Barriers to the Deployment of Natural Gas Vehicles in California

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Driving a Shift to Natural Gas as a Transportation Fuel

- Energy transitions are enormously difficult, but have happened before
- Strong, sustained, adaptive policies required for any transition

ENERGY

- Gas exploration & production
- Distribution & utilities
- Fuel station owners/operators
- Renewable fuels

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TECHNOLOGY

- Market-spanning experience
- Expansive IP portfolio
- Capital light business models

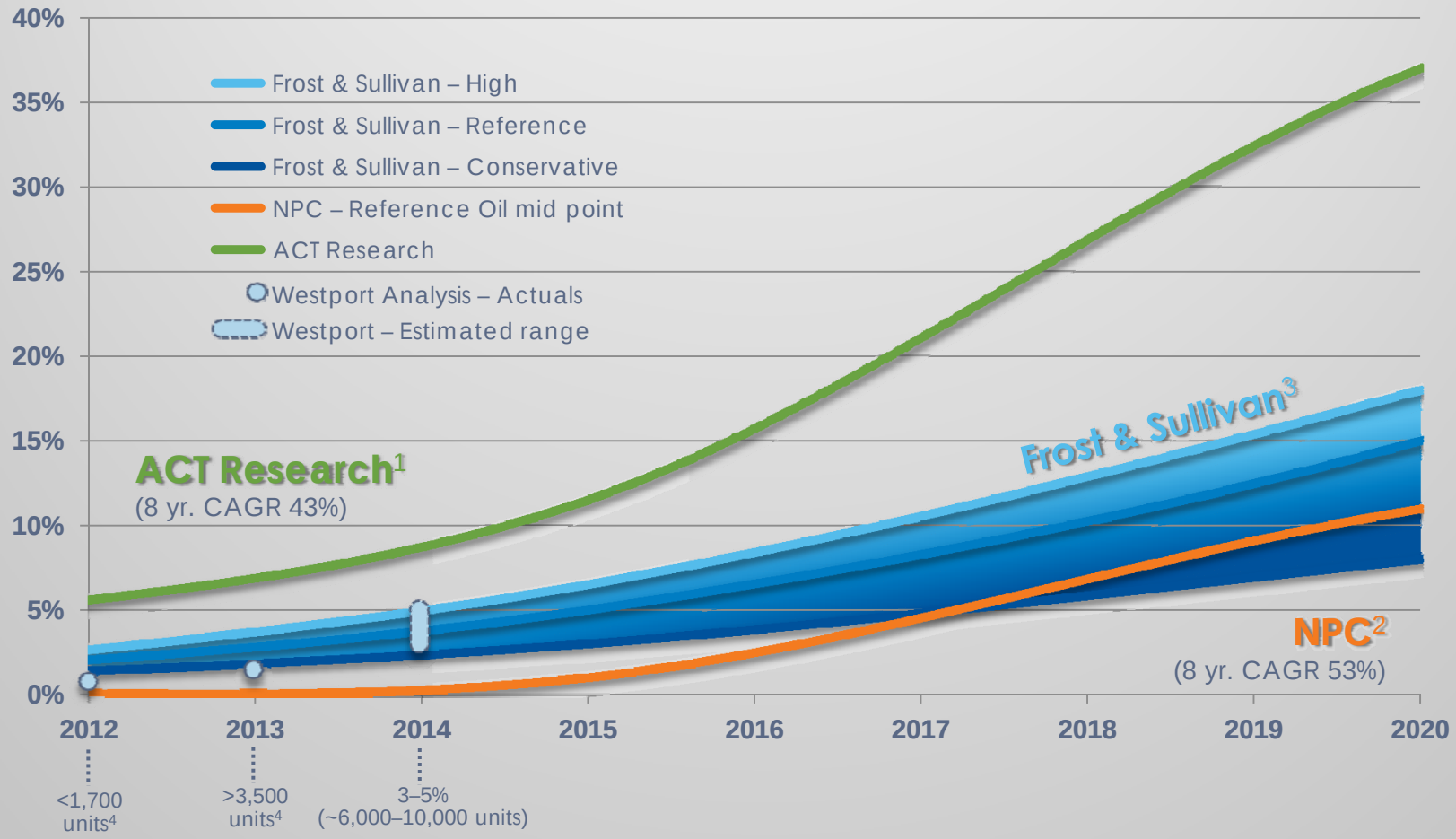
TRANSPORTATION

- Engine & vehicle OEMs
- Fleet operators
- Shippers, transportation users
- Consumers

Urban Commercial Fleets Case Study: Class 7&8 Trucks in North America

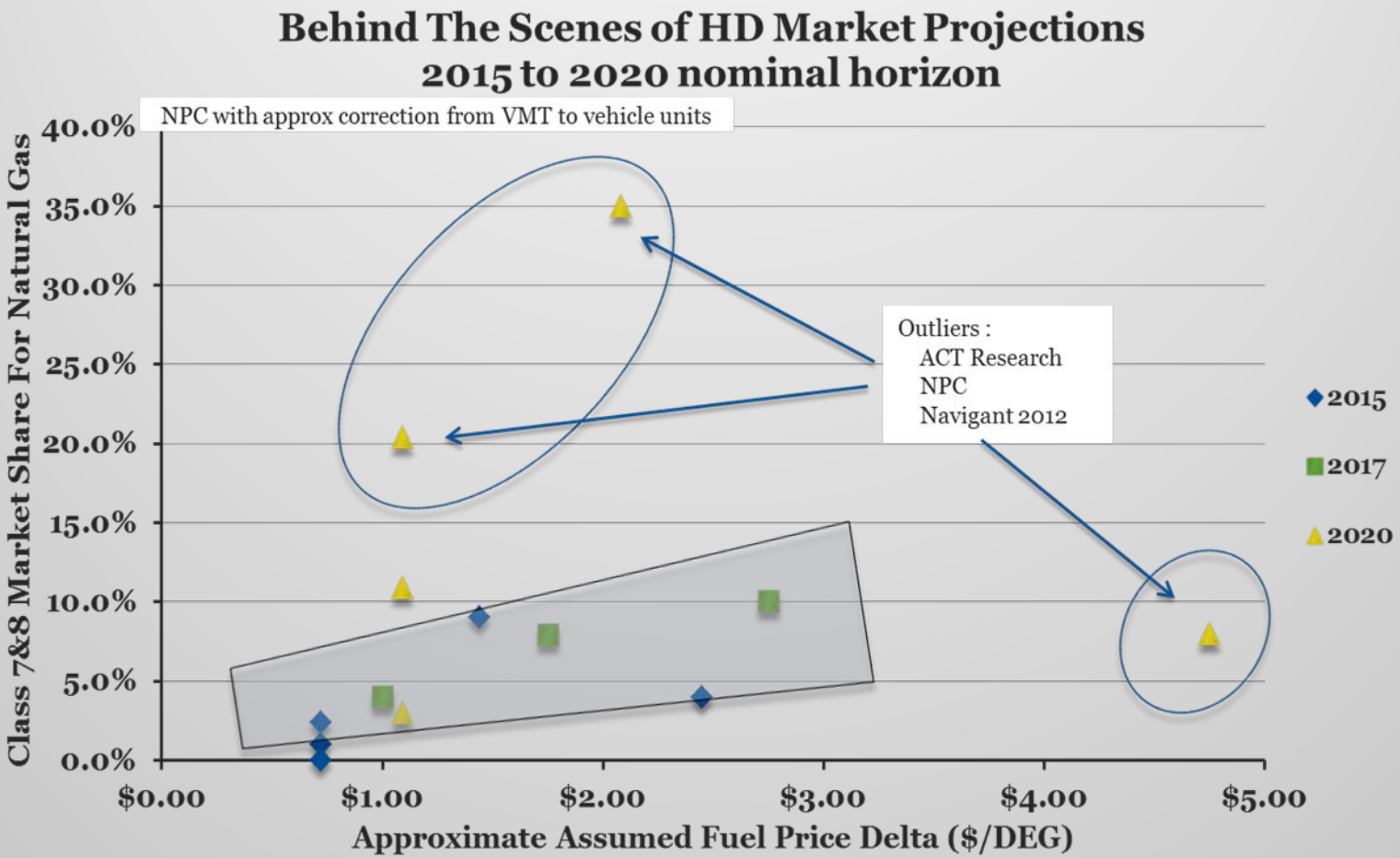
Market Share of New Class 7 & 8 Natural Gas Trucks

(NPC with approximate correction from VMT to vehicle units)



1. Act Research Future of Natural Gas Engines August 2012
2. NPC Advancing Technology, Reference Case, August 2012
3. Frost & Sullivan Strategic Outlook Truck Market 2013
4. Westport Analysis

How Does Fuel Price Differential Impact Early Market Potential and Transition?



Market shares of 3% to 10% are feasible as long as fuel price differentials of $0.75-$2.00 per DEG are maintained and other assumptions re. infrastructure, vehicle cost/performance, customer confidence are realized.

Source: GPWilliams Consulting, Westport Analysis (2014)

2014/16 Cummins Westport Products.

ISB6.7G

6.7 Litre

Spark Ignited
SEGR
Three Way Catalyst

ISL G

8.9 Litre

Spark Ignited
SEGR
Three Way Catalyst

Up to 60,000 miles/year
66,000 lb. GVW

ISX12 G

11.9 Litre

Spark Ignited
SEGR
Three Way Catalyst

Up to 80,000 lb. GVW

Opportunities

Natural gas vs. diesel fuel price differential makes NGVs very attractive for high fuel users
Momentum via increased natural gas awareness throughout government & transportation industry
Expanding public-access refueling network
Competition and innovation to drive down costs
Near-zero emissions capability (cost-effective fleet-average emission reductions vs. fuel cell or battery-electric)

Challenges

Learning curve for all stakeholders such as dealers and end users regarding fueling, maintenance, support. Example - inconsistency & confusion about maintenance facility safety requirements.
Wide range of potential natural gas fuel compositions – can't optimize engine performance & emissions for the fuel it's actually consuming
Unconventional fuels with constituents that are unproven in internal combustion engines such as refinery gas blends
Diverse fuel mix dilutes efforts to get any single one, or more than one to scale. Can't discount the significant investments in vehicles, infrastructure and fuel that will be required.

Threats

Erosion of fuel price differential
"Slower than expected market adoption"
Change in regulations or uncertainty around incentives and availability
Concerns about hydraulic fracturing and GHG emissions

How to Accelerate Market Penetration in California and the West?

Enhance economic value to end-users

- Significant vehicle price premium reduction
  - Engine & NG fuel system price decrease via volumes/innovation/competition
- Increase and sustain fuel price differential
  - Renewable fuels from low-cost feedstocks such as landfill gas
- Incentive funding
  - Natural gas penetration is most aggressive in areas where incentives like rebates, buy downs and tax credits are available

Enhance engine / vehicle performance

- Product line expanding with more engine options
  - ISB6.7 G will enable natural gas in new markets, notably school bus
  - Volvo VNL 300 LNG - D13 compression ignition engine available late 2015
- Accelerate investment in technology development
  - Improved efficiency, cost reduction, near-zero emissions

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Here and Now.

Thank you….

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