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The Transportation – Land Use – Environment Connection

Opportunities and Challenges Facing Electric Vehicles

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"In fifteen years, more electricity will be sold for electric vehicles than for lighting".
Thomas Edison, 1910

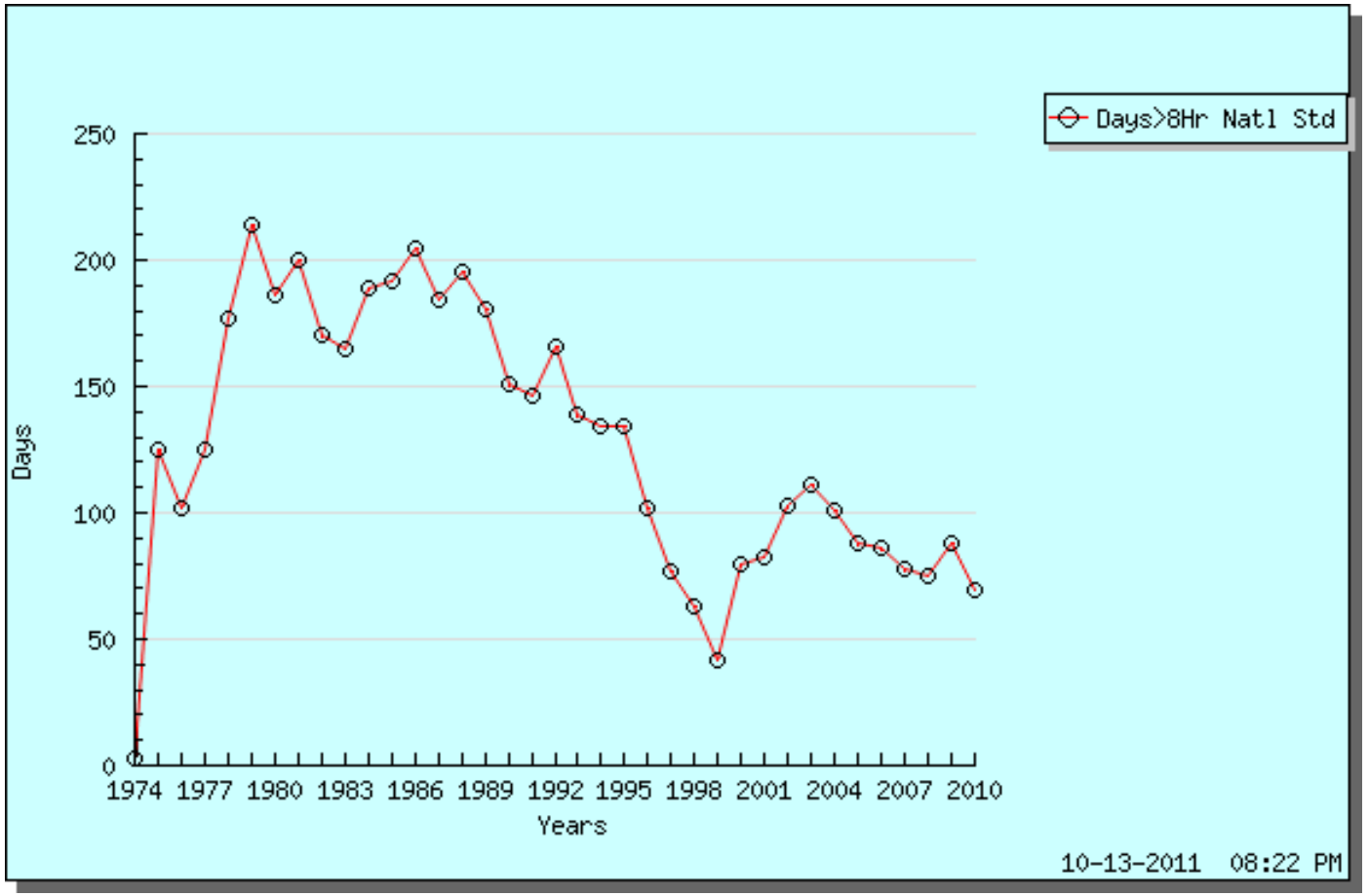
- We now know that Edison was a bit over-zealous in his prediction.
- In 1914, there were approximately 35,000 electric vehicles on city streets in the U.S. compared to 1.4 million liquid fuel powered vehicles
- Battle that raged in 1900-1920 between the battery and the internal combustion engine (ICE) is well-documented, a rich and interesting history, and the eventual winner is obvious
- Introduction of the electric starter production motor cars in proved critical to the success of ICE powered cars….no need to crank before you move, hence the term "crankiness".
- Detroit Electric, the most successful producer of battery electric vehicles, produced its last car in 1935.
- Renewed interest in electric vehicles did not reappear in any significant way until the late 1980's

The U.S. and all OECD countries have made considerable progress toward reducing motor exhaust and evaporative emissions, including CO2, since 1940's. Many contributors:

- Research in the 1940's – 1950's lead by Dr. Arie Haagen-Smit of CalTech on the complex mechanisms associated with photochemical smog formation and the sources of the multiple causal factors
- Significant air events such as Denora, Pennsylvania in 1948, London, England in 1952, and the serious deterioration of air quality in California's south coast basin.
- Public and political outcry for action
- Eventual creation of the State of California Air Resources Board in 1967-1968
- Federal authority established to regulate air quality under the 1970 Clean Air Act amendments
- Technical development and eventual introduction of three-way closed loop control technology on production motor cars in 1978-1979, based on the catalytic converter, exhaust oxygen gas sensors, fuel injection, and onboard electronic controls.
- EPACT passed by the U.S. Congress establishing first motor vehicle fleet fuel economy standards
- Advent of onboard diagnostics monitoring emission control systems on vehicles and eventual integration into State smog check programs for enforcement purposes
- Advent of reformulated gasoline, paving the way for more advanced technology
- California adopts its LEV and Clean Fuels program in 1990 establishing its ZEV mandate

Federal 8-Hour Ozone Standard Violations – Los Angeles County 1975 - 2010

Tremendous progress since 1975



Source: http://www.arb.ca.gov/adam/trends/graphs

Since CARB adopted its LEV program in 1990, we have experienced some rather frustrating "soul searching", in an attempt to find the best pathway toward cleaner transportation.

Soul Searching Translates To Technology Du Jour

1983 - 1990	Methanol and other Alternative Fuels
1988 – 1993	CNG Vehicles
1990 - 2001	ZEVs – Primarily Battery Electric Vehicles
1988 – 2007	FFVs – E85
(1999 – Today)	Hybrid Electric Vehicles (HEVs)
2001 - 2006	Hydrogen Fuel Cell Vehicles
2006 – Today	Plug-In HEVs and Battery Electric Vehicles
2011 - ????	What's Next?

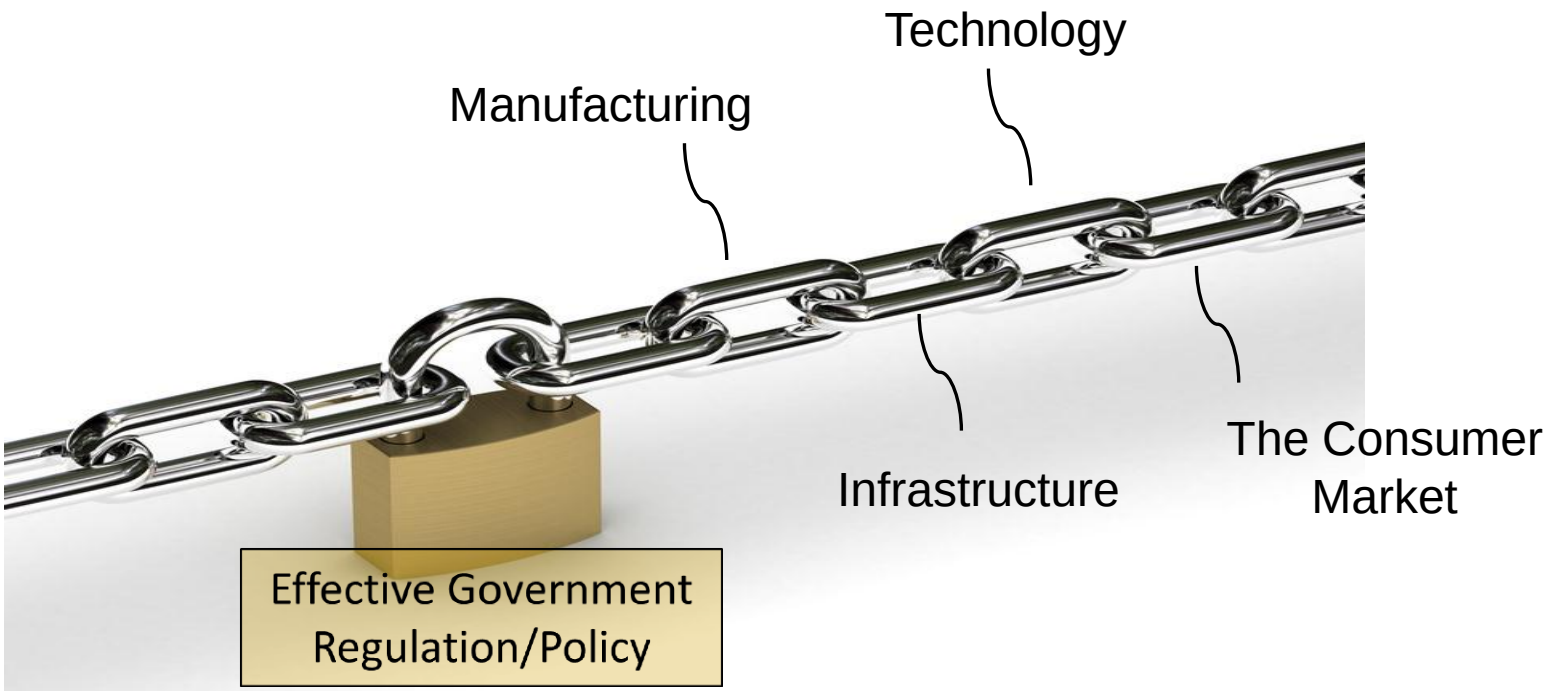
Current regulatory policy both challenging and problematic:

1. Constant change in direction very disruptive to technology development process
2. Strands and misapplies resources (e.g., recharging infrastructure installation)
3. Wrong signals sent to industry, VC firms and other investors, new market entrants
4. Incentives short-lived, not sustainable, and politically motivated
5. Difficult for industry to set strategy based on projected existence of incentives

Industry has to be a significant part of the solution and it needs longer term vision, constancy, and consistency.

Fundamental Need Exists for Broader Collective Will for Sustained ZEV Market

ZEV = Battery Electric Vehicle (BEV) or Fuel Cell Vehicle (FCV)



All important links in chain or pathway to success. Any weak link will cause failure or limit success. Collective will needed to ensure all links are addressed and collaborative effort is assembled and pursued.

Fundamental Need Exists for Broader Collective Will for Sustained ZEV Market

- Broad support of technology neutral regulatory policy and avoidance of past attempts at picking winners and losers
- Continuation of government incentives, preferably with global collaboration between both OECD and developing countries, applied to advanced and fundamental research, and not on trying to stimulate consumer markets
- Significant moderation in production mandates, as high volume production requirements are simply not a good use of resources absent clearly visible and sustainable markets; nor are they helpful to technical research or development or advancement of technology
- Supportive research and study and collaboration to enhance the understanding of regional transportation planning and demographic analysis, including internationally, therein enabling better strategic product planning and more informed dialogue with regulators and other key stakeholders.

A global perspective with facilitated collaboration is sorely needed.

Three Camps of ZEV Proponents

1. Rampant, Unbridled Optimism
   - Vehicles are coming in droves
   - No insurmountable barriers to rapid market expansion
   - Just need to install recharging infrastructure
2. Prudent Questioning With Lots of Skepticism
   - Vehicles or batteries not ready for mass market
   - No broad consumer market exists due to current state of technology
   - Market cannot be sustained without massive long term subsidies
   - Lithium ion technology still not optimum basic chemistry
3. Unbiased Optimism (Probably Most Realistic of Three Camps)
   - BEVs not for everyone but may work for many people
   - BEVs most likely will not displace a significant portion of motor vehicle fleet in next 2-3 decades
   - Need to more strategically find population clusters for BEV adoption
   - Manufacturer and supplier risks are still quite significant
   - *Broader set of societal stakeholders needs to be engaged in collaborative dialogue with vehicle producers to better understand what is most feasible technically and economically*
   - More strategic regulatory policy needed

Some Specific Things Needing Focus

- Best methods to evaluate, identify, and stimulate markets for ZEVs
  - Assists vehicle producers in strategic planning
  - Better defines types of vehicles needed and where
  - Assists in infrastructure installation and location strategy
- Processes toward a less-carbon intensive grid integrated with transportation needs
  - For example, nuclear power generation relative to less-carbon intensive electrolysis production of hydrogen for FCVs
- Planning for infrastructure installation
  - Avoidance of installation before market identification
- Longer term strategy in regulation
- Collaborative dialogue between vehicle producers and municipalities
  - Producers face unrealistic production mandates with little global foresight
  - Municipalities face requirements of SB375 transportation planning
  - Neither parties engaged in constructive communication to date

"Technological breakthroughs with a positive impact on battery performance are always possible but cannot be predicted, nor can policies be based on them."

Dr. Menahem Anderman
President
Advanced Automotive Batteries, Inc.
(Member – CARB Battery Technical Advisory Panel 1993 – 2010

Effective and Economically Viable Regulatory Policy

CARB's ZEV Credit Scheme – Misguided Policy and None of the Above?

ZEV Type	Performance Definition	Credit per vehicle	
		2009-2017	2018 and later
V	300-plus mile range with fast fueling	7	3
IV	200-plus mile range with fast fueling	5	3
III	100-plus range with fast fueling or 200-plus mile range	4	3
II	100-plus mile range	3	3
I.5	75-100 mile range	2.5	2.5
I	50-75 mile range	2	2
0	Less than 50 mile range	1	1
NEV	No minimum	0.3	0.3

Credit scheme in ZEV regulation drives vehicle OEMs toward higher range vehicles for compliance strategy, but also much higher cost vehicles, limiting market potential and missing critical and possibly broader markets for lower range more affordable ZEVs.

Types III, IV, and V: Extremely high cost so not optimal choice
Types I, I-5 , and II: Very high cost so not optimal choice
Type 0: More affordable but requires much greater production volume

WBCSD Vision of Sustainability

- Using free markets to address sustainability; i.e., pricing externalities so that full costs are born
- Promoting a privatized infrastructure
- Addressing the needs of developing countries and populations that strive to achieve the comfort and convenience of developed nations and the inherent tensions this will produce
- Addressing congestion and ad hoc urban planning
- Creating useful mechanisms for global technical standards and collaboration

All of the above being applicable toward future transportation systems planning and Zero Emission Vehicles

Thank you.

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