Cleantech Policy in an Age of Energy Abundance

A View From the OEM Perspective...
Who Makes Up the Alliance?

BMW, Chrysler, Ford, General Motors, Jaguar Land Rover, Mazda, Mercedes-Benz, Mitsubishi Motors, Porsche, Toyota, Volkswagen, Volvo
1. Massive and consequential innovation
2. Converging societal benefits
3. Commitment to One National Program
4. Consumers “economic” not altruistic
Setting the Context: Enormous R&D
Auto Sector R&D Has Been Profound

Amount Spent Annually on R&D in 2013

<table>
<thead>
<tr>
<th>$ Billions</th>
<th>Autos</th>
<th>Aerospace &amp; Defense</th>
</tr>
</thead>
<tbody>
<tr>
<td>$102 Billion</td>
<td></td>
<td>$25.5 Billion</td>
</tr>
</tbody>
</table>

99% Comes from the Auto Industry!
OEMs = Top Innovators

- Boston Consulting Group found half of world’s “Most Innovative Companies” are automakers (9 of top 20)
- More automakers on the list than technology & telecom companies
- Booz & Co.’s survey of annual global R&D expenditures also found five automakers among the top 20 in corporate R&D spenders.
- INNOVATION includes AVs, connected cars and a range of driver assists that will yield profound societal gains
Innovation Saving Lives

- Fatalities are at 1950s level
- Miles traveled much higher
- Fatalities as share of VMT = a multi decade pattern of massive safety gains
- As we move from crash worthiness to avoidance, we are entering a golden age of safety advances
- Technology is key
And Huge Environmental & Fuel Economy Gains

Cars are 99% Cleaner Today

Automakers have reduced smog-forming emissions like hydrocarbons dramatically since the 1960s

30+MPG Vehicles Available

Automakers increased high mileage vehicle choice by 552% in 8 years
“Convergence”
How It Use To Be…

Safety vs. Environment
How it is Today: Safety = Green

- Adaptive Cruise Control
- Real-Time Navigation
- Automatic Braking
- Driver Information Technologies
- Autonomous Cars
Although this Statement focuses on the enormous safety potential of these new technologies, they offer an even wider range of possible benefits. Vehicle control systems that automatically accelerate and brake with the flow of traffic can conserve fuel more efficiently than the average driver. By eliminating a large number of vehicle crashes, highly effective crash avoidance technologies can reduce fuel consumption by also eliminating the traffic congestion that crashes cause every day on our roads. Reductions in fuel consumption, of course, yield corresponding reductions in greenhouse gas emissions.
A report by MIT estimates that a 20 percent reduction in accelerations and decelerations should lead to a 5 percent reduction in fuel consumption and carbon emissions.

The Texas Transportation Institute estimates that, in 2011, congestion in 498 metropolitan areas caused Americans to travel 5.5 billion hours more and buy an extra 2.9 billion gallons of fuel for a congestion cost of $121 billion.

The Federal Highway Administration estimates that 25 percent of congestion is attributable to traffic incidents, around half of which are crashes.
After analyzing government data, Morgan Stanley observed, “to be conservative, we assume an autonomous car can be 30 percent more efficient than an equivalent non-autonomous car. Empirical tests have demonstrated that level of fuel savings from cruise control use/smooth driving styles alone. If we were to reduce the nation’s $535 billion gasoline bill by 30 percent that would save us $158 billion.

Extrapolating from several case studies and research papers, ITS America evaluates the cumulative fuel savings from a variety of technologies for light and heavy-duty vehicles, including:

- **Vehicle Technologies** could save 110 million barrels of oil or 20 million metric tons of CO2 over a 10-year period.
- **Traveler Information Technology** could save 420 million barrels of oil or 70 million metric tons of CO2 over a 10-year period.
- **Infrastructure and Systems Operations** could save 119 million barrels of oil or 19 million metric tons of CO2 over a 10-year period.
One National Program?
The Big CAFE Deal of 2011

◆ Cumulative cost of implementing Standards: $200 billion

◆ Yet OEMs embraced agreement because:

✓ Single national program wraps in EPA, NHTSA & California
✓ DNA of industry is to keep innovating
✓ Agreement includes a midterm review to adjust if necessary

(agency to decide if changes warranted by 11/17; changes specified by 4/18)
The endpoint of 54.5 represents the goal of 163 grams per mile of CO2 emissions from improved fuel economy plus credits for other measures that reduce GHG emissions.
So How Are We Doing on GHG and Fuel Economy?

Source: 2014 EPA Trends Report
"If we don't quite get there ... it is not going to be the fault of those companies... They are trying hard. They are working. They are investing."

Gina McCarthy
EPA Administrator
January 13, 2014
California has a separate ZEV mandate that nine other “CA LEV” states follow.

Under the mandate, by 2025, 15.4% of sales in those states will have to be PHEVs, BEVs or FCVs.

Compliance with both ZEV mandate and the GHG/CAFE rules is challenging and potentially contradictory.

ZEV states are developing “action plans” to incent consumers.

OEMs want success – invested billions – yet mandate is ambitious and may not have the infrastructure / incentives to work.
Is Government Practicing What it Preaches?

Data from R.L. Polk

(2020 Target = 25%)
2015 CA Target = 10%

<table>
<thead>
<tr>
<th></th>
<th>CA</th>
<th>CT</th>
<th>MA</th>
<th>MD</th>
<th>ME</th>
<th>NJ</th>
<th>NY</th>
<th>OR</th>
<th>RI</th>
<th>VT</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>1.40</td>
<td>0.10</td>
<td>0.38</td>
<td>1.52</td>
<td>0.00</td>
<td>0.55</td>
<td>1.64</td>
<td>1.15</td>
<td>0.56</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Is Government Practicing What it Preaches?
Key Issues of the Mid-Term Evaluation

- Technology Advances and Costs
- Payback Period and Incremental Vehicle Costs
- Trends In Consumer Demand/Preferences
- Fuel Pricing
- Market Penetration of Fuel Efficient Technologies
- Availability of Alternative Fuels/Recharging Infrastructure
- Mass Reduction Methods
- Impacts on Employment
- Other Factors
“Rational” Consumer Behavior?
Automakers are flourishing “thanks to our rules”

“Consumers are on board”

With 64% of participants selecting it as important or very important, Fuel Economy received only the fourth-highest number of votes, but when forced to rank all ten factors against one another, fuel economy was clearly the top factor.
Consumers See CAFE as Pretty Aggressive

Which best reflects your view about the federal government requiring automakers to build cars that reach 54.5 mpg by 2025?

- **Too aggressive:**
  - Republican: 34%
  - Democrat: 47%

- **About right:**
  - Republican: 41%
  - Democrat: 33%

- **Not aggressive enough:**
  - Republican: 16%
  - Democrat: 12%

- **Not sure:**
  - Republican: 9%
  - Democrat: 8%
Success with Gas Powertrains Inhibits Appetite to Switch?

What Type of Engine Will Your Next Vehicle Be Powered By?

- Gasoline
- Hybrid
- Diesel
- Electric
- Not Sure

• Remarkable consistency over two years
• Subtle increase in preference for gas
• Subtle decrease in preference for hybrids

(37) (47)
And Consumers Want More Pick-ups / SUVs

(Want less Have)

-6% -4% -2% 0% 2% 4% 6%

May '12 Nov. '12 May '13 Nov '13 May '14

Car Mini-Van Pick-Up SUV Something Else
### Bunch of Factors Motivating Consumers...

Historically, Fuel Economy importance and the price of gas in the US have been directly connected. Customers have felt (and complained) of pain when operational costs increase.

However, in recent years, even though gas price has been more stable, there has been an increase in demand of all aspects of Value.

#### Purchase Reasons (% Extremely Important - Top Box)

<table>
<thead>
<tr>
<th>Model Year</th>
<th>Warranty Coverage</th>
<th>Technical Innovations</th>
<th>Value for the Money</th>
<th>Fuel Economy</th>
<th>Price of Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>56%</td>
<td>44%</td>
<td>64%</td>
<td>50%</td>
<td>$3.38</td>
</tr>
<tr>
<td>2013</td>
<td>52%</td>
<td>34%</td>
<td>59%</td>
<td>45%</td>
<td>$3.49</td>
</tr>
<tr>
<td>2012</td>
<td>49%</td>
<td>30%</td>
<td>55%</td>
<td>45%</td>
<td>$3.60</td>
</tr>
<tr>
<td>2011</td>
<td>45%</td>
<td>26%</td>
<td>53%</td>
<td>39%</td>
<td>$3.56</td>
</tr>
<tr>
<td>2010</td>
<td>46%</td>
<td>24%</td>
<td>60%</td>
<td>37%</td>
<td>$3.07</td>
</tr>
<tr>
<td>2009</td>
<td>48%</td>
<td>26%</td>
<td>59%</td>
<td>39%</td>
<td>$2.13</td>
</tr>
<tr>
<td>2008</td>
<td>48%</td>
<td>27%</td>
<td>57%</td>
<td>49%</td>
<td>$3.57</td>
</tr>
<tr>
<td>2007</td>
<td>45%</td>
<td>31%</td>
<td>46%</td>
<td>43%</td>
<td>$2.39</td>
</tr>
<tr>
<td>2006</td>
<td>44%</td>
<td>31%</td>
<td>48%</td>
<td>42%</td>
<td>$2.24</td>
</tr>
</tbody>
</table>

Source: Strategic Vision - 2014 New Vehicle Experience Study (NVES)
Fuel Economy May Not Be a Top Priority

Balancing the vehicle experience with other priorities in one’s life, including overall value, are greater considerations for most new vehicle buyers than fuel economy – which places 10th out of the top ten customer attitudes.

Customer Attitudes (% Extremely Important - Top Box)

<table>
<thead>
<tr>
<th>Rank (of 45)</th>
<th>Customer Attitudes</th>
<th>Top Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I prefer a balance of comfort and performance</td>
<td>53%</td>
</tr>
<tr>
<td>2</td>
<td>When I drive for fun, I mainly prefer to relax and listen to music or talk</td>
<td>50%</td>
</tr>
<tr>
<td>4</td>
<td>I prefer vehicles that provide superior handling and cornering agility</td>
<td>43%</td>
</tr>
<tr>
<td>5</td>
<td>Value equals balance of costs, comfort &amp; performance</td>
<td>42%</td>
</tr>
<tr>
<td>7</td>
<td>I want [a vehicle] that I love so much that I look forward to nice enjoyable drives</td>
<td>37%</td>
</tr>
<tr>
<td>9</td>
<td>I want a vehicle that provides the quietest interior</td>
<td>34%</td>
</tr>
<tr>
<td>10</td>
<td>Fuel economy is a leading consideration in my purchase decision</td>
<td>33%</td>
</tr>
</tbody>
</table>

Source: Strategic Vision - 2014 New Vehicle Experience Study (NVES)
Altruism Not Terribly Compelling For Most

Other aspects of value and ownership have a greater impact on owners’ daily lives, making more removed environmental considerations a sincere — albeit secondary — consideration. Interest in paying significantly more for this is among the least important customer attitudes.

Customer Attitudes (% Extremely Important - Top Box)

<table>
<thead>
<tr>
<th>Rank (of 45)</th>
<th>Customer Attitudes</th>
<th>Top Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Driving is one of my favorite things to do</td>
<td>32%</td>
</tr>
<tr>
<td>12</td>
<td>I prefer a vehicle that has the capability to outperform others</td>
<td>30%</td>
</tr>
<tr>
<td>13</td>
<td>I need my vehicle to work as hard as I do</td>
<td>29%</td>
</tr>
<tr>
<td>14</td>
<td>I prefer vehicles that provide superior straight ahead power</td>
<td>28%</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>43</td>
<td>I would pay significantly more for environmentally friendly vehicle</td>
<td>8%</td>
</tr>
<tr>
<td>45</td>
<td>I really don't enjoy driving</td>
<td>6%</td>
</tr>
</tbody>
</table>

Source: Strategic Vision - 2014 New Vehicle Experience Study (NVES)
## Technology Comparison

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Conventional</th>
<th>PHEV</th>
<th>BEV</th>
<th>FCV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost*</td>
<td>~$25,000</td>
<td>$42,818</td>
<td>$42,562</td>
<td>$48,472</td>
</tr>
<tr>
<td>Annual Fuel Cost**</td>
<td>$1,150</td>
<td>$550</td>
<td>$400</td>
<td>?</td>
</tr>
<tr>
<td>Range (Summer)</td>
<td>350 miles</td>
<td>350 miles</td>
<td>75-100 miles</td>
<td>300 miles</td>
</tr>
<tr>
<td>Range (Winter)</td>
<td>350 miles</td>
<td>350 miles</td>
<td>45 miles</td>
<td>300 miles</td>
</tr>
<tr>
<td>Refueling Time</td>
<td>5 minutes</td>
<td>5 minutes</td>
<td>4-8 hours</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Fuel Stations</td>
<td>120,000</td>
<td>120,000</td>
<td>6,500</td>
<td>10</td>
</tr>
</tbody>
</table>

* Costs based on CARB cost projections
** Assuming 10k miles/year
<table>
<thead>
<tr>
<th>Questions</th>
<th>Responses / Readily Available Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>Depends (Freeway, streets, hills, temperature)</td>
</tr>
<tr>
<td>Fed. &amp; State Financial Incentives</td>
<td>Known</td>
</tr>
<tr>
<td>State Non-Financial Incentives</td>
<td>Known, but importance to customer will vary (e.g., parking, HOV usage)</td>
</tr>
<tr>
<td>Local Incentives</td>
<td>Depends on where the customer lives and/or works</td>
</tr>
<tr>
<td>Cost of Charger</td>
<td>Depends ($495 - $1,500)</td>
</tr>
<tr>
<td>Expense to Install Charger</td>
<td>Depends (contractor rates, house layout, age of home, sub-meter, etc.)</td>
</tr>
<tr>
<td>Permit</td>
<td>Depends (local jurisdictions can range from 1 hour to 30 days)</td>
</tr>
<tr>
<td>Cost to Recharge</td>
<td>Depends on time of charging, local utility rate, rate plan, current usage, sub-meter</td>
</tr>
<tr>
<td>Workplace charging</td>
<td>Depends on workplace or close proximity to workplace</td>
</tr>
</tbody>
</table>
The next 11 years will mark an unprecedented time in increasing FE standards.

Automakers are rapidly adopting new technologies to meet future requirements.

The success of CAFE and Greenhouse Gas Programs is dependent on consumer adoption.
  - Many options are currently available for the fuel economy conscious buyer
  - Reliability, quality, and durability are the top three purchase reasons.
THANKS