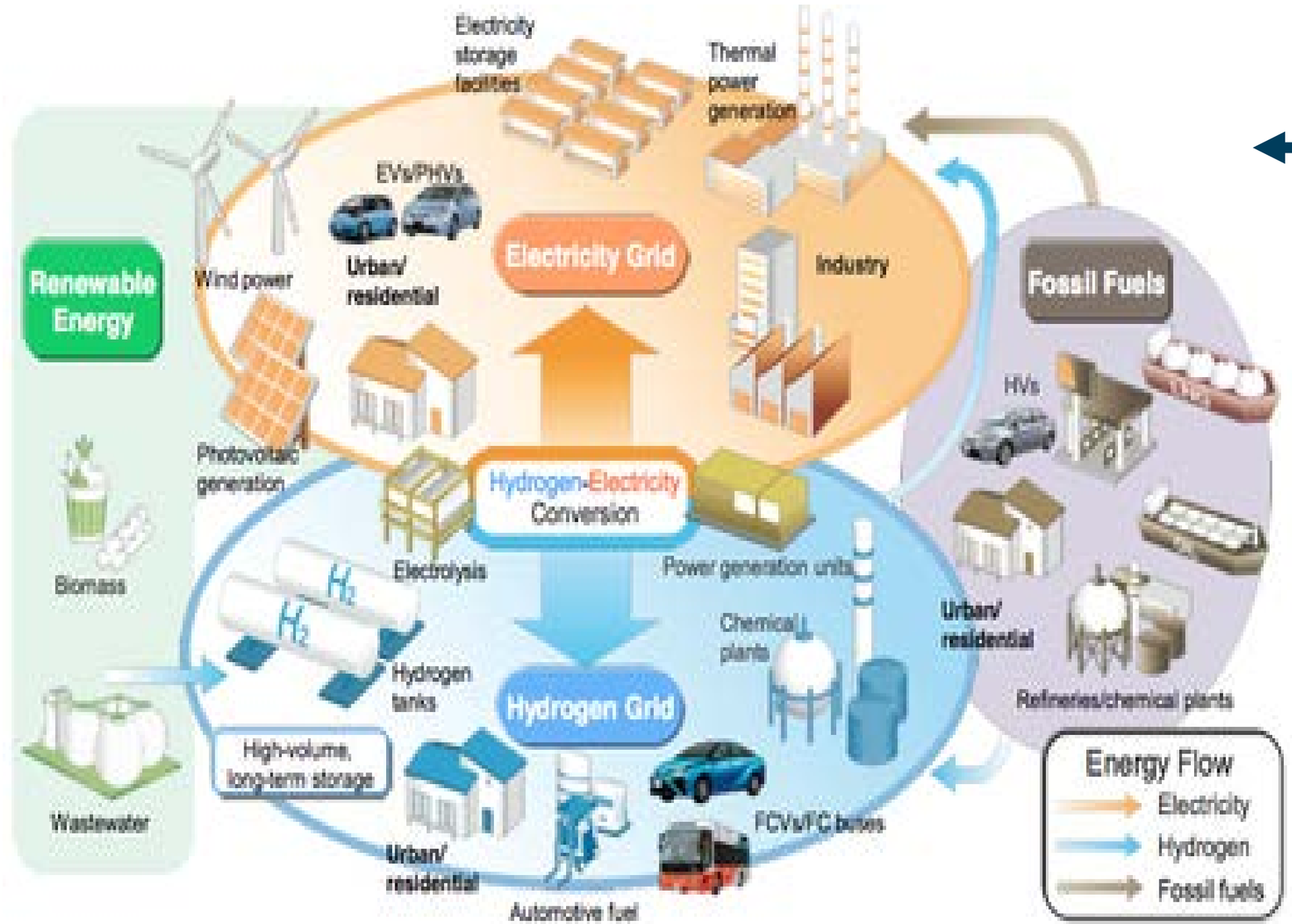
Target Year	H2 FCEV Goals
2030	• 5000,000 Commercial Trucks • 10-15 million LDV/LDT sold in California, Germany, Japan and South Korea • Significant penetration in trains and ships
2050	• 15 to 20 million Commercial Trucks • 5 million Buses • 25% of passenger ships • 20% of trains • 400 million LDV/LDT

Created: 2017 Davos World Economic Forum

Steering Members:

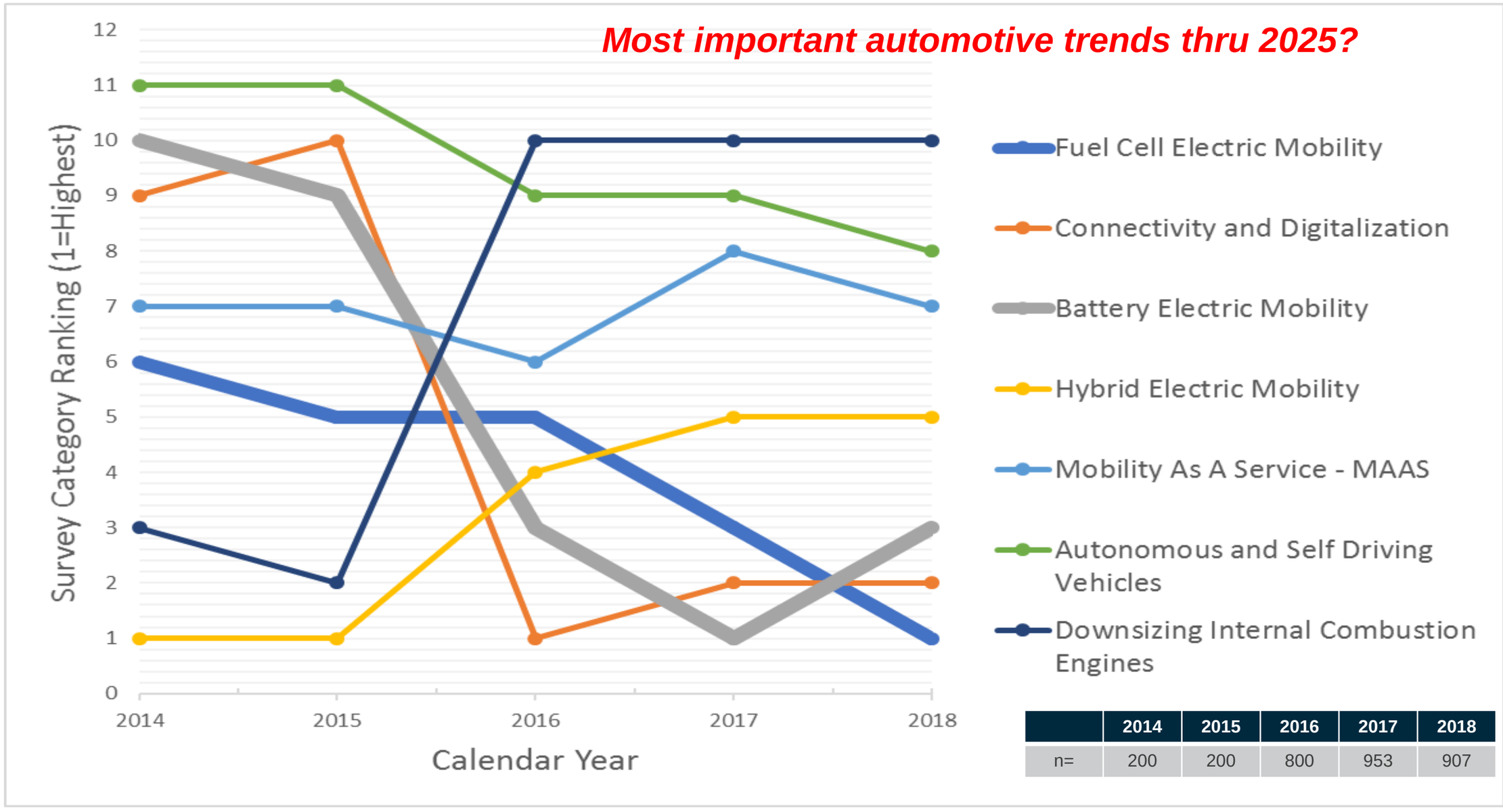
- Air Liquide
- Alstrom
- Anglo American
- Audi
- BMW Group
- Daimler-Benz
- Engie
- General Motors
- Honda
- Hyundai
- Iwatani
- Kawasaki
- Linde Group
- Plastic Omnium
- Shell
- Statoil
- Total
- Toyota

Hydrogen society concept



TOKYO 2020

KMPG Global Automotive Executive Survey 2018 – January 5, 2018



	2014	2015	2016	2017	2018
n=	200	200	800	953	907

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Thank you for this opportunity!!

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