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# **Hazardous Driving: Cars, Consumers and Policy on the Road to Sustainability**

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Mike Millikin  
Founder and Editor, Green Car Congress  
*[mmillikin@bioagemedia.com](mailto:mmillikin@bioagemedia.com)*

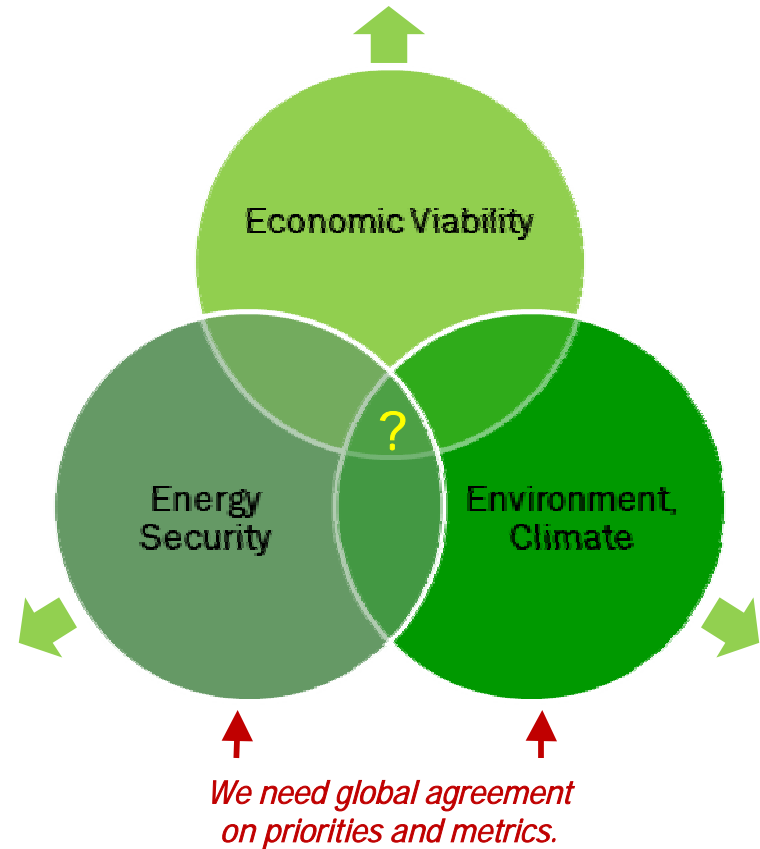
# Agenda

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- Main challenges on the road to sustainability
- Barriers
- Technologies
- Policies
- Tactics & Strategy, Regional & Global Needs for the Auto Industry

# Main Auto Industry Challenges

- How to stay in business
- How to reduce full lifecycle greenhouse gas emissions from the global transportation fleet
- How to reduce dependence on petroleum-derived fuels

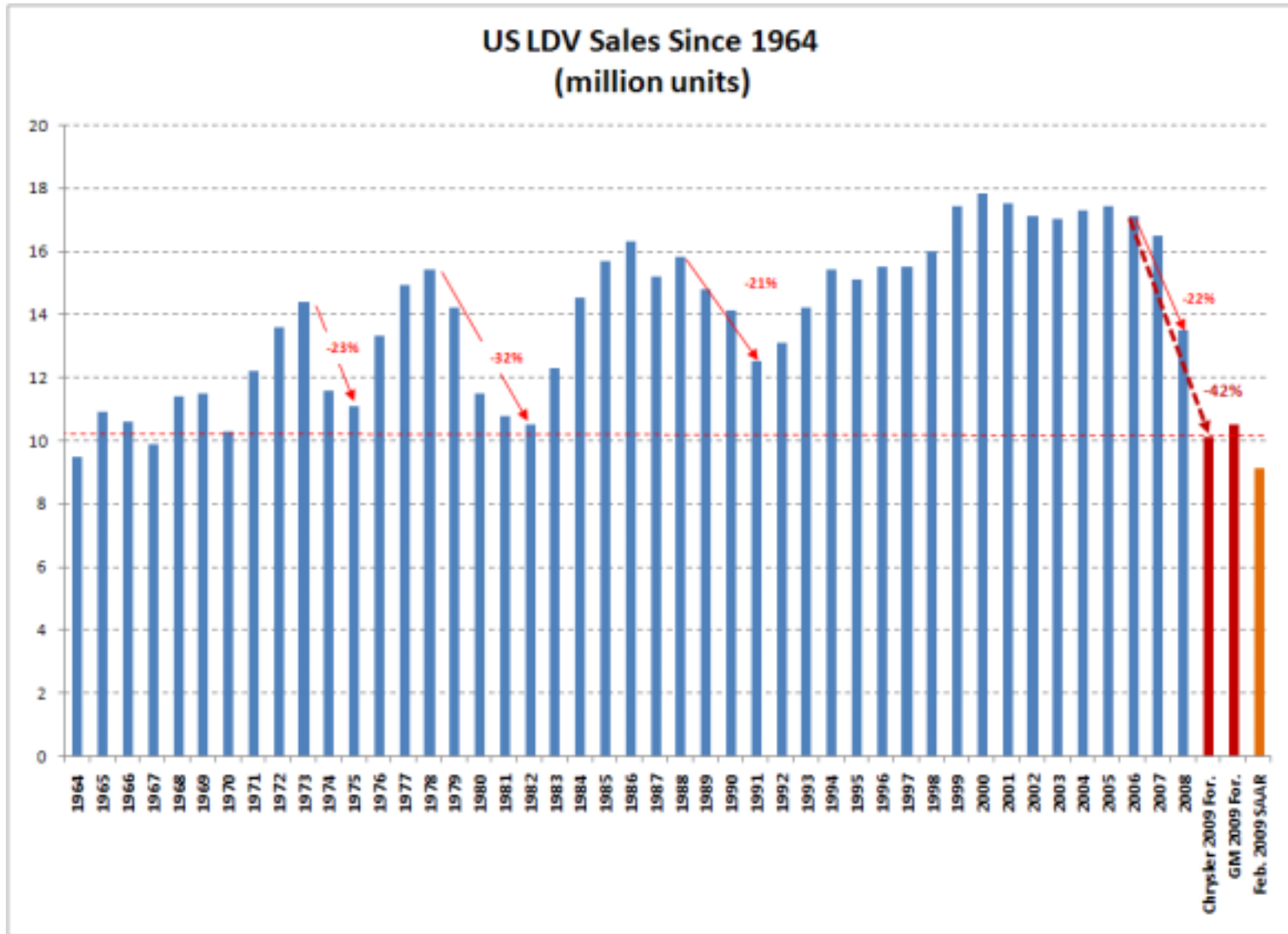


# Barriers

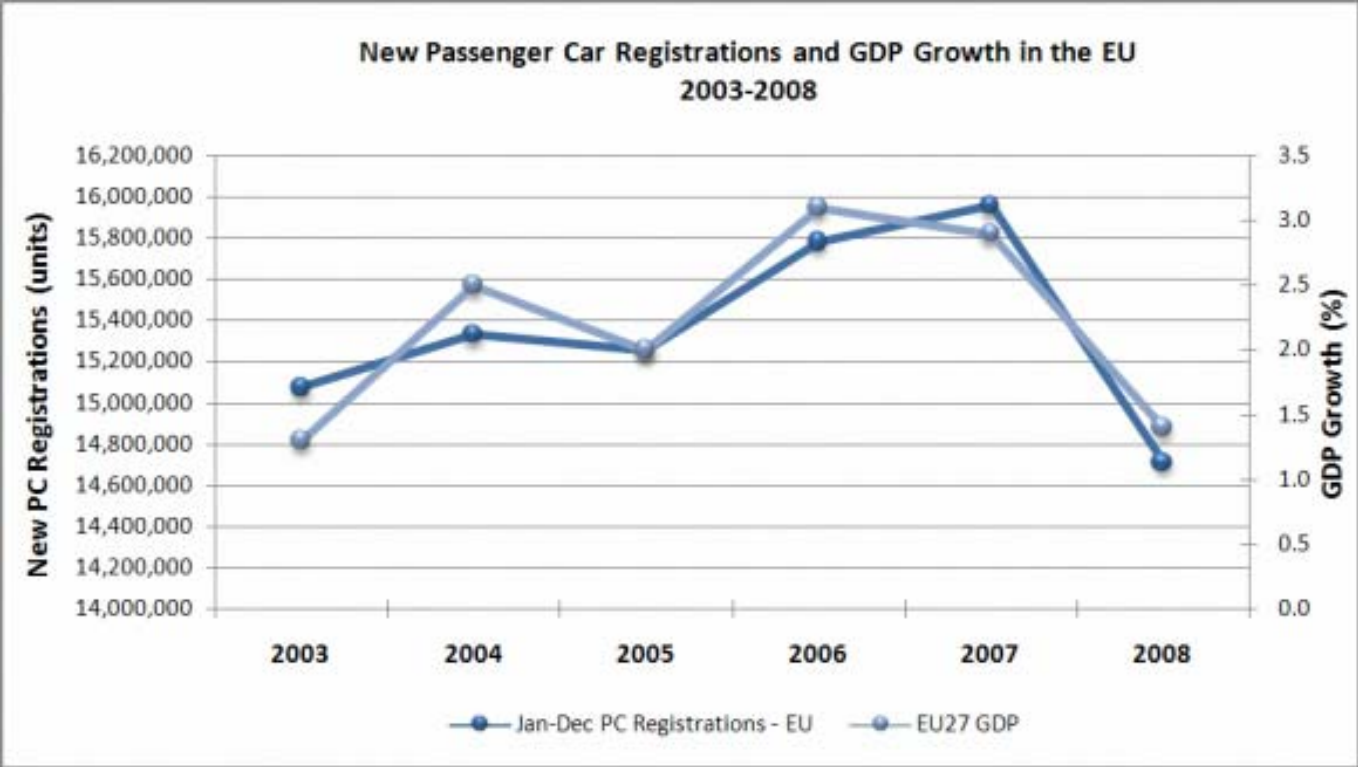
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- Economy and consumer demand
- Regulatory constraints, current and future
- Stakeholder perceptions/demands

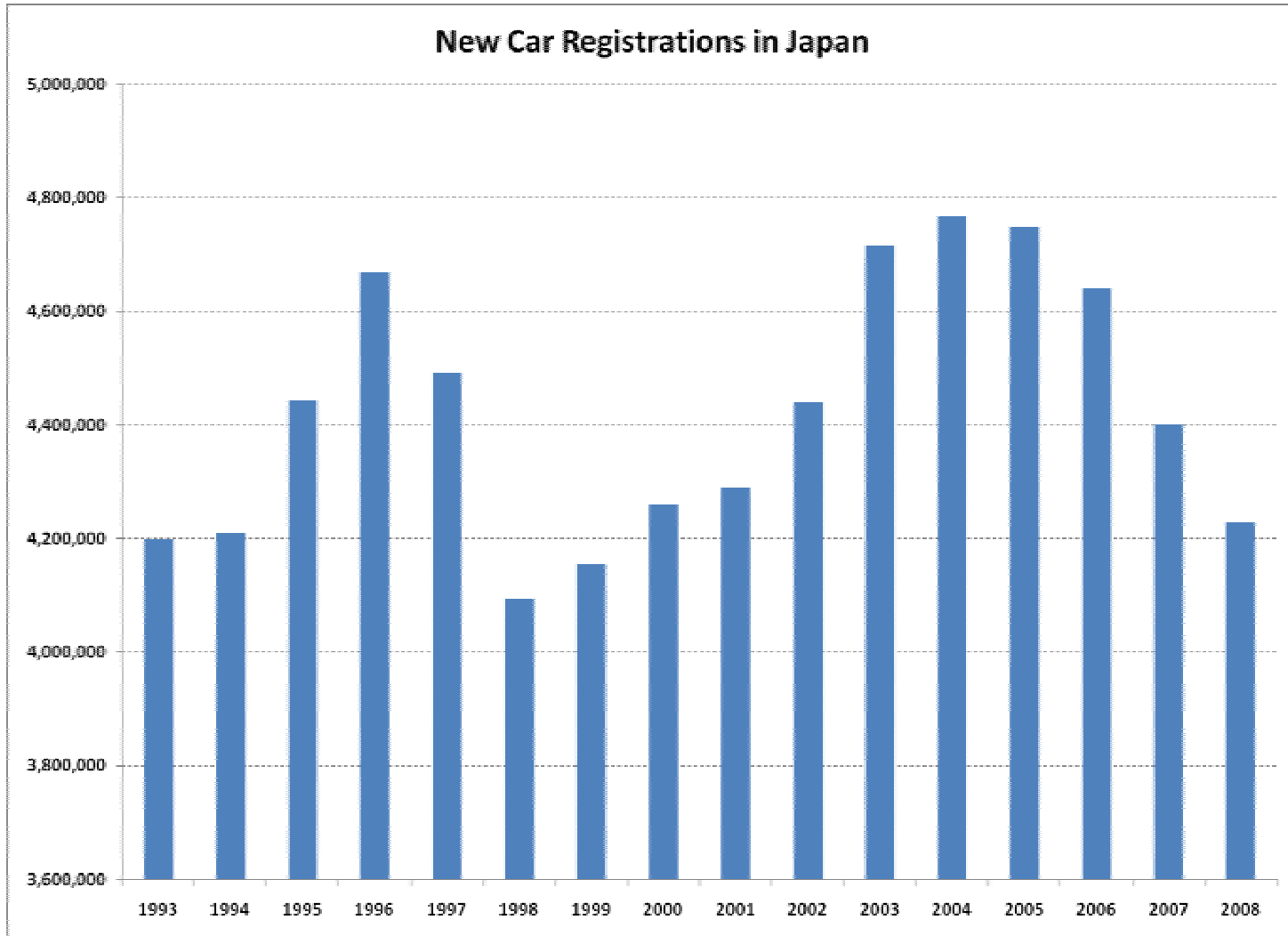
# US LDV Sales



# EU New Car Registrations and GDP Growth

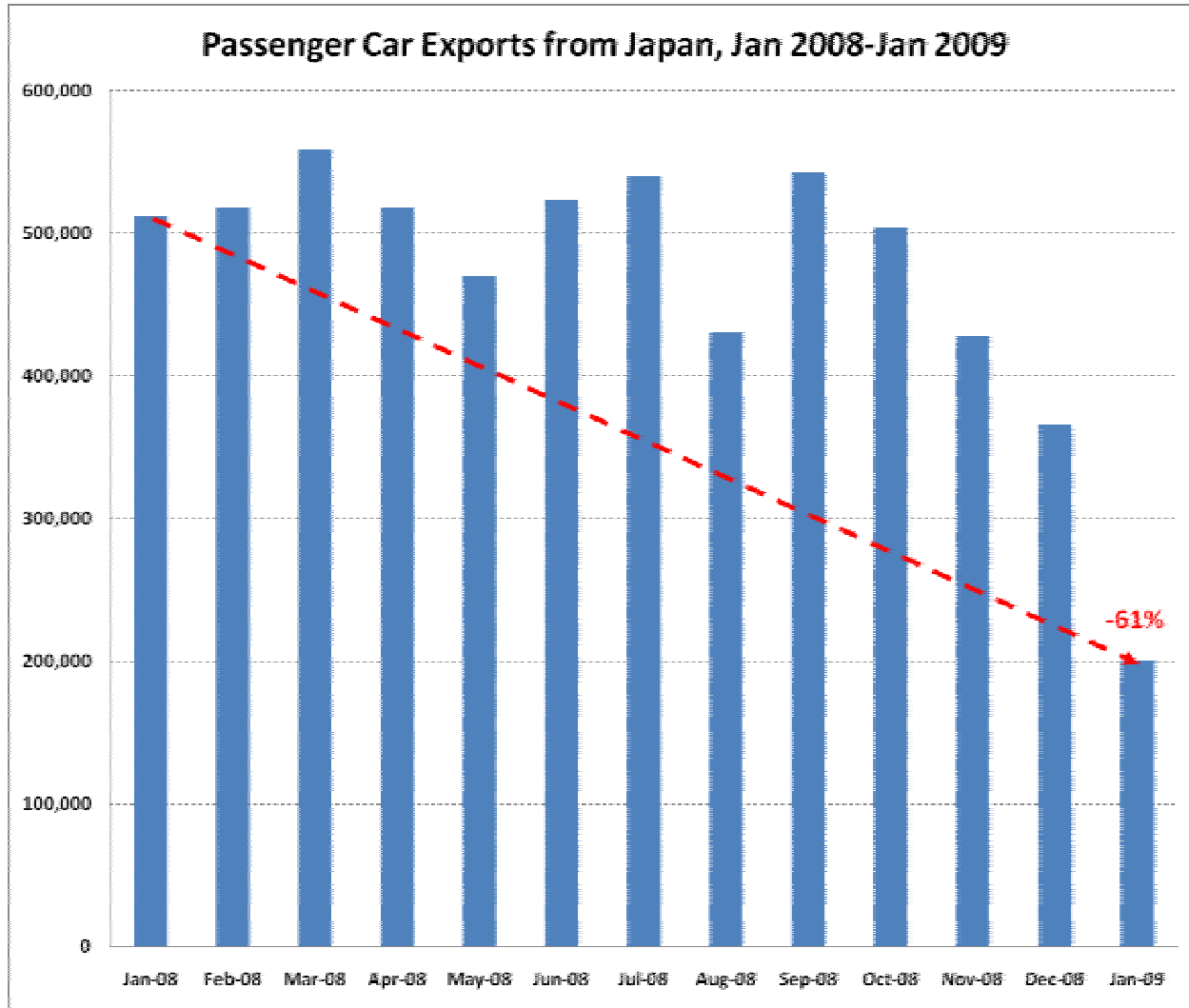


# Japan



*Data: JAMA*

# Passenger car exports from Japan



# Local Impacts

- 3 Mar: Bosch to cut 12% (170 jobs) from Clayton plant “after an ‘unprecedented’ 40 to 50 percent drop in overseas demand for its parts, as well as a significant slowdown in Australia”
- 2 Mar: Holden to cut production by 10 days in April at its Adelaide plant.



# Transportation and CO<sub>2</sub>

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*“The signal we have heard from the scientific community is crystal clear: global greenhouse gas emissions need to peak over the next 10 to 15 years and drop by at least 50% against 2000 levels by the middle of the century in order to stabilize global mean temperature increases around 2-2.4 °C.*

*“For industrialized countries this means reductions by 2020 between 25 and 40% against 1990 levels. All of the current trends in transport fly in the face of what science tells us is required. Present political action in the transport sector is woefully inadequate.”*

—Yvo de Boer, Executive Secretary UNFCCC

*Ministerial Conference on Global Environment and Energy in Transport, January 2009*

*“Cars are 17% of the problem and receive 100% of the attention.”*

—Bill Reinert, National Manager, Advanced Technology Group

Toyota Motor Sales, USA

# What will it take to meet CO<sub>2</sub> targets?

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- Increase vehicle efficiency
- Reduce VKT
  - Modal shifts, development changes (e.g., anti-sprawl)
- Reduce carbon intensity of remaining VKT—i.e., lower carbon fuels and/or change driver behavior
- One example for US to hit 450 ppm target by 2050  
(Grimes-Casey *et al.*, 2009, *ES&T*)
  - Vehicle Well-to-Wheel carbon emissions to 20 g/mi (12.4 g/km); equivalent to 73 gCO<sub>2</sub>/mile, or ~45 gCO<sub>2</sub>/km
- Vehicle Technology can be only one component of the solution
- Need for a combination of strategies.

# Consumer (and government) perceptions

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- Climate change
- Severity and timing of climate change impacts
- Technology capability of auto industry
- Role of the auto industry
- Major perceptual challenge for automakers (Bill Reinert):

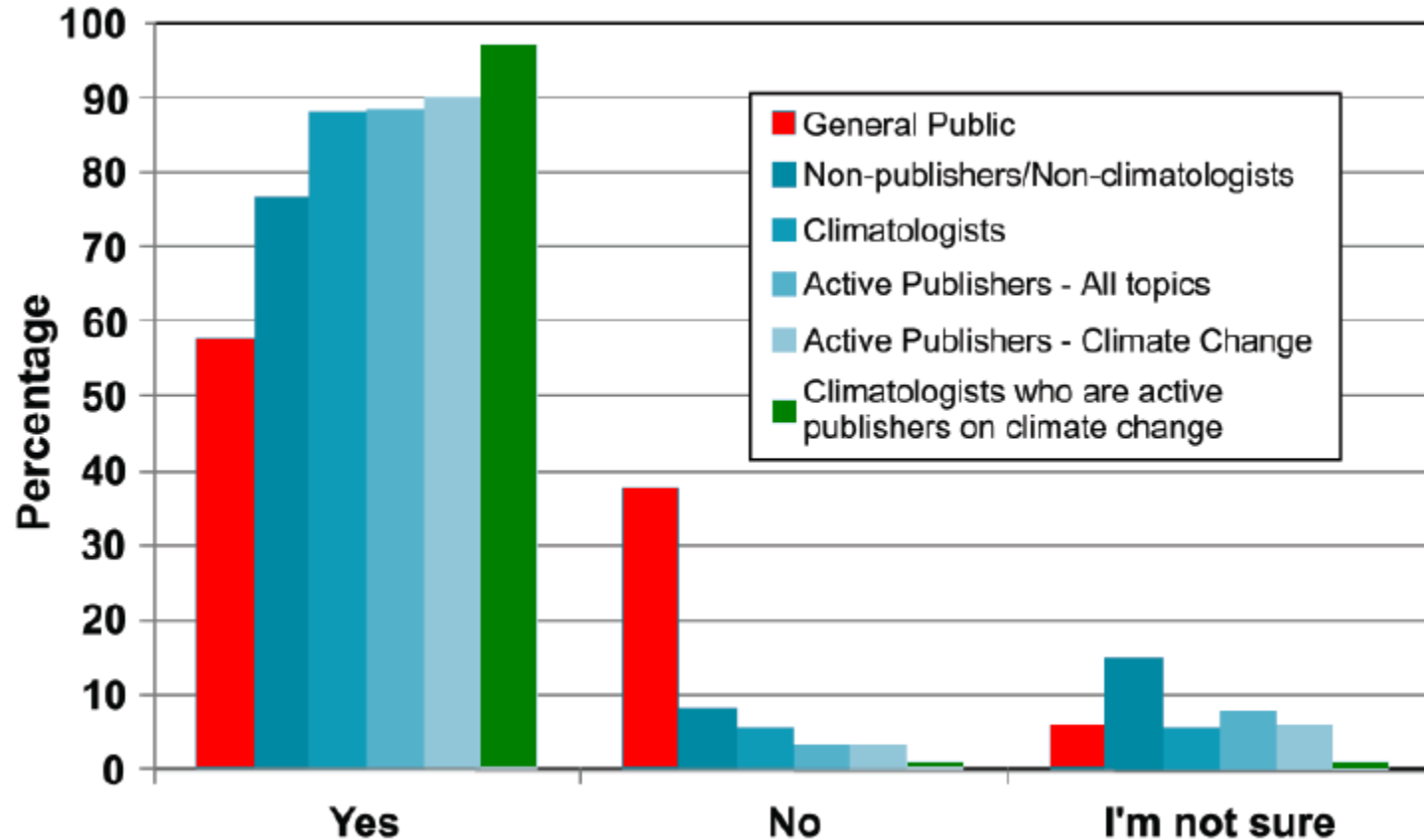
The First Law of Thermodynamics

VS.

The First Law of Disney

(i.e., wishing makes it so)

# Do you think human activity is a significant contributing factor in changing mean global temperatures?



Doran and Kendall Zimmerman, *EOS, Transactions, American Geophysical Union*. Vol. 90., No. 3, 20 January 2009

# The Adaptation Myth

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Organizations also face institutional and human barriers to adaptation: the need to overcome or revise codes, rules, and regulations that impede change; the lack of clear directions and mandates to take action; political or ideological resistance to the need for responsiveness to climate change; the preoccupation with near-term challenges and priorities and the lingering perception that climate change is a concern only for sometime in the future; and the inertia created by a business-as-usual assumption that future conditions will be more or less like those of the past.

Without national leadership and concerted efforts to remove these barriers and obstacles, adaptation to climate change is likely to continue to lag. It will be largely reactive rather than anticipatory and preventive, responding to damaging impacts once they have occurred. To say that the United States can adapt to climate change does not imply that the United States will adapt.

Robert Repetto (2008) *The Climate Crisis and the Adaptation Myth*  
Working Paper #13, Yale School of Forestry & Environmental Studies

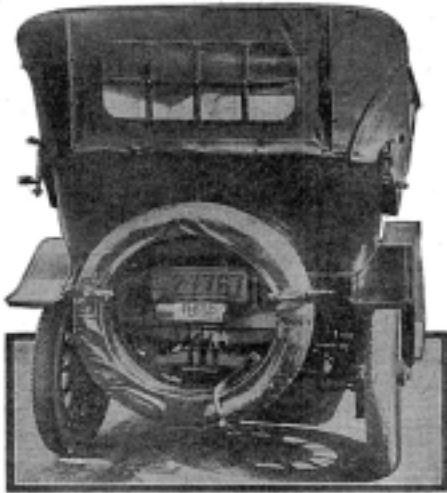
# Response: Re-invention

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*"The market has changed permanently. It would be crazy of us with the way the industry is going to not be reinventing the company from the core."*

—GM Holden Chairman and Managing Director, Mark Reuss  
*The Australian*, 28 Feb 2009

# Technologies to transform the auto industry



Electric taxi  
 “the electric is  
 destined to be the  
 taxi of the future”  
*New York Times*  
 21 March 1915



Compressed air motor  
*Science & Mechanics*  
 Jan 1932



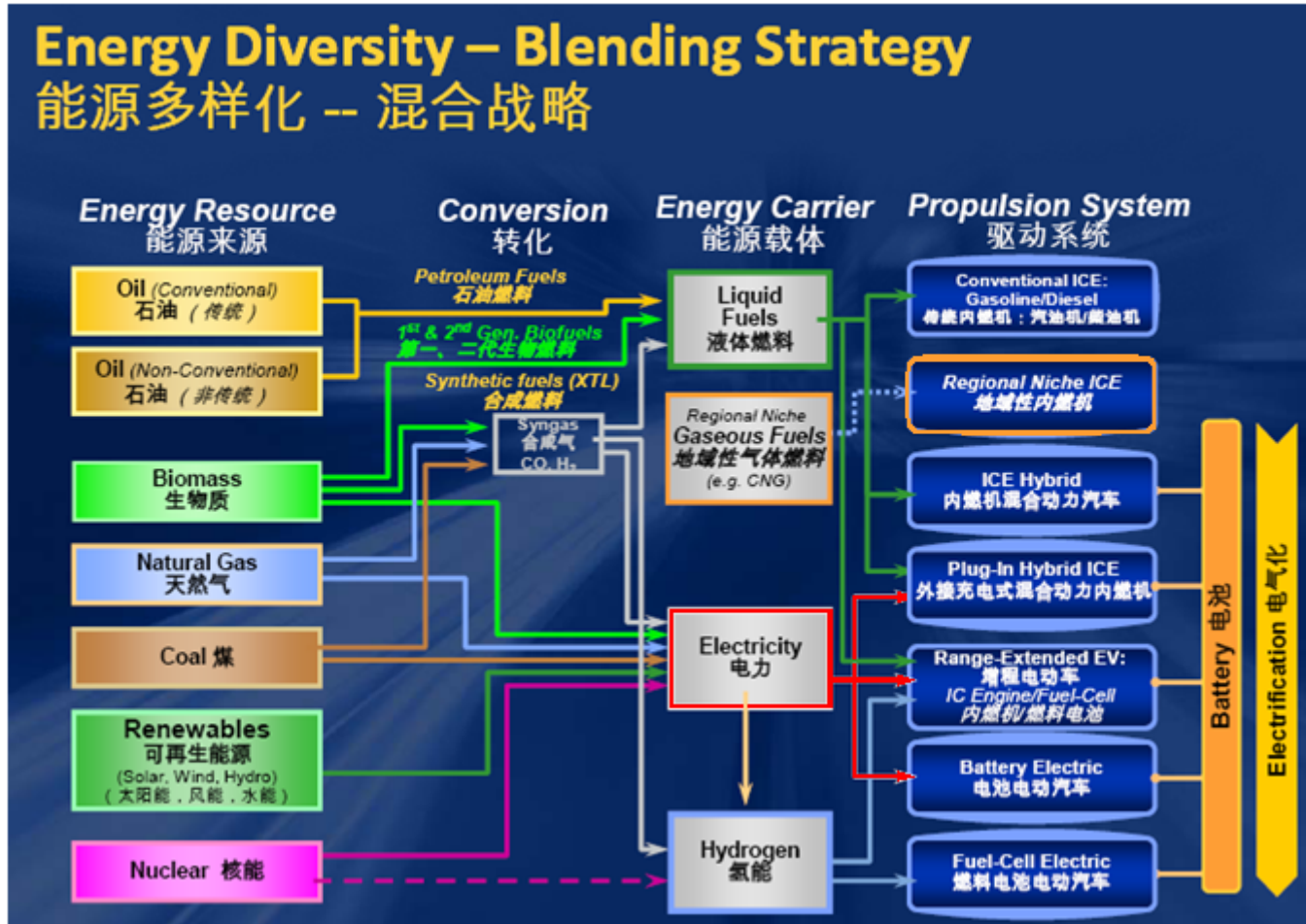
Electric truck  
 1913

# Technology

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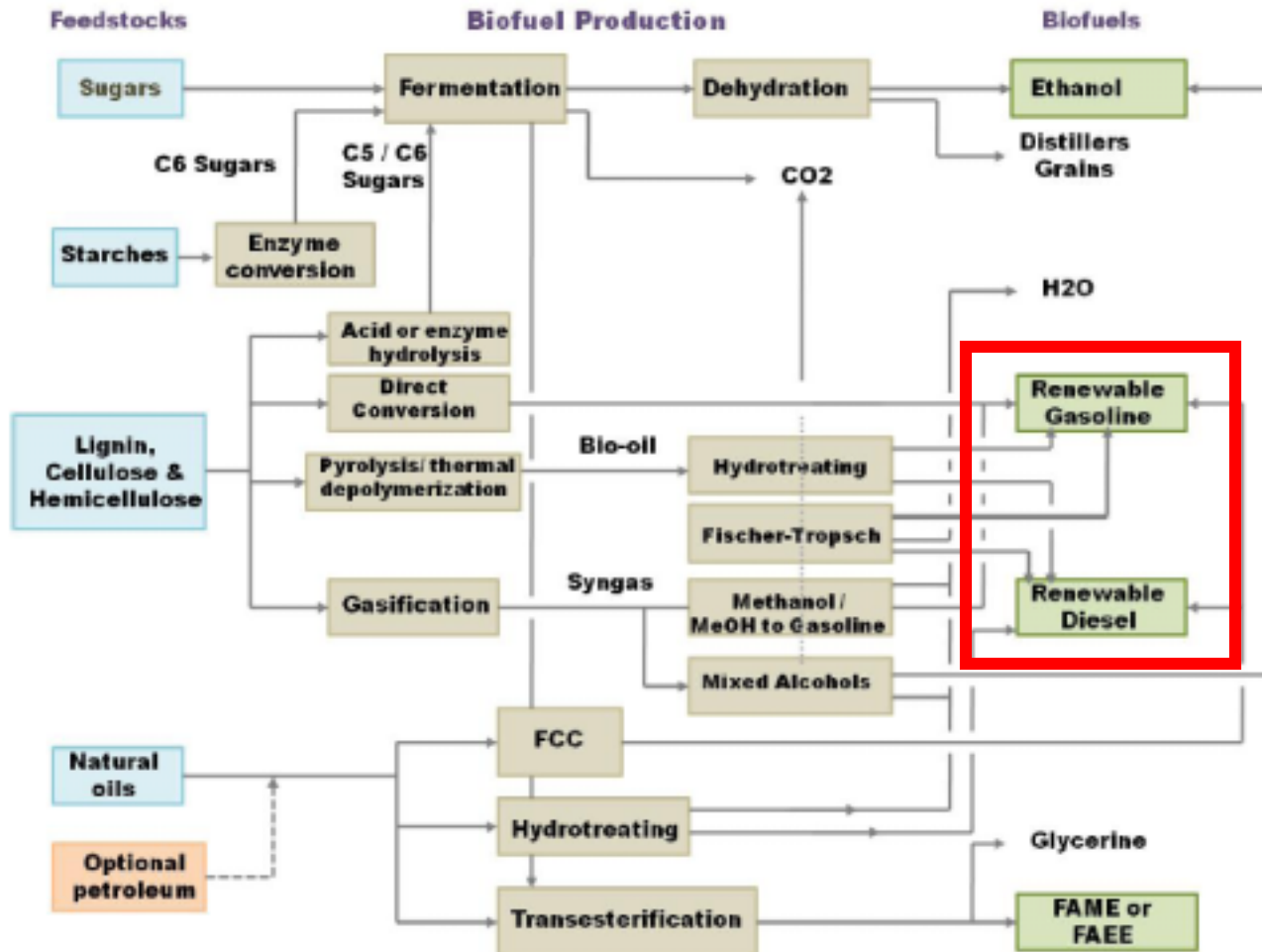
- The complexity of choices can be a barrier
- It is extremely difficult to forecast the likely success of competing advanced powertrains (Steven Plotkin, Argonne National Laboratory) when we don't know:
  - The future price of fuel...and what consumers think it will be
  - Future attitudes about climate change, energy security and the economy...and what people are willing to do about them
  - Future regulations and incentives
  - Future technology progress or breakthroughs
  - Consumer response
- New technologies (e.g., PHEVs, EVs, Fuel Cells) will be competing against significantly improved “conventional” drivetrains
  - Global Fuel Economy Initiative (UNEP, IEA, ITF, FIA Foundation) targeting 30% improvement in new car fuel efficiency by 2020 and 50% by 2030 mainly through incremental change to conventional internal combustion engines and drive systems, along with weight reduction and better aerodynamics.
- No single “Silver Bullet”
- Regional variations and combinations

# Fuels and Powertrains



Source: Dr. Andreas Lippert, GM

# Beyond Biofuel Blends and Additives



Adapted from Holmgren et al (2008); Hydrocarbon Processing, Sep.

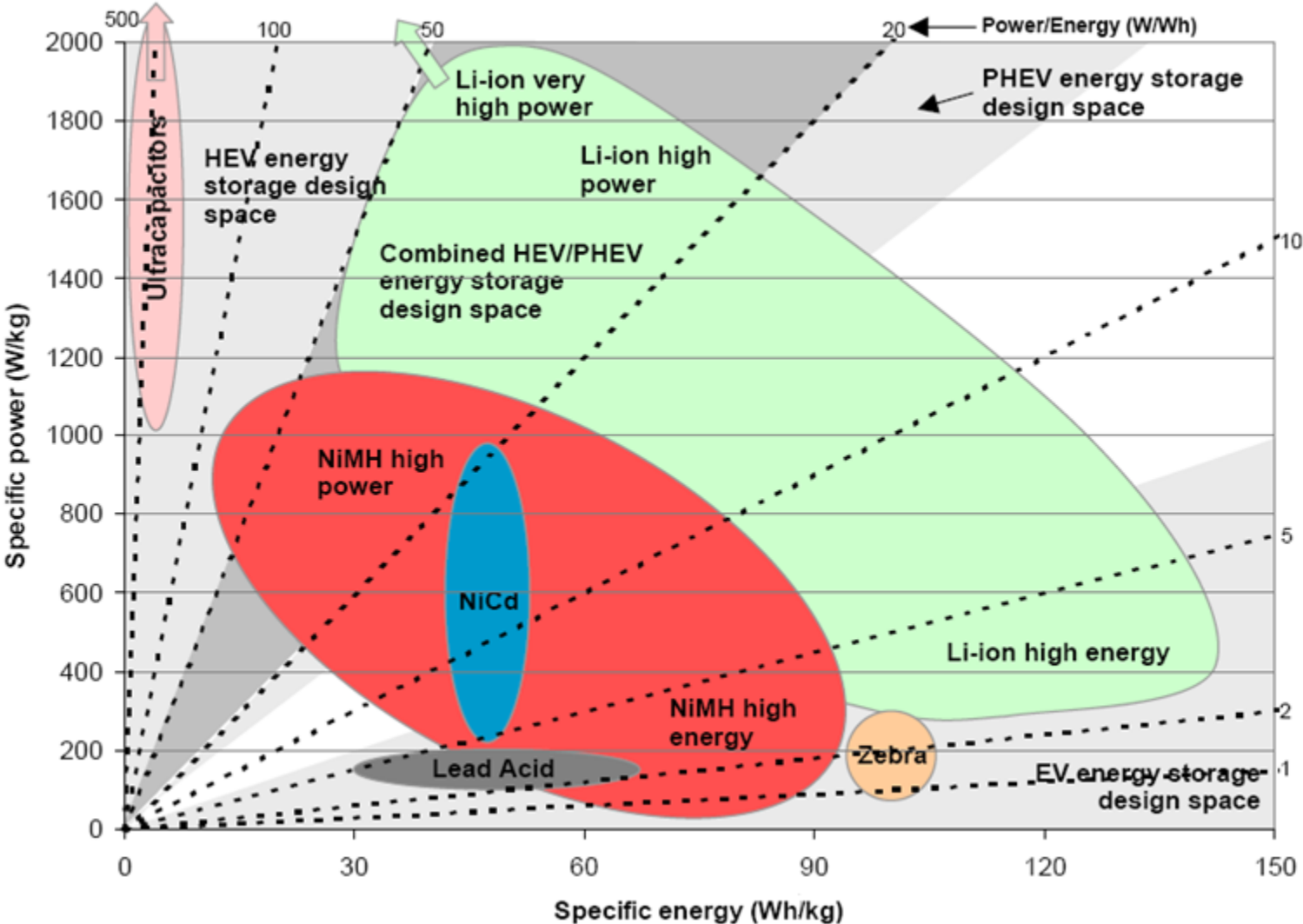
# Bio-hydrocarbons

(renewable gasoline and diesel)

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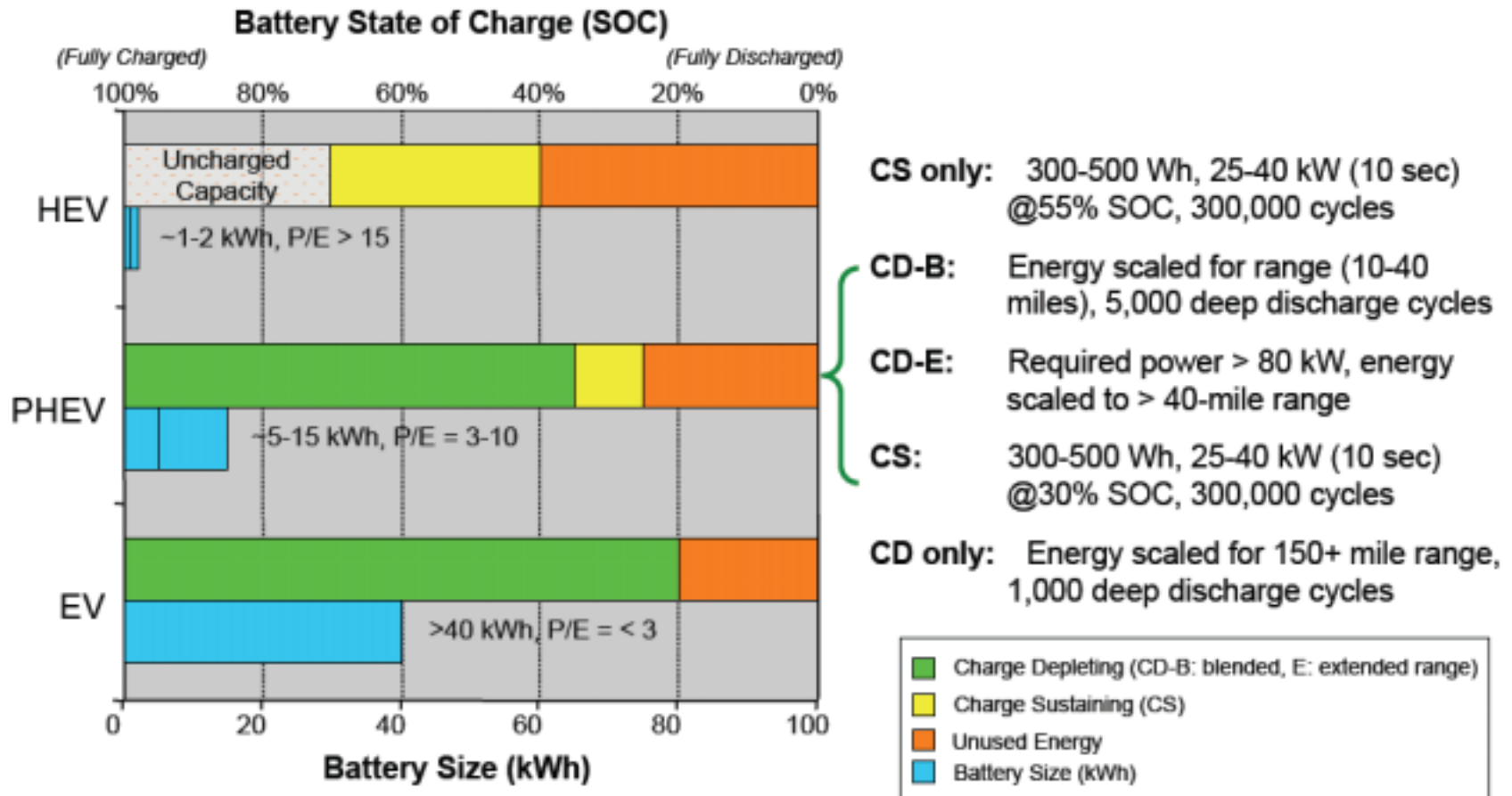
- Conversion of cellulosic biomass
  - “Conventional” BTL thermochemical (Fischer-Tropsch)
  - New bio-thermochemical (Byogy)
  - Aqueous phase reforming (Dumesic, Virent)
  - PKU/EPFL (Kou)
- Conversion of lipidic compounds
  - E.g., Centia, UOP, Solazyme
- Direct biological production
  - Amyris (diesel molecule)
  - LS9
  - Myco-Diesel (Strobel, Univ. of Montana)

# Battery chemistries and applications



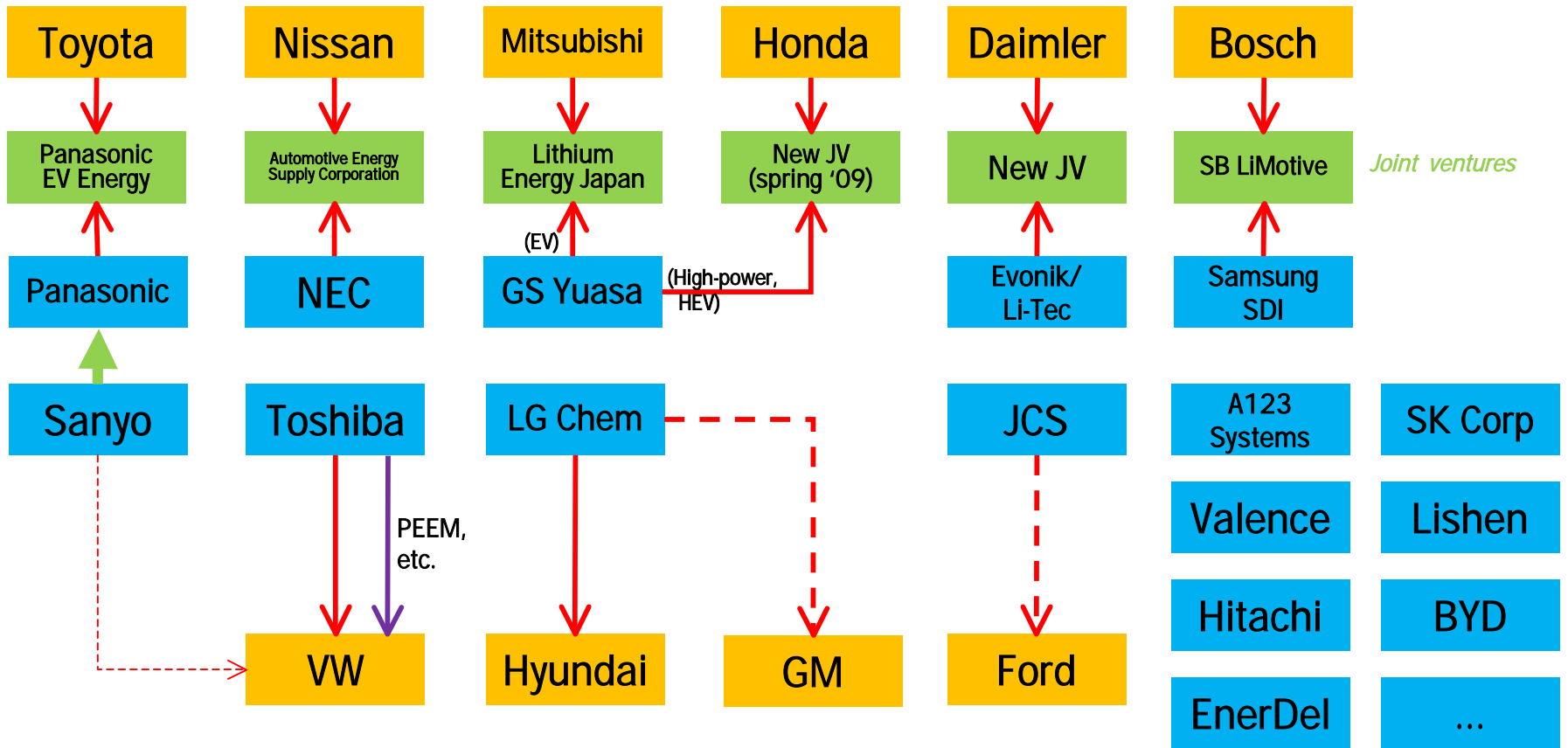
Source: Ricardo plc

# Wide range of battery requirements



Complete requirements and test procedures available from [http://www.uscar.org/guest/view\\_team.php?teams\\_id=12](http://www.uscar.org/guest/view_team.php?teams_id=12)

# LDV Li-ion Supplier-OEM Relationships

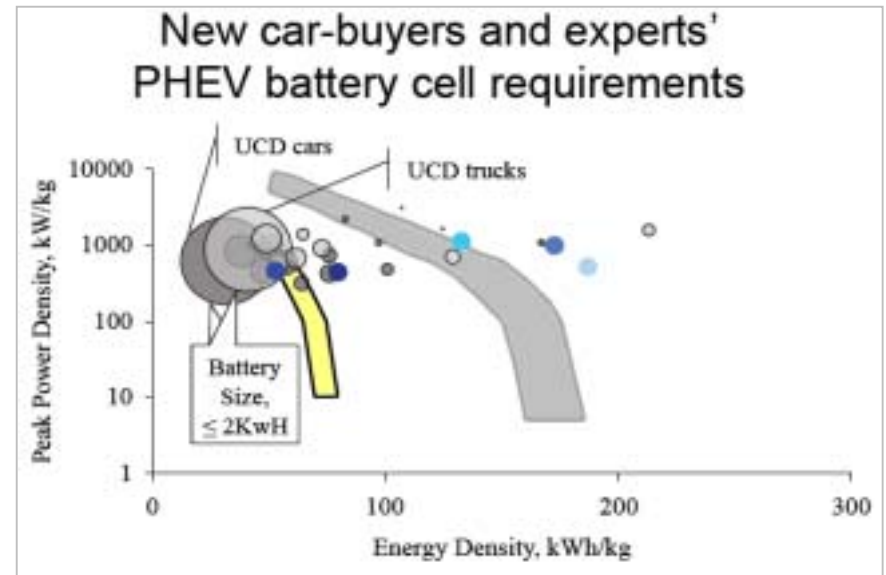
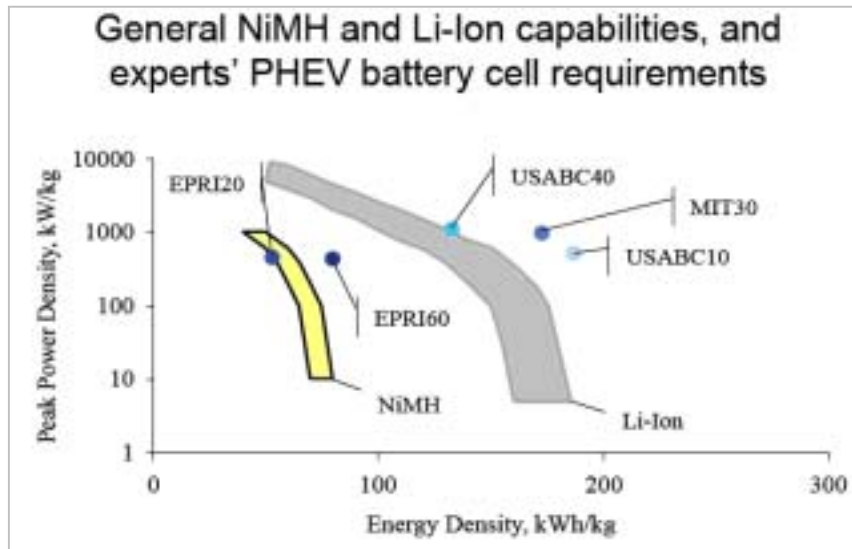


# Challenges with all Li-ion chemistries

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- Cost
  - ~US\$1,000/kWh. Needs to be reduced by 2x-3x
- Durability
  - Increasing available energy reduces life of most chemistries, impact of HEV/PHEV cycles unknown
- Directions
  - Near-term, existing HEV technologies will be re-engineered for 10-mile (16-km) electric range PHEV.
  - Intermediate-term, new high-capacity materials and electrolytes stable up to 5 V
  - Need to increase cell energy densities by 50% to 100% to meet system weight and volume targets for 40-mile (64-km) electric range PHEV.

# Is the industry overdesigning given customer requirements?



Ken Kurani *et al.*, UC Davis Plug-in Hybrid Electric Vehicle Research Center

What should the role of policy be?

# Sample Technology ‘Black Swans’

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- Renewable hydrocarbon fuels
- New H<sub>2</sub> production method (e.g. Roach *et al. Science* on the geometry of Al clusters for water-splitting to produce hydrogen at room-temperature)
- Energy storage breakthrough

# Conditions for market success for new technologies

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## 1. Adds value

The new technology must be stable, must offer advantages not provided by what it is displacing, and must be competitive in traditional areas of evaluation. In cases where the advantage is quantified (e.g., lifecycle greenhouse gas emissions), the metrics and boundary conditions should be stable and consistent.

## 2. Infrastructure must be ready

More than alt fuel production, delivery and dispensing infrastructure or charge points to a smart grid. Codes, policies, education, etc. Very much a regional issue in addition to a national one.

## 3. Market conditions or signals encouraging adoption must be consistent

E.g., the price of fuel

Right now, the auto industry can only (mostly) control #1.

# Policies

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- Clean Air Regulations
- Clean Fuel Regulations
- Safety standards
- Fuel Economy Regulations
- Carbon Emission Regulations ←
- Renewable Fuel Standards
- Low Carbon Fuel Standards ←

# Successful Policies for the Auto Industry

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*“To succeed, any policy approach must adhere to three principles: It must inspire industry to pursue innovation aggressively; it must be flexible and performance-based so that industry, not government, picks the winners; and it should take in account all GHG emissions associated with the production, distribution, and use of the fuel, from the source to the vehicle.”*

—Daniel Sperling, UC Davis ITS, California ARB

“Low Carbon Fuel Standards”

*Issues in Science and Technology*, Winter 2009

# Combine Regulation with Fiscal Policies

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*“Fiscal as well as regulatory approaches have a role to play. Alongside the push for new technologies and fuel options through mandatory requirements, fiscal policies can harness market forces to pull efficiency gains in vehicles toward reducing fuel consumption.*

*“...Using incentives to align the interests of transportation consumers with the goals of a policy intervention would improve the effectiveness of regulations placed on smaller groups of industrial actors.*

*“There are numerous opportunities to reduce energy use and emissions along the entire vehicle life-cycle. Policy drivers that influence the choices of manufacturers and consumers can be applied at the time of vehicle design, production, purchase, operation, and retirement. Without addressing these different life-cycle stages, a measure may unintentionally alter the behavior of stakeholders in ways that reduce the effectiveness of policy interventions.”*

*–On the Road in 2035 (MIT)*

# Examples of what governments can contribute

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Government fleet purchasing programs

Incentives for consumer purchases

Consumer education

Support for RD&D for Fuel and Vehicle Tech

Support for LCA Normalization

Performance-based targets for vehicles and fuels (e.g., CO<sub>2</sub>)

Sufficient price on carbon or consistent floor price on fuel

# Tactical vs. Strategic

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- The auto industry is responding tactically and reactively to an economic crisis (survival).
- Auto makers are developing (or revising, or accelerating) strategic product plans—but the auto industry (OEMs and suppliers) does not have a “strategic voice.”
- Very different than a lobbying voice.

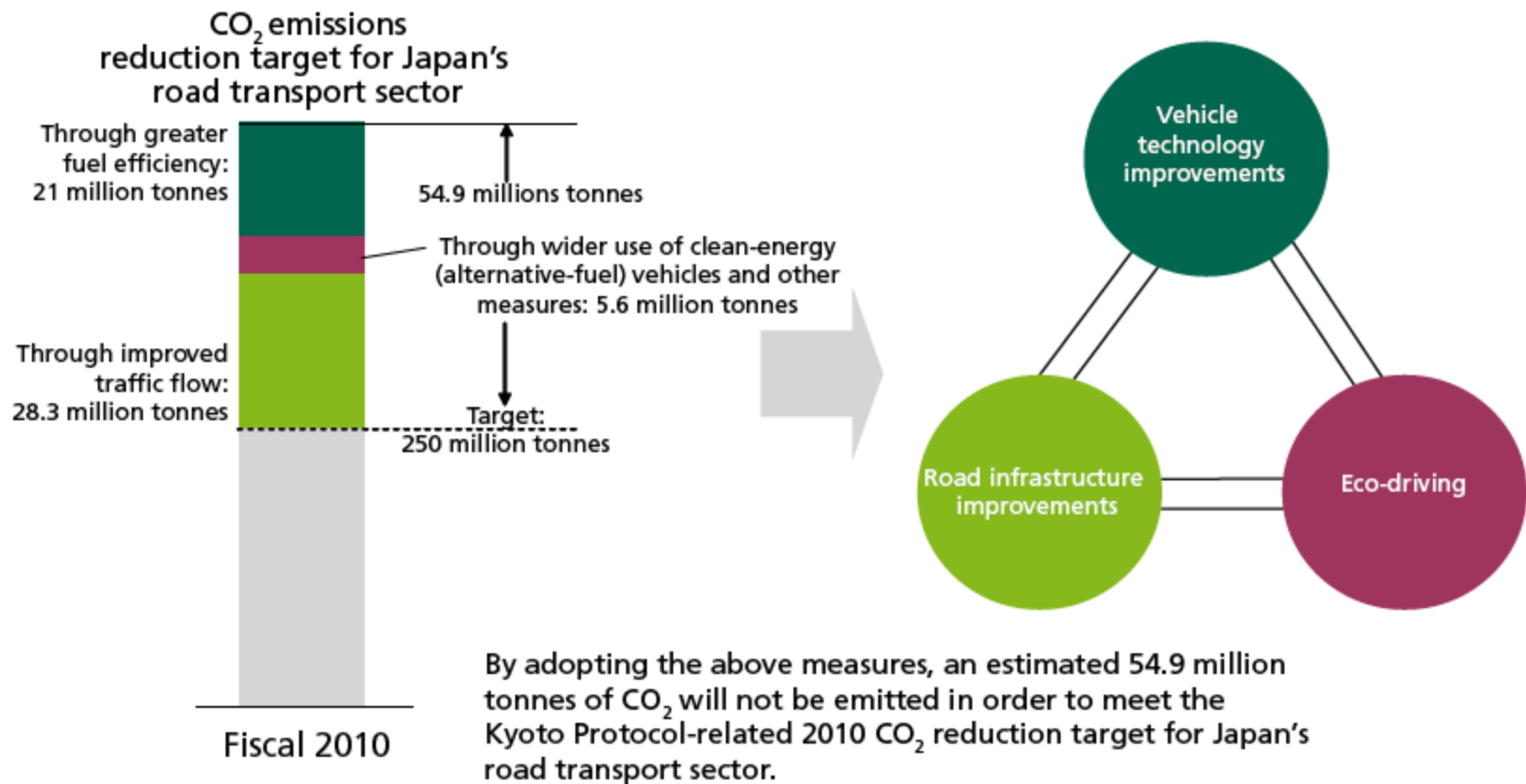
# Role of a “Strategic Voice”

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- Education of critical stakeholders (i.e. customers, funders and regulators)
- Contribution to pro-active Policy Formulation
  - Example of US CAFE vs. California Pavley
- Get in front of the key issues of our time
- A “strategic voice” has to be (and be seen as) an honest voice

# Japan's Three-Legged Approach to Reducing CO<sub>2</sub> from the Transport Sector

An integrated, "three-in-one" approach is required.



# Regional Opportunities

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- Regional markets might offer a more tractable theater for innovation and proof of leadership.
  - California ZEV requirements have initiated some of that
  - Potential for Australia?
- Regional markets can (may) move more rapidly.
- That does not obviate the need for the “strategic voice”, or for outbound education and leadership.

# The auto industry needs to lead

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*“Transport industries should no longer find themselves in the position of beggars for billions of taxpayer’s dollars. Instead, they need to come back into pole position of drivers of economic growth, through the production of smart and efficient cars, trains, ships and planes.*”

*“There is simply no alternative to facing up to the inevitable changes that lie ahead. Climate change is already altering the face of the planet we live on. Disenchantment at the end of the road is not an option.”*

Yvo de Boer, Executive Secretary UNFCCC

*Ministerial Conference on Global Environment and Energy in Transport, January 2009*