

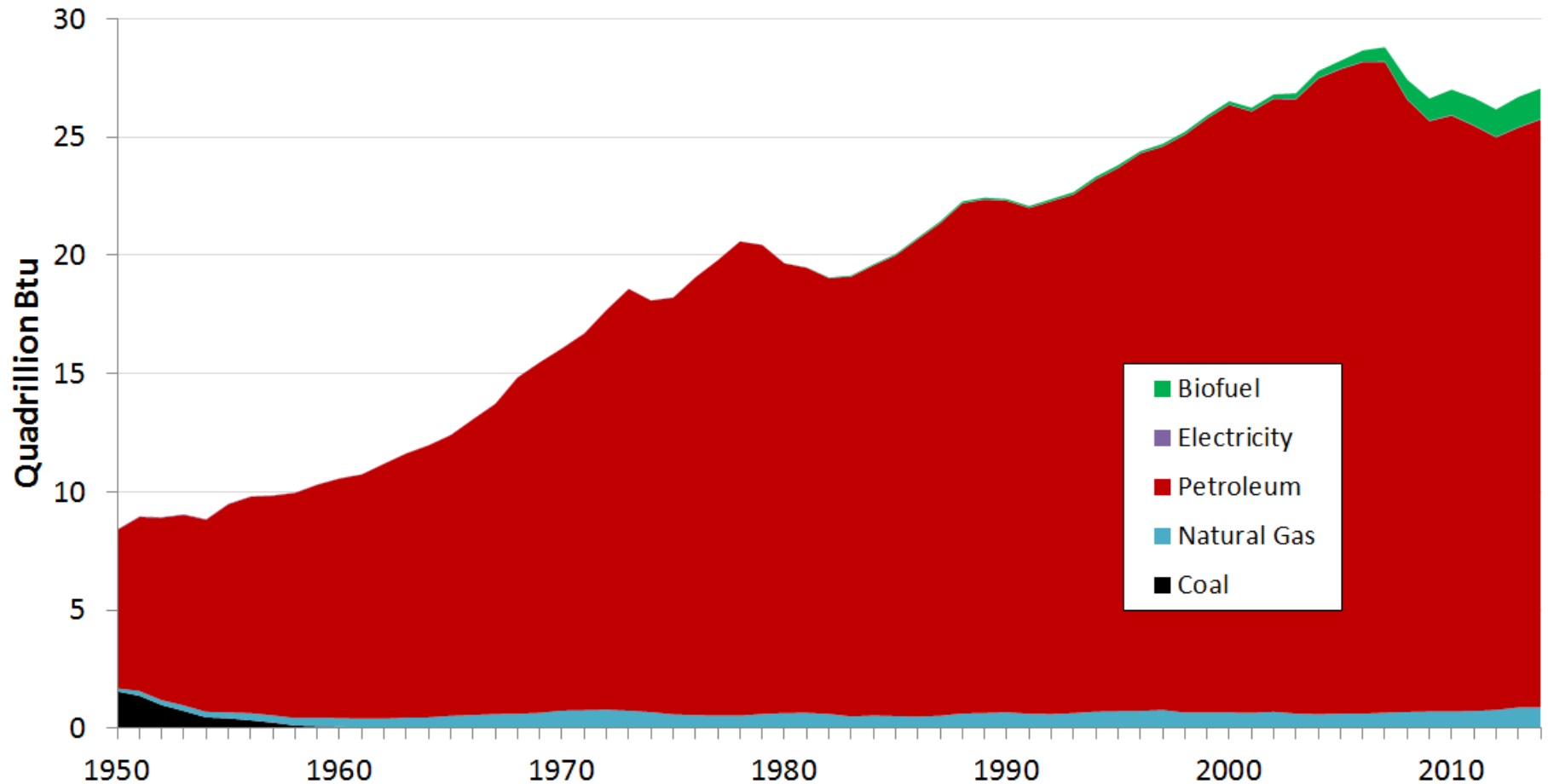
The Future of Transportation

Innovation: Alternative Fuels

Karen Hamberg – Vice-President, Strategy
Sustainable Supply Chain and Transportation
November 27, 2015

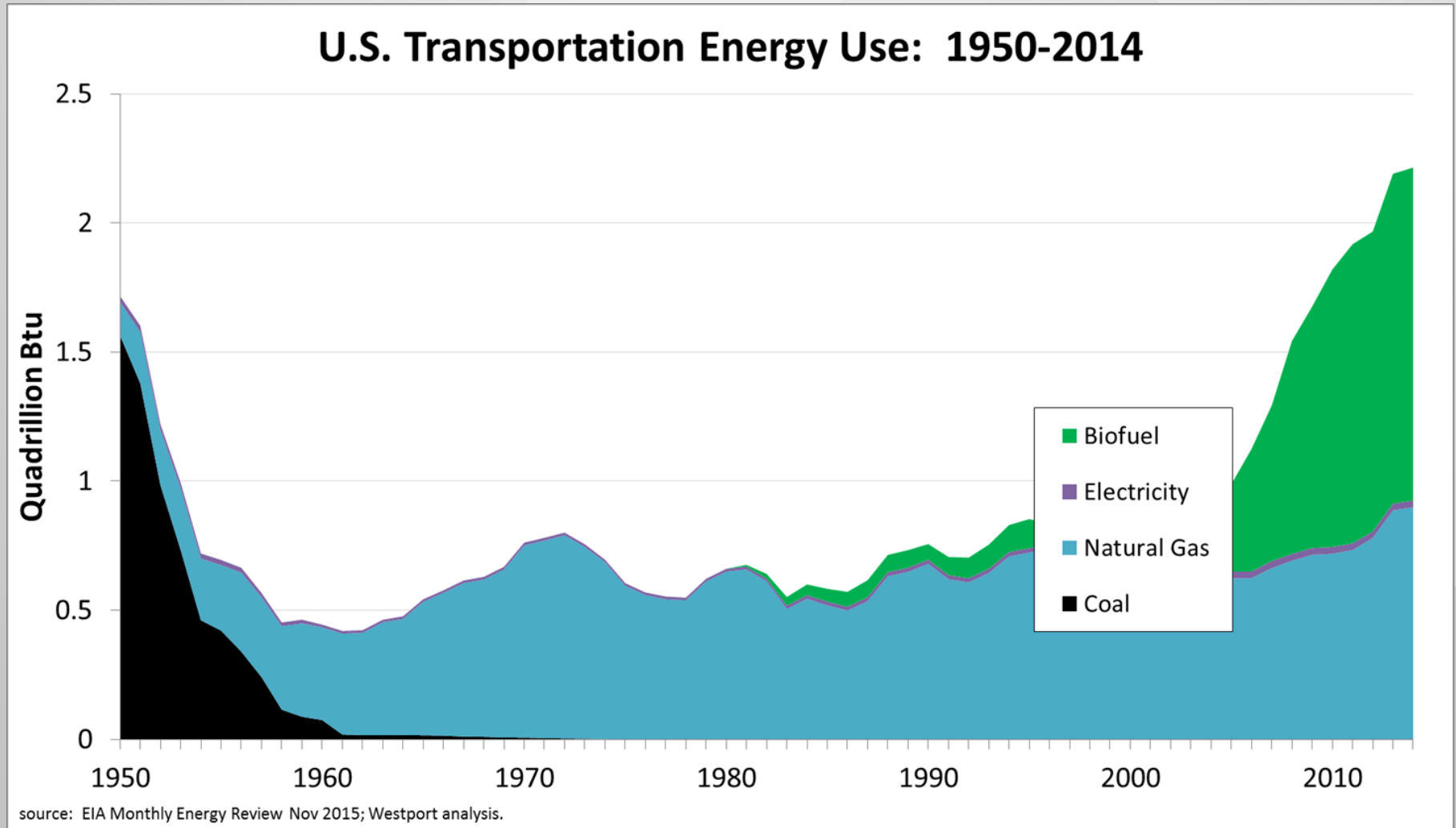
If Energy Transitions were Easy....OR Non-Petroleum Share Highest Since 1954

U.S. Transportation Energy Use: 1950-2014

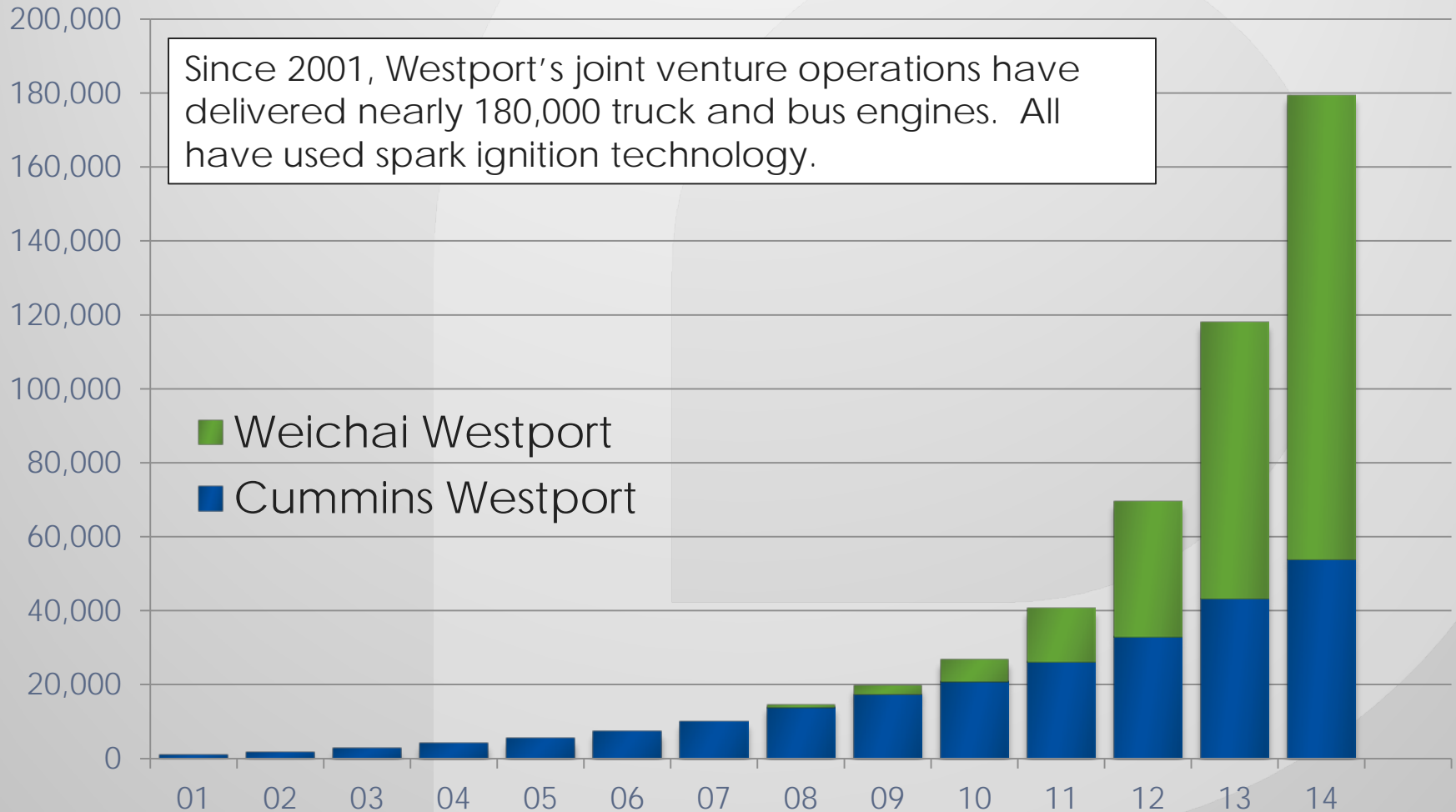


source: EIA Monthly Energy Review Nov 2015; Westport analysis.

A Closer Look at Natural Gas and Electricity...



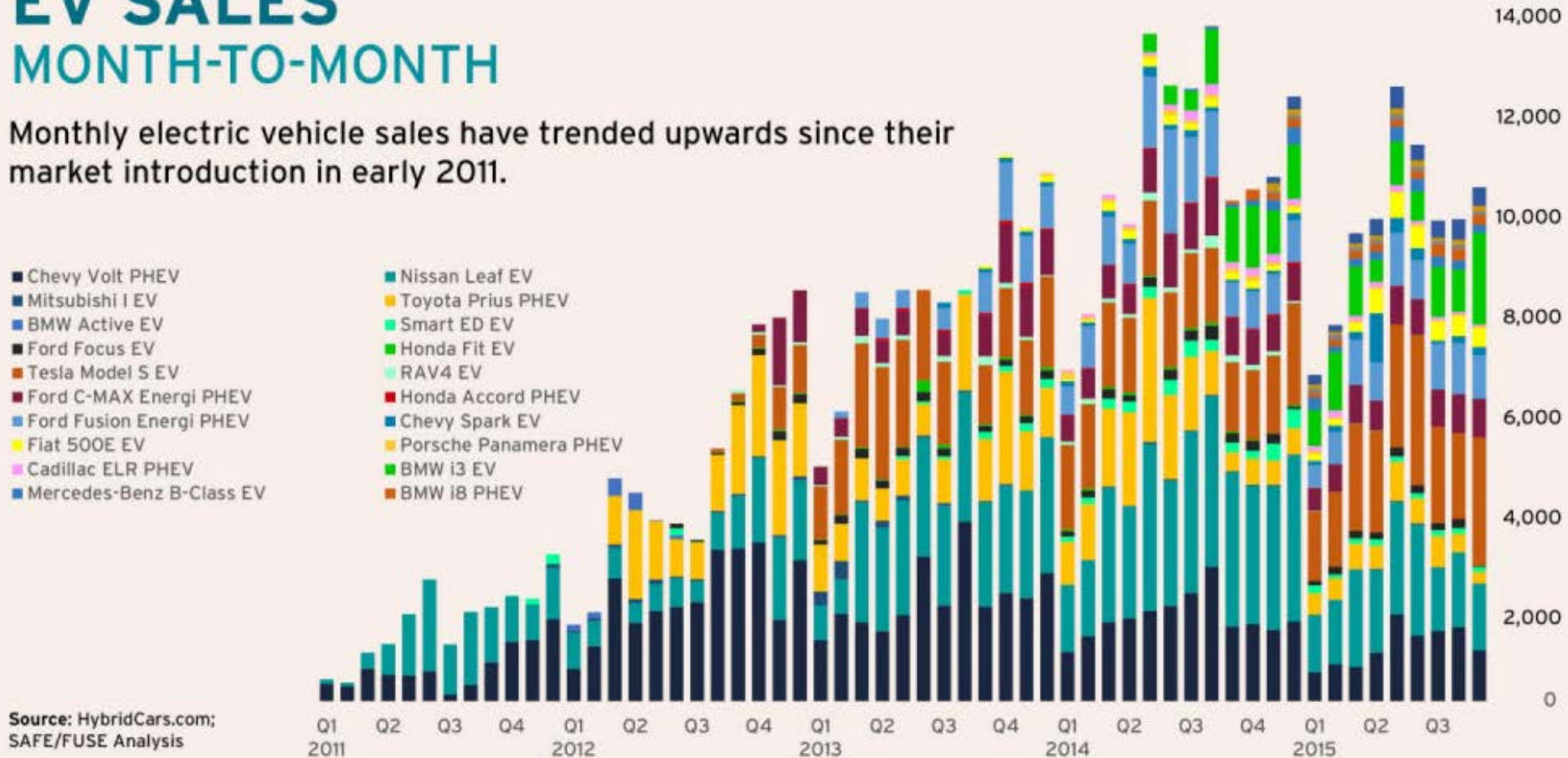
Cumulative Natural Gas Truck & Bus Engine Shipments



EV Sales Down Compared to 2014 but Supported by Robust Charging Network

EV SALES MONTH-TO-MONTH

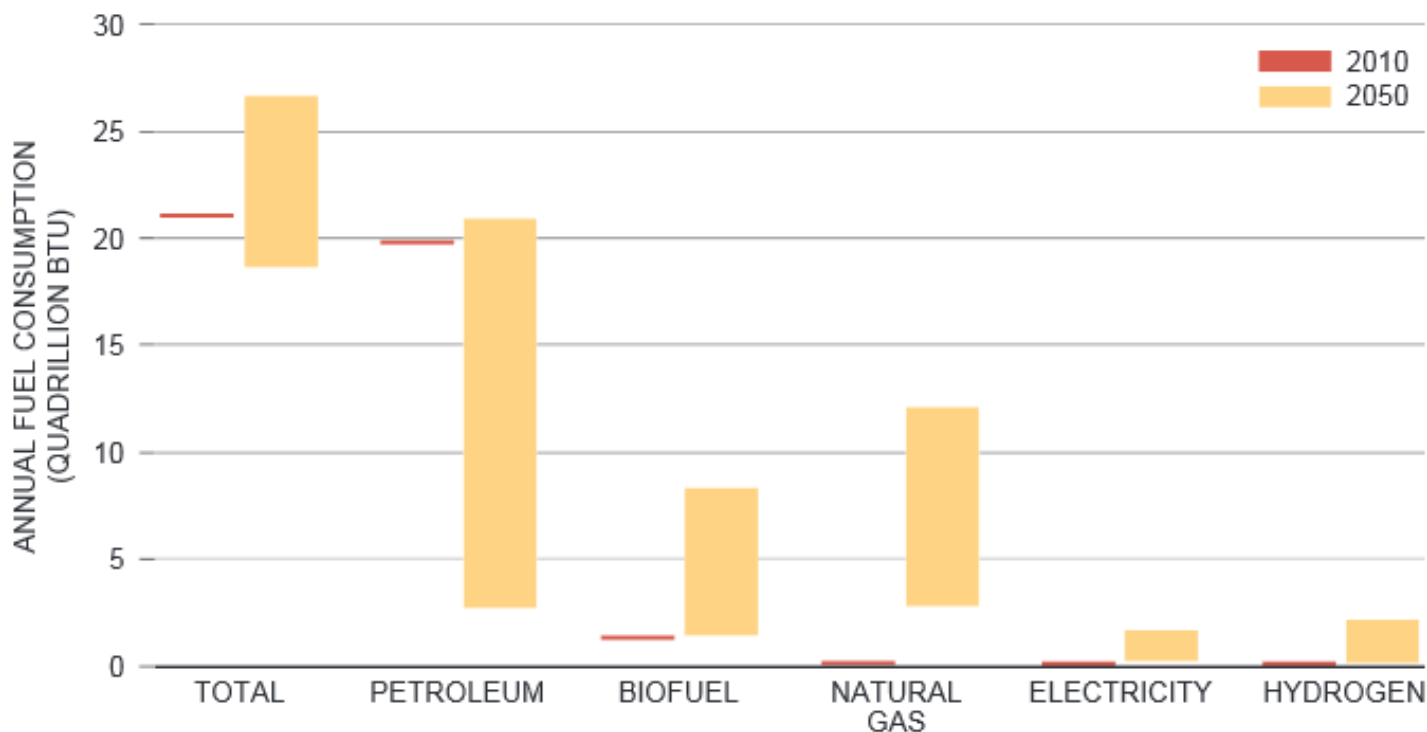
Monthly electric vehicle sales have trended upwards since their market introduction in early 2011.



"You Can't Handle the Energy Transition" ... A New Problem for Public Policy

- » Strong, sustained adaptive policies required for any transition scenario
- » All fuels have trade-offs
- » A diverse fuel mix dilutes efforts to get any single one (or more than one) to scale
- » Technological progress inherently uncertain
- » There is a long list of things we need to know, but currently don't
- » Natural market barriers to displacing incumbent fuels
- » Urgency to decarbonize transportation to address climate change

Range of 2050 On-Road Fuel Consumption: All Alternatives Commercialized



Notes: On-road includes light-, medium-, and heavy-duty sectors.

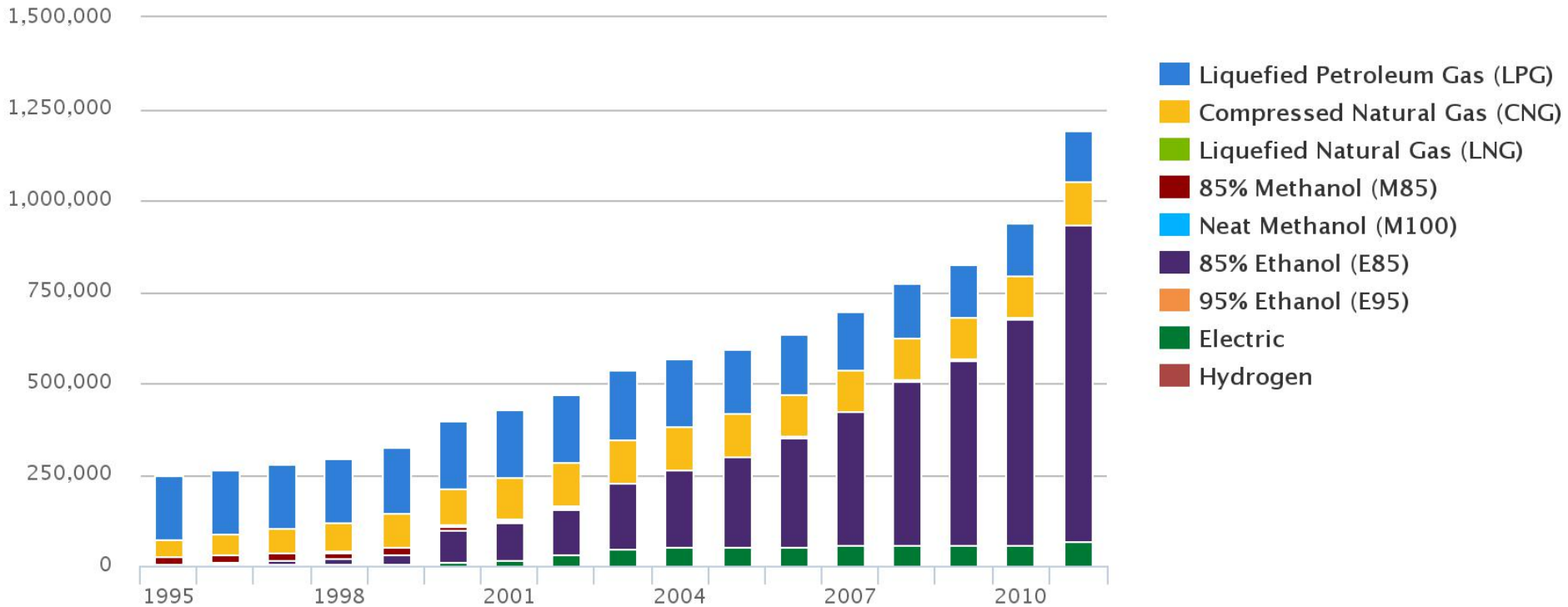
Figure does not include additional energy consumption associated with fuel production.

At equivalent fuel consumption (by energy), alternatives such as hydrogen fuel cell electric vehicles and other electric vehicles can support two to three times the miles due to their higher fuel economy.

Source: National Petroleum Council (2012) http://www.npc.org/reports/trans-future_fuels_summary-2012.pdf

But a Transition is Underway....

Alternative Fuel Vehicles in Use



Last updated: August 2014
Printed on: November 26

Source: Alternative Fuels Data Centre (2015) <http://www.afdc.energy.gov/data/10300>

THE NEW NORMAL....

Global momentum building for aggressive climate action in a period of rapid freight growth. Regulation is expected with a global accord coming out of COP21.

Collaboration is the only way to address industry wide, sector wide sustainability challenges.

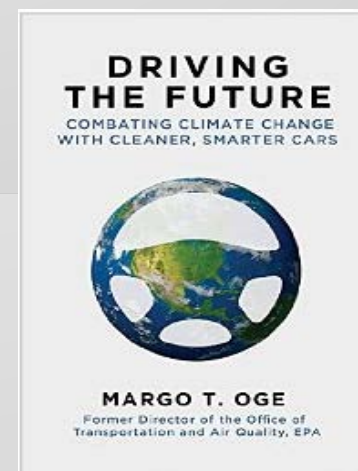
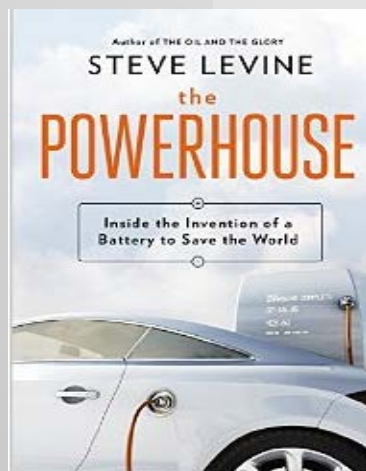
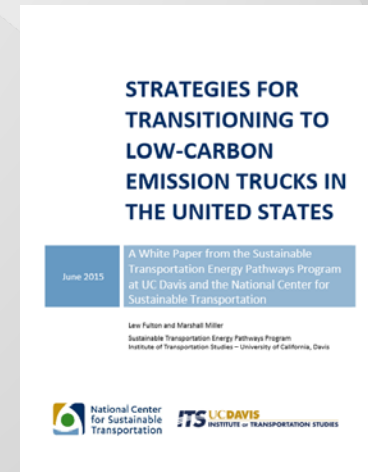
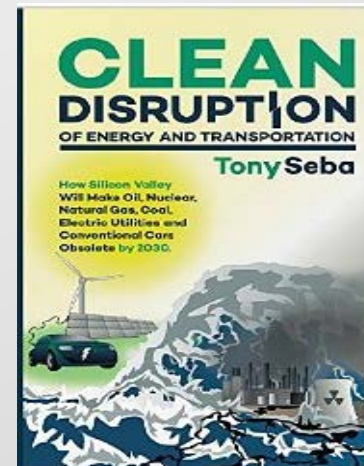
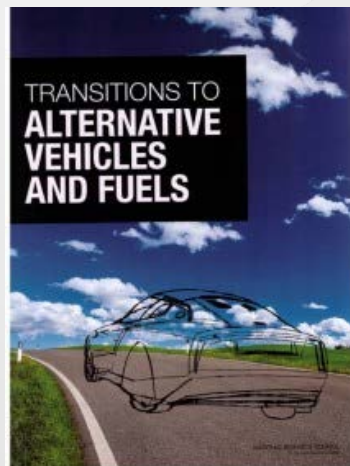
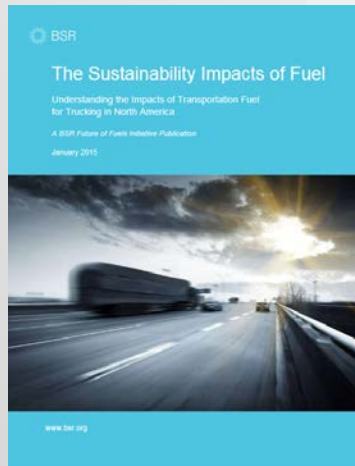
What Factors Affect the Rate of Energy Transitions?

1. **Scale or market size:** More difficult to transform a large market than a small system
2. **Infrastructure needs:** The more complex and infrastructure intensive the technology system, the slower the change.
3. **Uncertainty** about policy and technology can lead to risk averse behaviour.
4. **Preexistence of niche markets** offering an early test bed for experimentation can help speed adoption.
5. **Comparative advantage** across multiple dimensions can encourage transitions.
6. Need both vehicles and fuels in the right place at the right time with good policy support.

Fuel Transition Considerations....

1. Marketplace undergoing profound change
2. Sustainable fuels not yet scalable
3. The issues are complex
4. Sustainability standards are underdeveloped
5. Different views on the path forward
6. Technology and innovation may only get us so far

Reading List...



THANK YOU....

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