



FIAT CHRYSLER AUTOMOBILES

Perspectives on Vehicle Technology and Market Trends

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We can build it!

But, if the customers don't buy it, transitions to low carbon solutions will not happen.

Most customers are focused on fuel economy (direct cost avoidance) vs. environmental and social benefits, but still a reasonable surrogate

So what's happening in the market today?

- Consumers say that want higher fuel economy
- But what they buy often differs and is driven by other requirements
- Manufacturers need to improve efficiency and emissions across entire fleet
- Willingness to pay for fuel economy remains low and there are other opportunity costs and perceptions for customers to overcome
- Manufacturers react to these attitudes by applying higher benefit to cost technologies first

Key challenges to meeting modeled transitions to low carbon transportation:

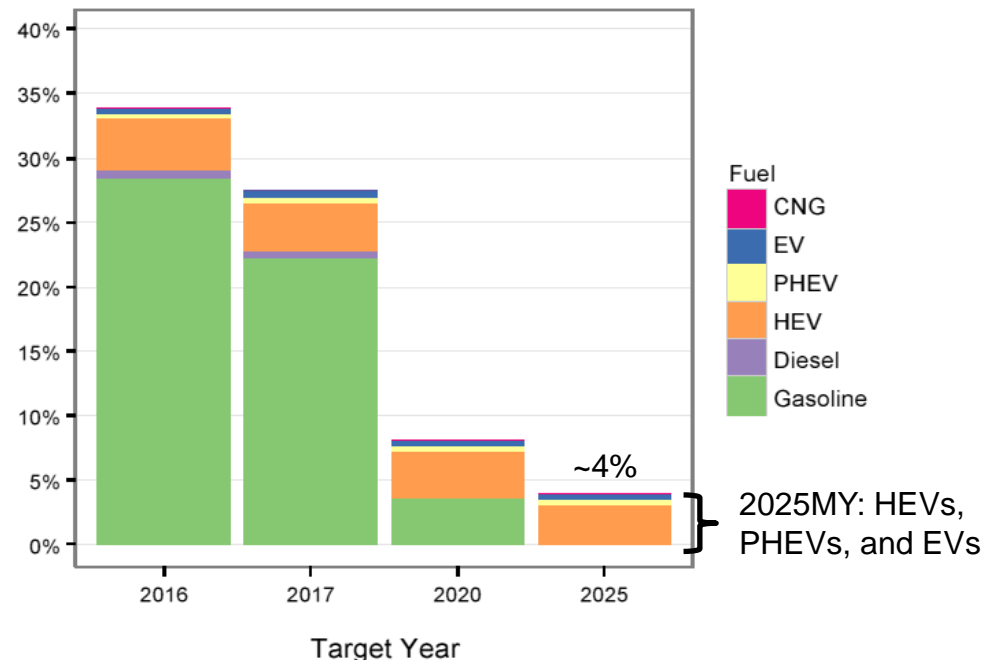
- Not availability of technology, but perhaps development of technology
- Broad customer acceptance of technologies needed across all vehicle segments at high volume
- Time to successfully transition while maintaining overall profitability

- Manufacturers appear to be focused on meeting 2025 GHG targets with improvements to and electrification of internal combustion engines
- Internal combustion and related fuels are likely to remain mainstream for at least the next ten years

Manufacturer Technology Introductions to Meet 2025 GHG Regulations

- Advanced internal combustion engines
- High efficiency transmissions
- Mild and micro hybrid systems
- Mass, aerodynamic, and tire improvements
- Additional A/C system and other “off-cycle” technologies
- Growing numbers of HEV, PHEV, and BEV offerings
- The (new) start of fuel cells

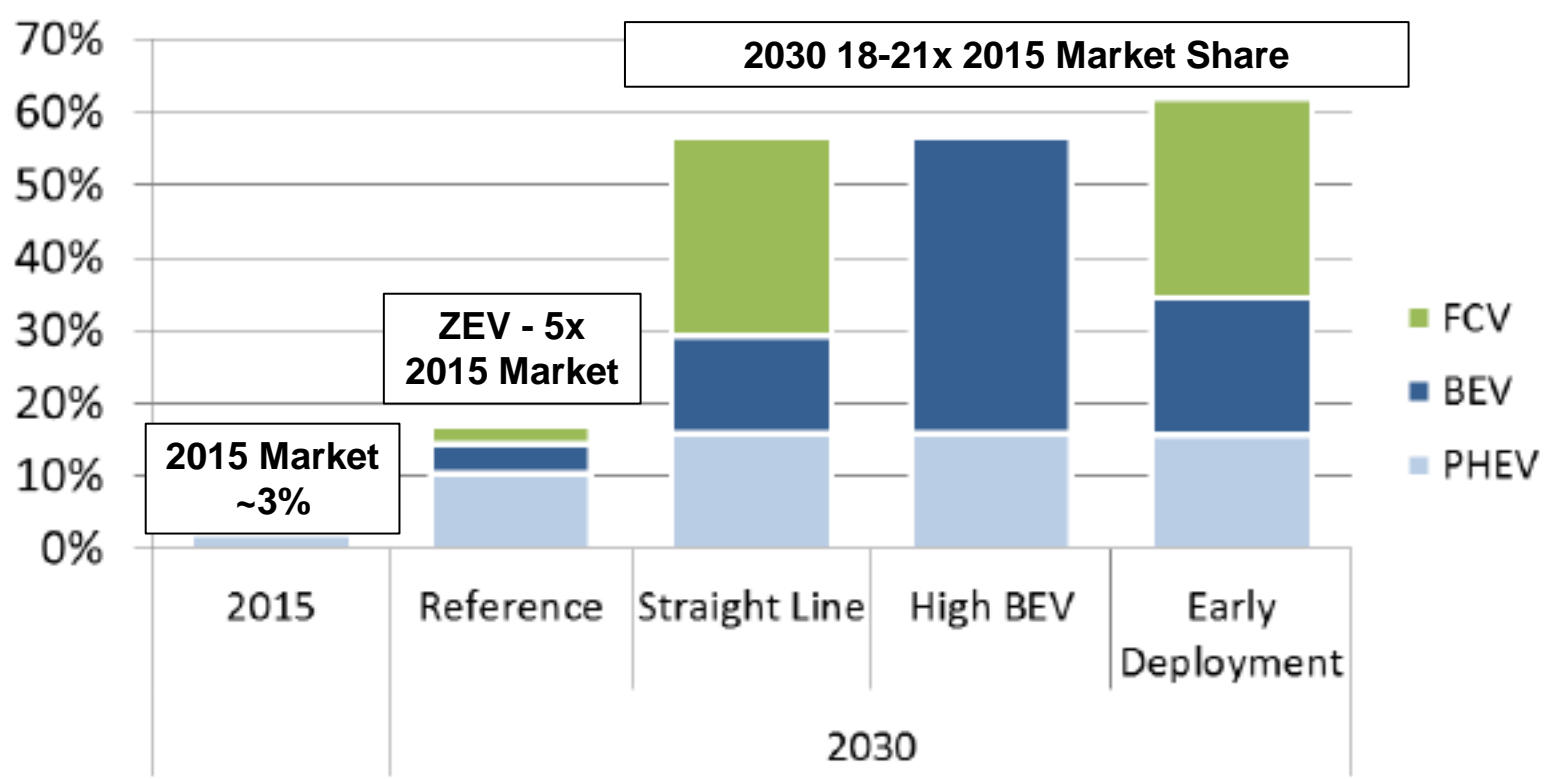
Model Year 2014 Vehicle Production That Meets Future CO2 Emission Targets with Current Powertrains



Source: Environmental Protection Agency, “Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2014” (EPA-420-R-14-023a), October 2014

- Policy goals and regulations drive towards much greater electrification in California than current levels
- Need significant cost reductions and improvements in customer acceptance to achieve

Share of New Vehicle Sales by Year and Technology



Source - E3. California PATHWAYS: GHG Scenario Results Presentation, Slide 11 (Apr 2015)
 Available at https://ethree.com/public_projects/energy_principals_study.php (last accessed 5/7/2015)

Case for Lower Prices

- Technology still advancing
- Scale helps, but requires new manufacturing capacity
- Negative pricing pressure to meet growing regulatory demands

Addressing Customer Concerns and Desires will Add Cost

- More range – 200 miles minimum*
- Faster charging*
- Easier charging*
- More product variety

Conundrums

- Low oil prices degrade economic case for customers
- Manufacturers do not receive benefits of technology advances until next generation
- High depreciation / low residual value
- Customers only willing to pay ~\$2,300 for BEV* but need to satisfy investors – positive business case?
- Federal tax incentives run out for many by early 2020s
- Large product investments to cover multiple regulations

* Frost & Sullivan 2014 Consumers' Perceptions and Preference for Powertrain Systems by Fuel Type, Technology and Features (June 2014)



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- **Absolute cost reductions seem unlikely to occur as fast as projected**
- **Multiple issues remain for manufacturers in developing and marketing BEV technology**

▪ **HEV and lower forms of vehicle electrification**

- Likely to become increasingly mainstream as manufacturers strive to meet current GHG regulations

▪ **Plug-In Hybrid Electric Vehicles**

- Increasing volume resulting from GHG and zero emission vehicle policies
- Likely easier sales proposition during transition to true zero emission vehicles (fewer customer compromises)
- Significant potential to replace petroleum consumption with zero emission miles given typical daily operation patterns

▪ **Hydrogen fuel cell vehicles**

- Supportive policies driving initial market introduction

- Past modeling efforts have focused on what is needed to meet policy
- Future efforts need to also focus developing realistic transition scenarios, even if it means the transition takes longer than desired
- Continued research and support is needed from all parties to aid technology and market development for low carbon transportation solutions.

■ **Internal Combustion Engines –**

- Need to account for expected market direction over next 5-15 years and legacy fleet beyond
- Role of drop-in, lower carbon fuels which enable higher engine efficiency

■ **Battery Electric Vehicles –**

- What are realistic transition scenarios given the current state of technology and potential development direction?
- Direct and opportunity costs suggest the need for continued OEM and government support for the technology for at least the near- to mid-term future

■ **PHEVs –**

- Policy / regulatory and model recognition that significant electric miles can be achieved with fewer compromises for customers