UCDAVIS

SUSTAINABLE TRANSPORTATION ENERGY PATHWAYS

An Institute of Transportation Studies Program

Initiating Transitions 2015-2030:

What is required for early alternative fuel/vehicle transitions to succeed?

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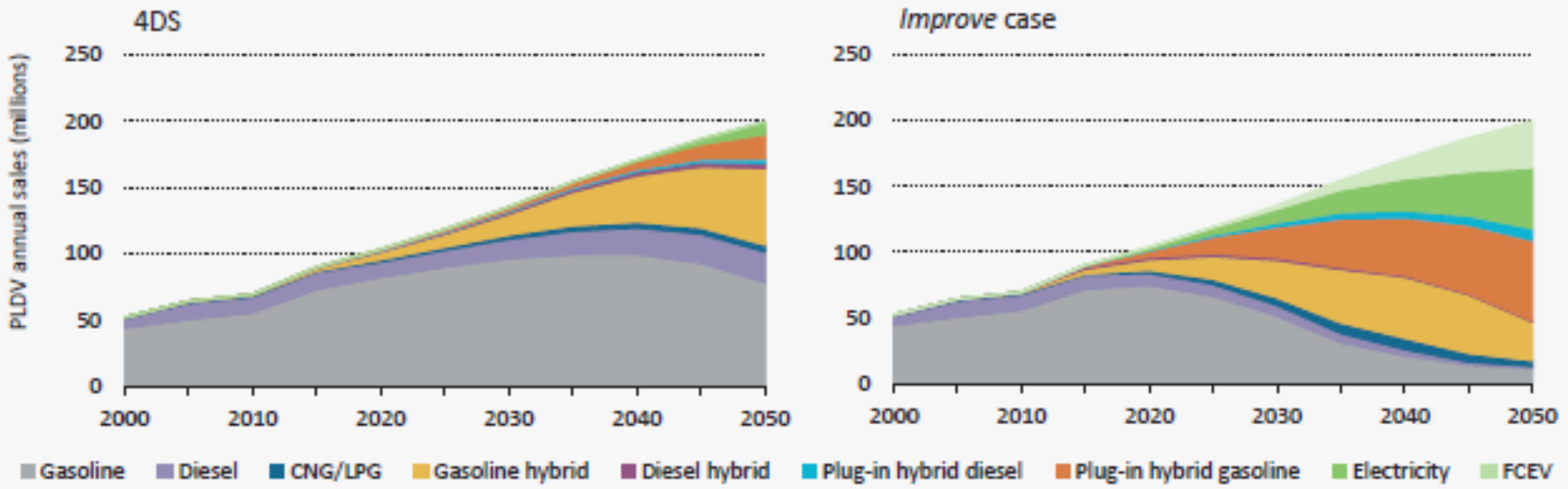
MEETING 2050 GHG REDUCTION GOALS => EFF. LIGHT DUTY SECTOR W/ MAJOR USE OF ELEC. DRIVE (Hybrid, Plug-in EV & H2 Fuel Cell) & LOW CARBON ELECTRICITY AND FUELS

Figure 13.18 Global portfolio of technologies for passenger LDVs



Key point *In the Improve case, electric, PHEV and FCEVs together account for nearly three-quarters of new vehicle sales in 2050.*

Source: IEA Energy Technology Perspectives (2012)

TRANSITION ->SUSTAINABLE TRANSPORTATION => MULTIPLE CHALLENGES + COSTS

- Introduce new types of vehicles
- Modify existing or build new fuel infrastructures
  - Portfolio approach => more than one future fuel
  - Develop low carbon primary supply
- Fuel/vehicle pathway face different challenges: all take time, investment
  - Buy-down cost of new types of vehicles
  - Build new fuel infrastructures

STEPS 3: Understanding Critical Transition Dynamics for Sustainable Transportation

Four Key Research Areas:

1. Initiating Transitions 2015-2030
2. Future of Fuels and the Oil & Gas Industry
3. Global Urban Sustainable Transport (GUSTo)
4. Modeling Analysis, Verification, Regulatory and International Comparisons (MAVRIC)

EARLY TRANSITION QUESTIONS

- Actions over the next 10-15 years will be critical to launching alt fuel pathways. New types of stakeholder coordination required

QUESTIONS:

- How will vehicle markets develop?
- How much does it cost to initiate various fuel/vehicle pathways?
  - to reach breakeven "competitiveness" with incumbents
- Can we afford to build more than one transport fuel infrastructure (e.g. biofuels + electricity + H2)?
- Can we leverage existing infrastructure?
- How do long term costs and benefits compare to BAU (energy system without transition)?
- What kinds of policies are needed to support early transition?

BACK TO BASICS: SOME THOUGHTS ON TRANSITIONS

In March 2015

I won an academic writing fellowship at the Bellagio Institute on Lake Como to study "Transportation Transitions"

GOALS: Review insights from recent studies of energy transitions; examine implications for a future transition to low carbon transportation.

3 robust attributes of past energy transitions
(Grubler et al 1999)

1) reductions in cost and improvements in performance through learning

2) patterns of dynamic competition among technologies

3) co-evolution of long lived infrastructures and technological clusters due to network effects – externalities and synergisms that make it costly for any single component to be incompatible with the whole.

Historically energy transitions are slow, but there are factors that can affect the rate of change. (Grubler 2012)

- **Scale or market size**. It is more difficult to transform a large market than a small system.
- **Infrastructure needs.** The more complex and infrastructure intensive the technology system, the slower the change.
- **Uncertainty** about policy and technology can lead to risk averse behavior.
- **Preexistence of niche markets** offering an early test bed for experimentation can help speed technology adoption
- **Comparative advantage across multiple dimensions can encourage transitions.**

End use innovation is major driver of energy transitions. *(e,g. consumer adoption of new types of vehicles)*

- **Sometimes new energy end-use technologies get adopted for reasons not emergent from traditional economic analysis.** *(For example, the desire for high-tech, green, petroleum free cars.)*
- **Potentials for new technology hinge on corresponding institutional and organizational changes** *(including new infrastructure and policies to support transitions).*
- **Consumers are where the transition starts**

Current barriers to consumer adoption of ZEVs include

- First cost of vehicles
- Technical barriers
- Fuel infrastructure availability
- Risk aversion to an unfamiliar new technology
- Availability of different styles and models

Consumer interest necessary but not sufficient for Alt Fueled Vehicles., Coord. needed among all stakeholders

- Coordination among all stakeholders is crucial to nurture very early market growth *(automakers, consumers, energy suppliers, policymakers/regulators).*
  - *e.g. through public private partnerships*
- Desirable to find a business case (within a reasonable time frame) or/and durable incentives so all the actors will play from the beginning.
- For successful transition need both the vehicles and fuels in the right place at the right tine with good policy support.

Stages in successful scale up of energy technology systems

- Extended period of experimentation and learning
- Scale up at the unit level realizing scale effects. Scale up at industry level, sell many and larger units in core markets. Often industry consolidates at this point. *(maybe seeing this in Battery EVs?)*
- With both unit scale and manufacturing scale and core markets beginning to be saturated, go after rim and peripheral markets.
- Transitions begin on small local scales, evolve into nationwide developments, then become truly global phenomena. (Smil 2010). *(in tune with "lighthouse city or regional concept for AFVs).*

Each stage takes time.

- Don’t short cut the extended period of experimentation and learning needed.
- Should resist pressure to go big early. Many failures happen due to premature scale up. Argues against “Manhattan Project” type moves on energy system

An unprecedented rate of change ahead?

"Energy history cautions against bold moves that might be feasible in cost insensitive sectors such as military and space,. But not in a sector where new technologies need to find many customers and applications and which requires a decades long process of experimentation, debugging and learning before scaling up should be attempted. " (Grubler et al. 2012)

BUT meeting 2050 goals to reduce GHG emissions requires rapid transformation of energy system beginning now.

STEPS 3 PROJECTS ADDRESS CRITICAL QUESTIONS FOR INITIATING TRANSITIONS 2015-2030

STEPS Scenario Model for Alternative Fuel Adoption in the U.S.
PEV Transitions: ”What is required for early alternative fuel/vehicle transitions to succeed?”
PEV Consumer Studies
Lifecycle Cost Models: (1. Advanced Liquid Fuel Vehicles and Hybrids, 2. Transitions to gaseous fuels-natural gas and hydrogen, 3. Transitions to Plug-in vehicles - EVs and PHEVs)
Hydrogen Infrastructure for LDVs (regional and national level)
Spatial Consumer Choice & Infrastructure: Modeling &analyzing near term transitions to alt. fueled vehicles using a spatial regional consumer choice and fueling infrastructure model
Many other projects also relevant to initiating early markets.

DISCUSSION QUESTIONS; INITIATING TRANSITIONS 2015-2030 What do we do in near term?

MOTIVATING RESEARCH QUESTIONS

- How will early vehicle markets develop?
- How do we better understand decisions, stakeholder interactions
- How much does it cost to launch various fuel/vehicle pathways?
- What do near term actions mean for meeting long term GHG goals?
- What are costs and benefits of portfolio strategies over tine?
  - Can we afford to build more than one transport fuel infrastructure (e.g. biofuels + electricity + H2)?
  - Can we leverage existing infrastructure?
- What kinds of policies are needed to support early transition?

WHAT KINDS OF "EARLY TRANSITION" ANALYSIS AND STUDIES ARE MOST VALUABLE?

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