

Towards a Policy Framework for Transportation's Energy Transition

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January 29, 2010



How're we gonna do that?

“Thus, the policy task may be less to promote zero carbon technologies from the laboratory bench to the market and more to explore ways to ensure that **network effects** enhance rather than bar those low-carbon technologies that on their own will become innovations and commercialized in niche markets.”
Grübler, Nakićenović and Victor (1999).

Emphasis added.

Why a “policy framework”?

- Transitioning transportation to a new energy source to accomplish “public goods” is unprecedented.
 - Greenhouse Gas Mitigation
 - Oil Independence
 - Sustainable Energy
- Natural market barriers appear to be sufficient to prevent a “free market” transition.
- Technologies and energy markets are **uncertain**.
 - Electricity?
 - Hydrogen?
 - Biofuels?

What are the “natural market barriers”?

- ❖ **Need for technological advances**
- ❖ Learning by doing
- ❖ Scale economies
- ❖ Resistance to novel technologies
- ❖ Lack of diversity of choice
- ❖ Chicken or egg?
 - ❖ Lack of fuel availability
 - ❖ Lack of vehicles to use new fuel

The natural market barriers are costs, but looked at from another perspective they are *positive externalities*.

“In economics and business, a **network effect** (also called **network externality**) is the effect that one user of a good or service has on the value of that product to other people. When a network effect is present, the value of a product or service increases as more people use it.”

http://en.wikipedia.org/wiki/Network_effect

Network externalities are the effects on a user of a product or service of others using the same or compatible products or services. Positive network externalities exist if the benefits are an increasing function of the number of other users. Negative network externalities exist if the benefits are a decreasing function of the number of other users.

http://economics.about.com/cs/economicsglossary/g/network_ex.htm

Step 1 is to determine whether the societal goal is worth achieving.

- ❖ In terms of the *net present value* of the transition:
 - ❖ Private benefits $>$ Private costs ?
 - ❖ Short run, yes
 - ❖ Long run, ?
 - ❖ Public goods benefits $>$ Public goods costs ?
 - ❖ Is the net present societal value of transition $>$ net present societal value of no transition?
- ❖ What about uncertainty of technological progress?

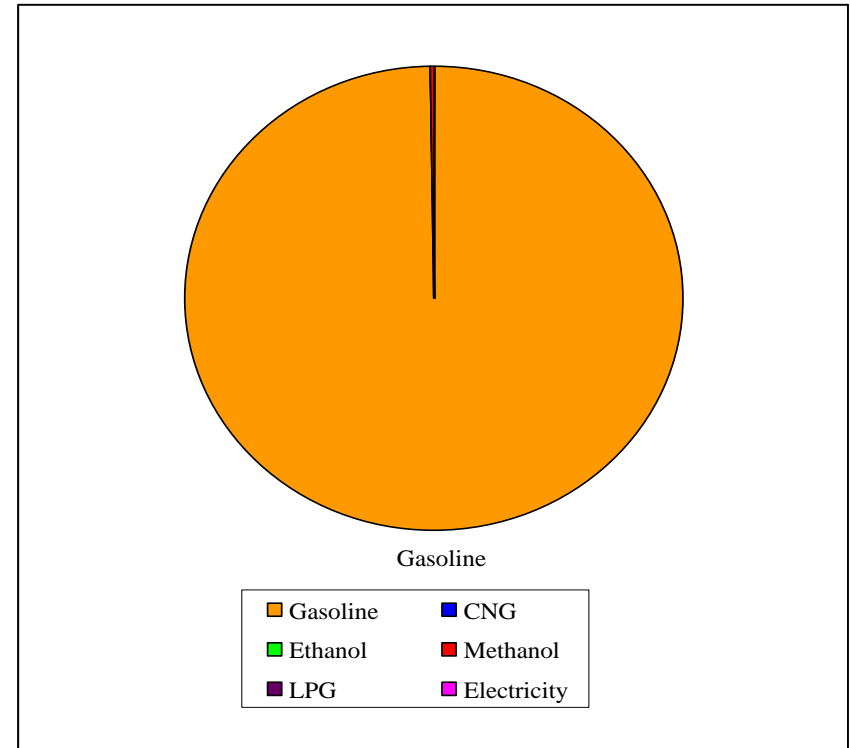
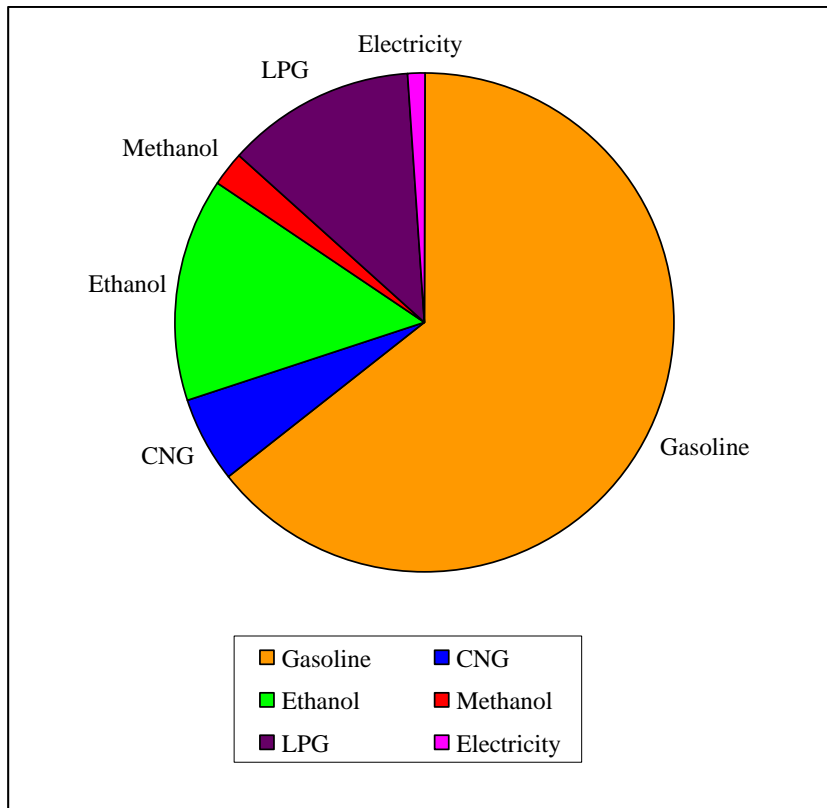
How big are the external benefits?

- ❖ Based on the NRC 2009 study of “maximum practicable” hydrogen fuel cell vehicles study.
 - ❖ Rough estimation based on figures 6.32 and 6.33:
 - ❖ Approx. 20 Gigatons cumulative CO₂ reduction by 2050
 - ❖ Approx. 50 billion barrels of reduced petroleum consumption
 - ❖ Converting to dollars & *undiscounted*:
 - ❖ CO₂ at \$50/ton → \$1 Trillion
 - ❖ Oil security at \$20/bbl → \$1 Trillion
- ❖ **Very roughly**, estimated cost of efficiently compensating for transition costs is on the order of 2-5% of estimated of public benefits.

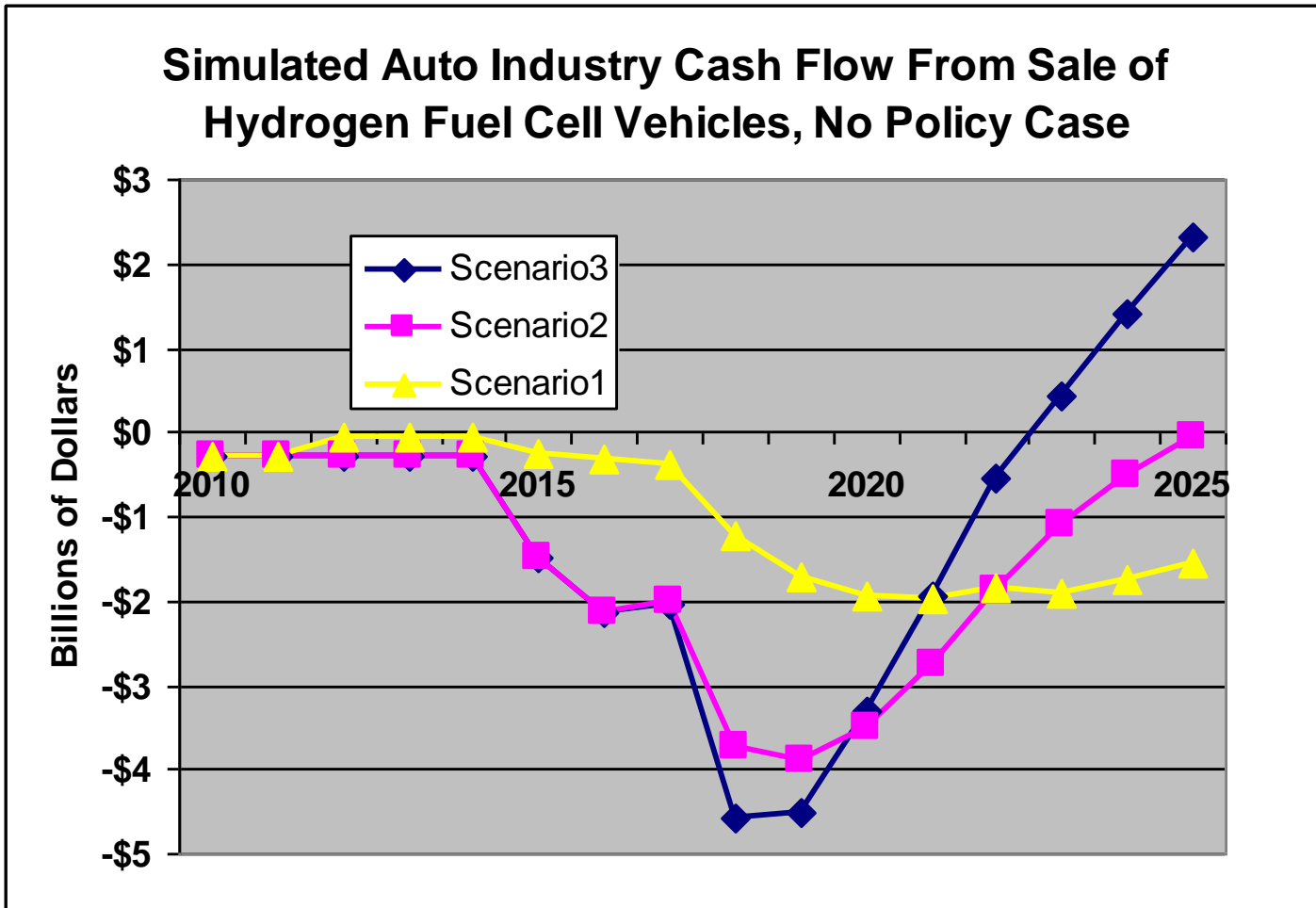
Natural market barriers to a fuel transition are very significant.

No transition barriers
AFTM 1997

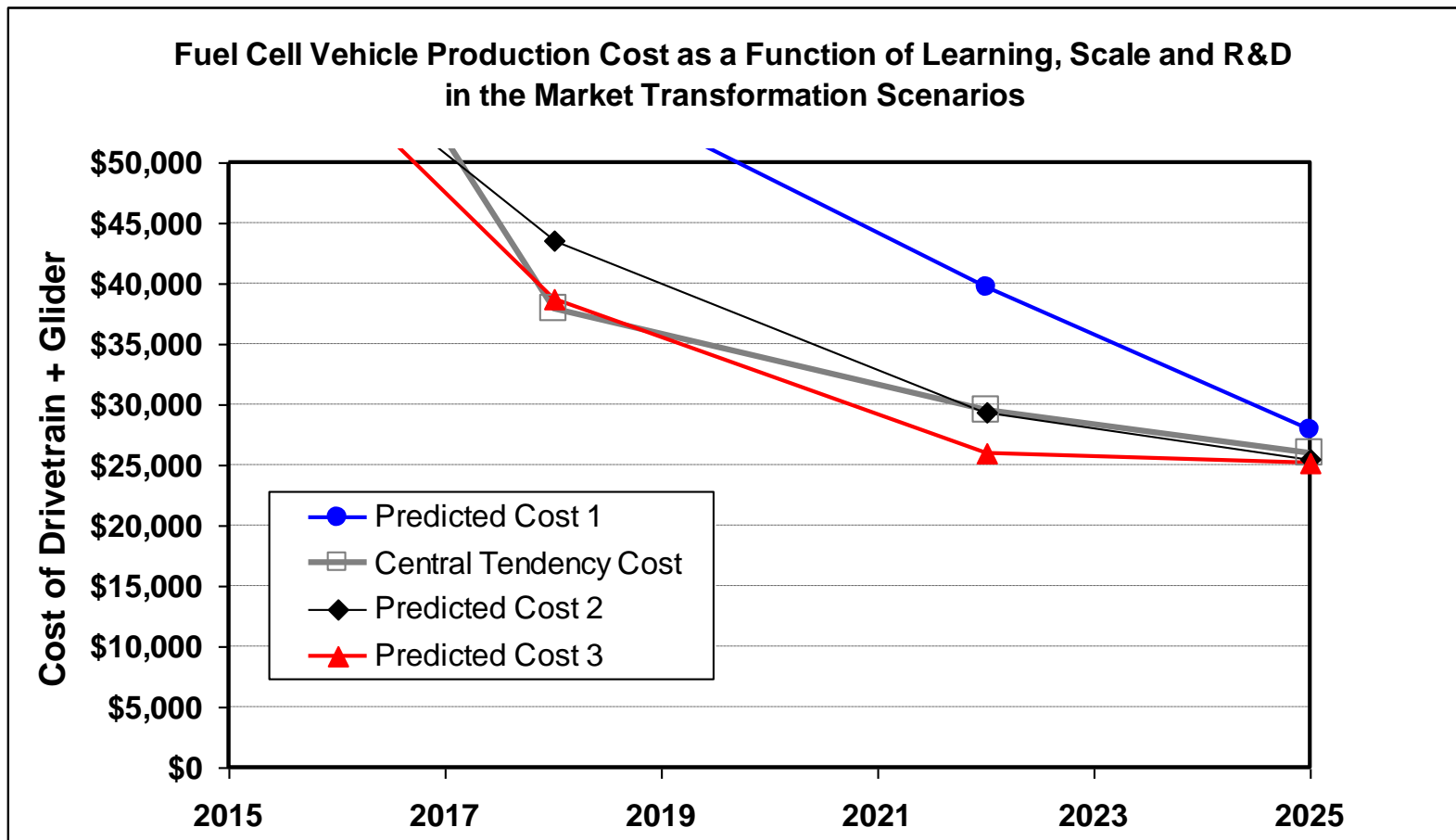
Transition barriers
TAFV 2001



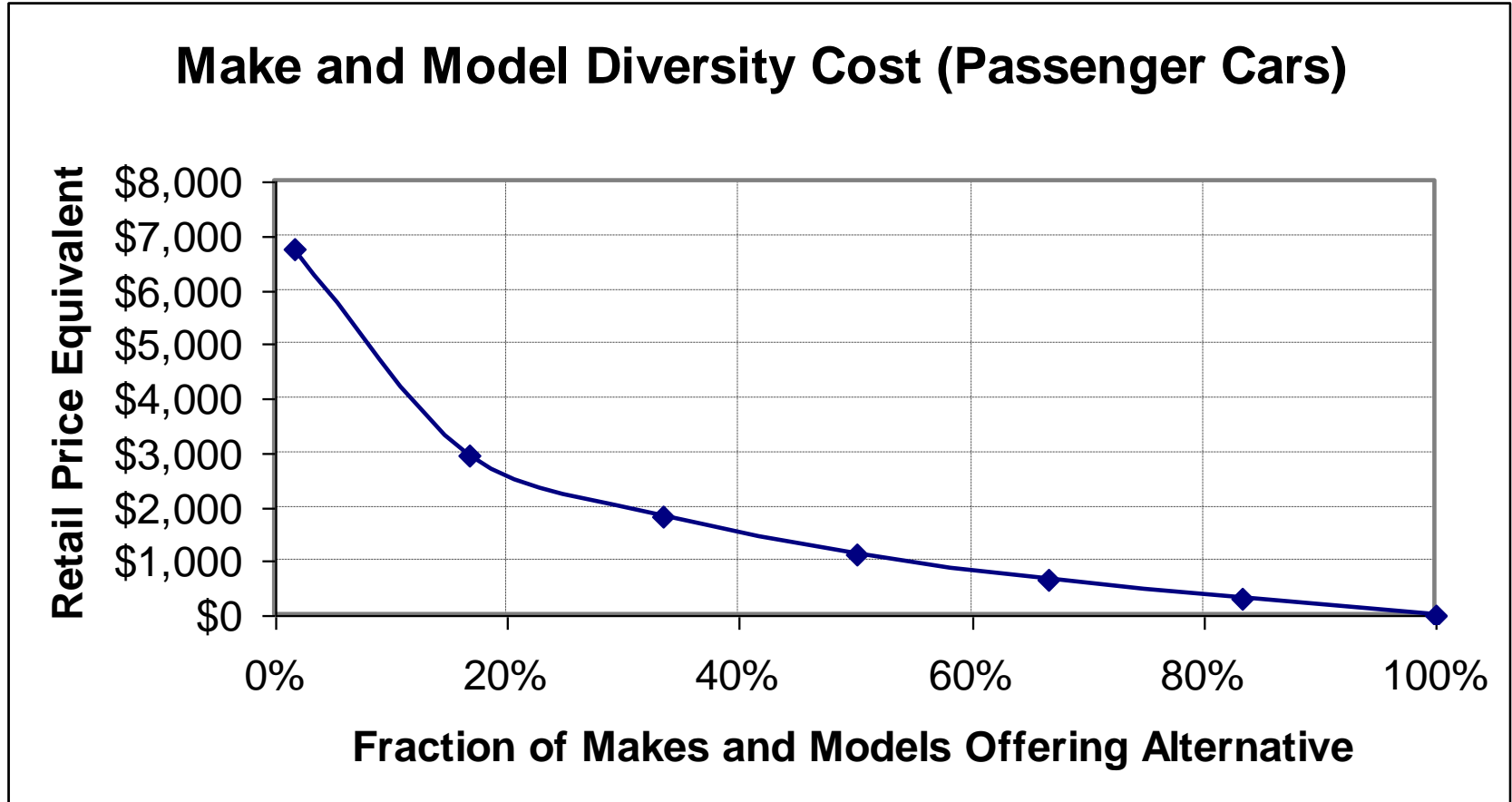
The transition's extended period of negative cash flow can make the transition's private NPV unattractive.



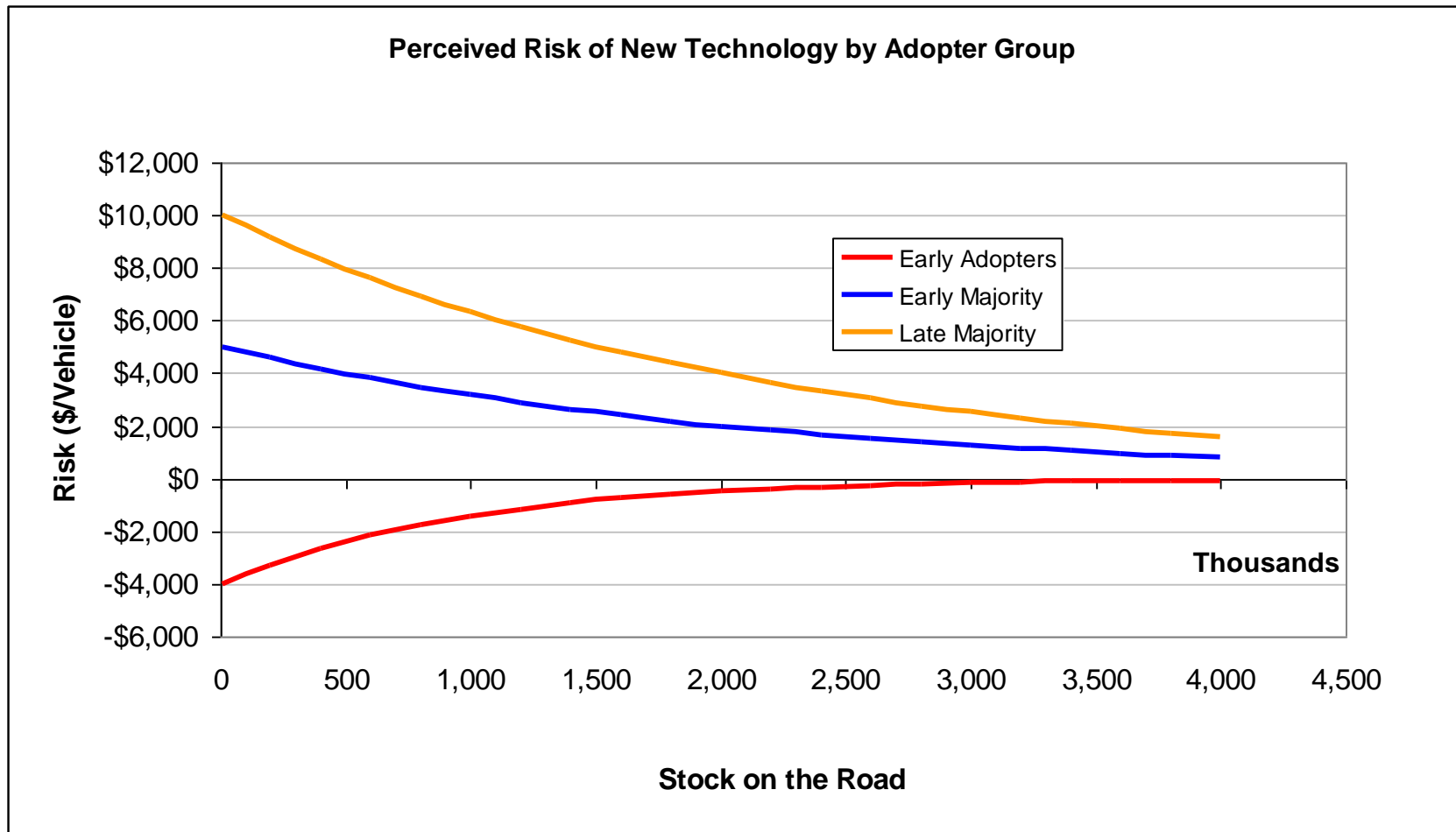
Some of the costs can only be reduced by learning by doing and scale economies. Someone must pay for the initial excess costs.



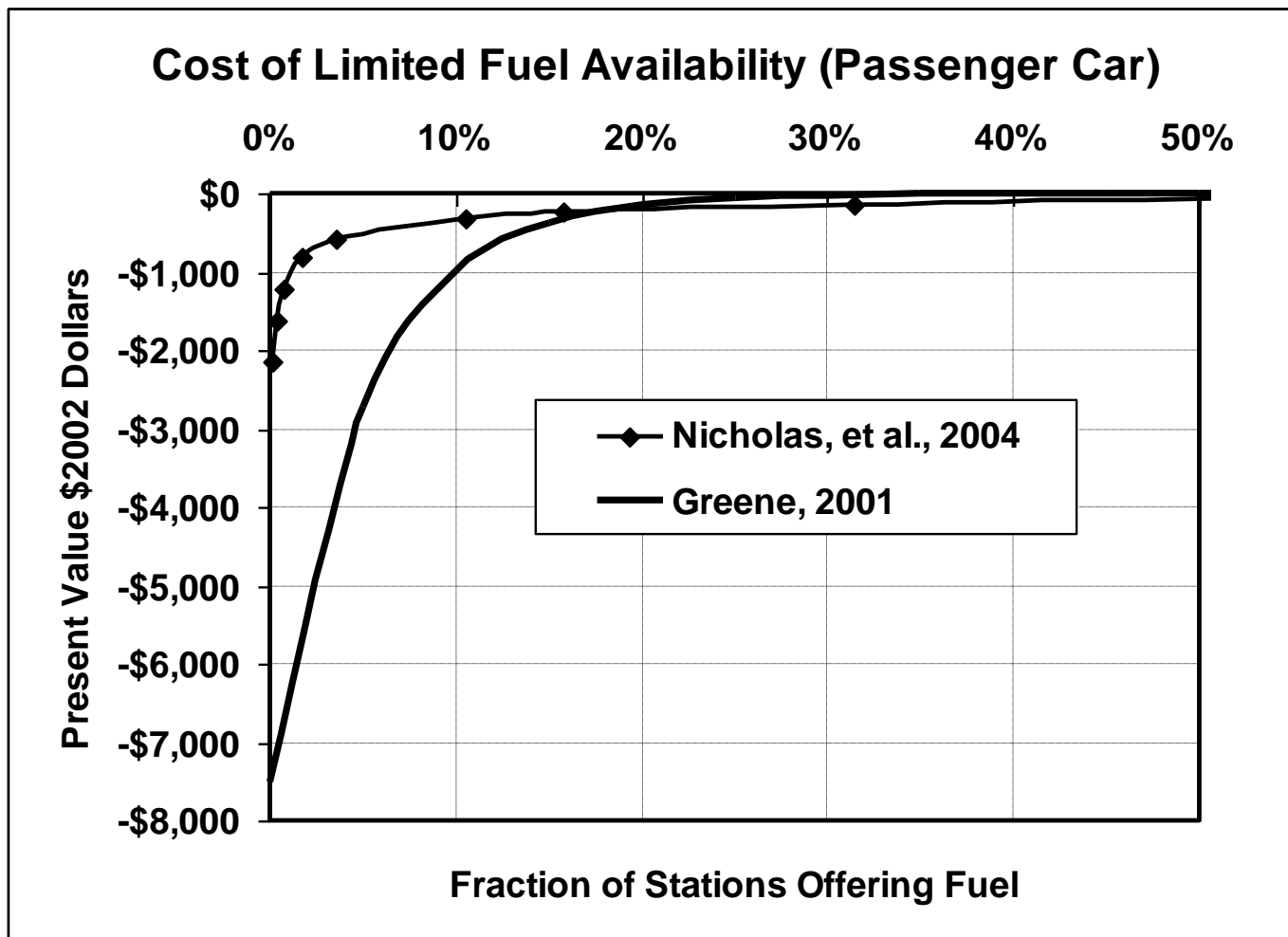
Lack of choice diversity decreases the chance that a given consumer will choose an advanced technology vehicle, and that can be translated into an equivalent price effect. Increased sales lead to greater diversity.



Early adopters reduce the risks of novel technologies for later adopters but reduce the value for their own group. The net effect is a positive externality.

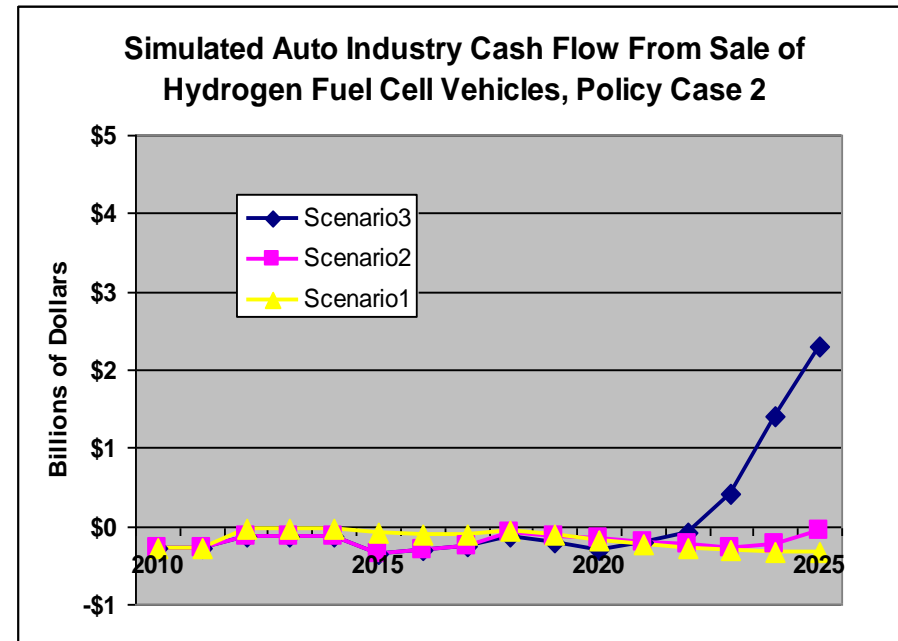
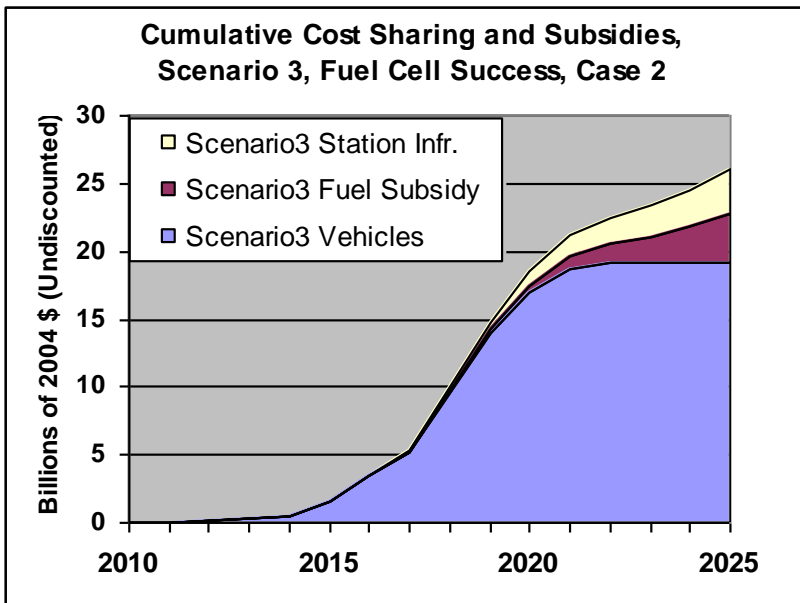
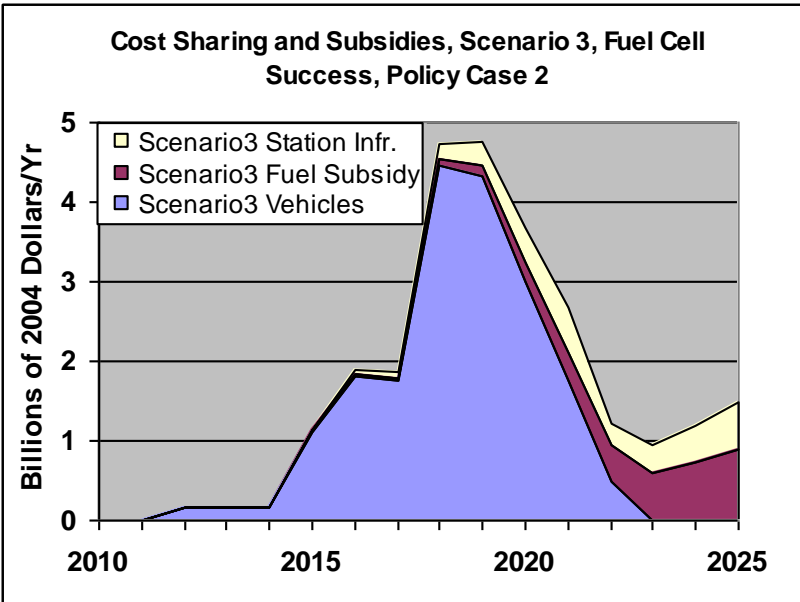


Adding refueling stations increases the value of alternative fuel vehicles to potential buyers. Adding vehicles increases the value of existing stations.



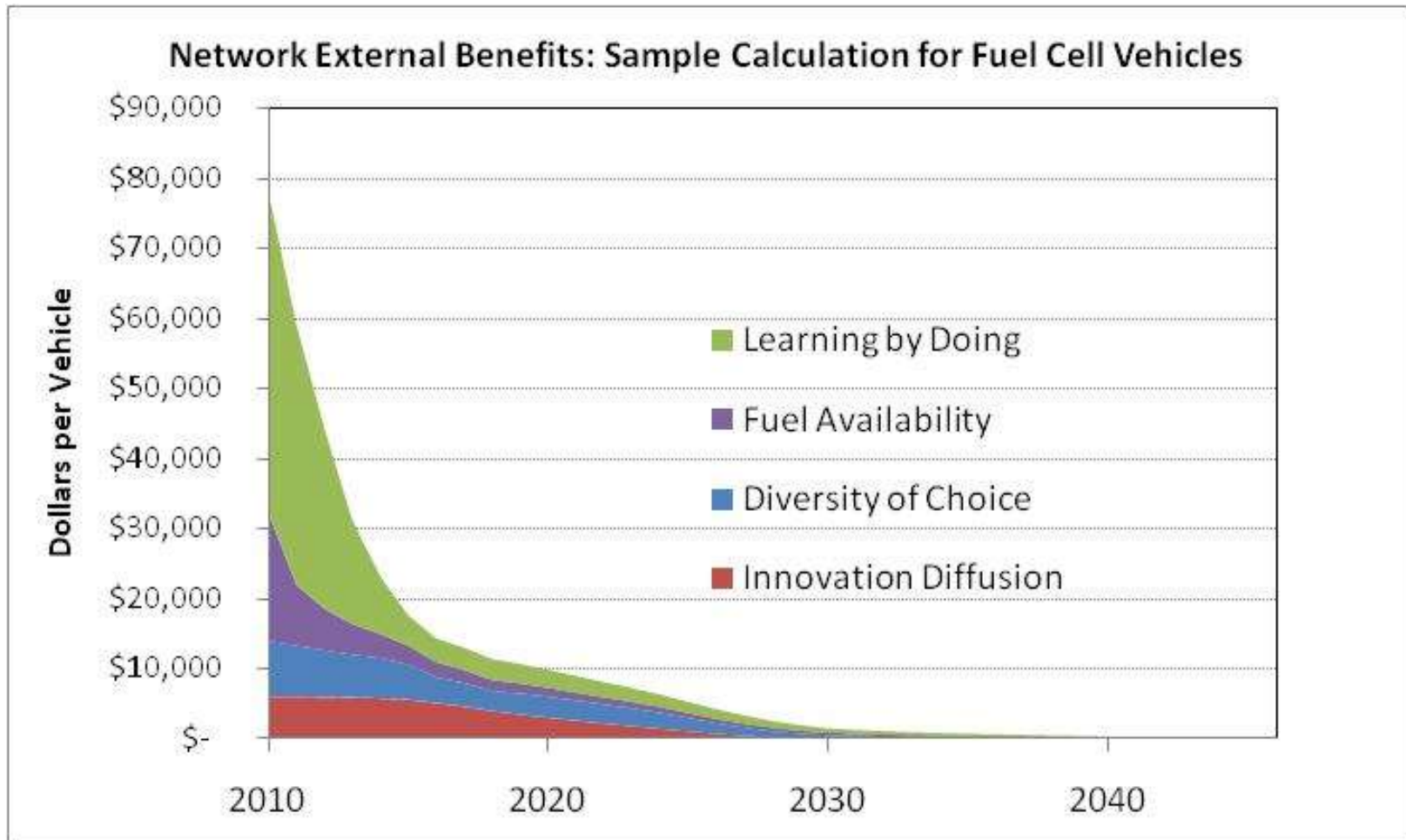
It appears that the transition costs may not be large from a societal perspective. DOE's hydrogen study estimated \$25-40B. NRC estimated \$55B. Both assumed success in meeting tech goals.

These are not total costs. NAS estimated H2 infrastructure cost alone at \$400B.

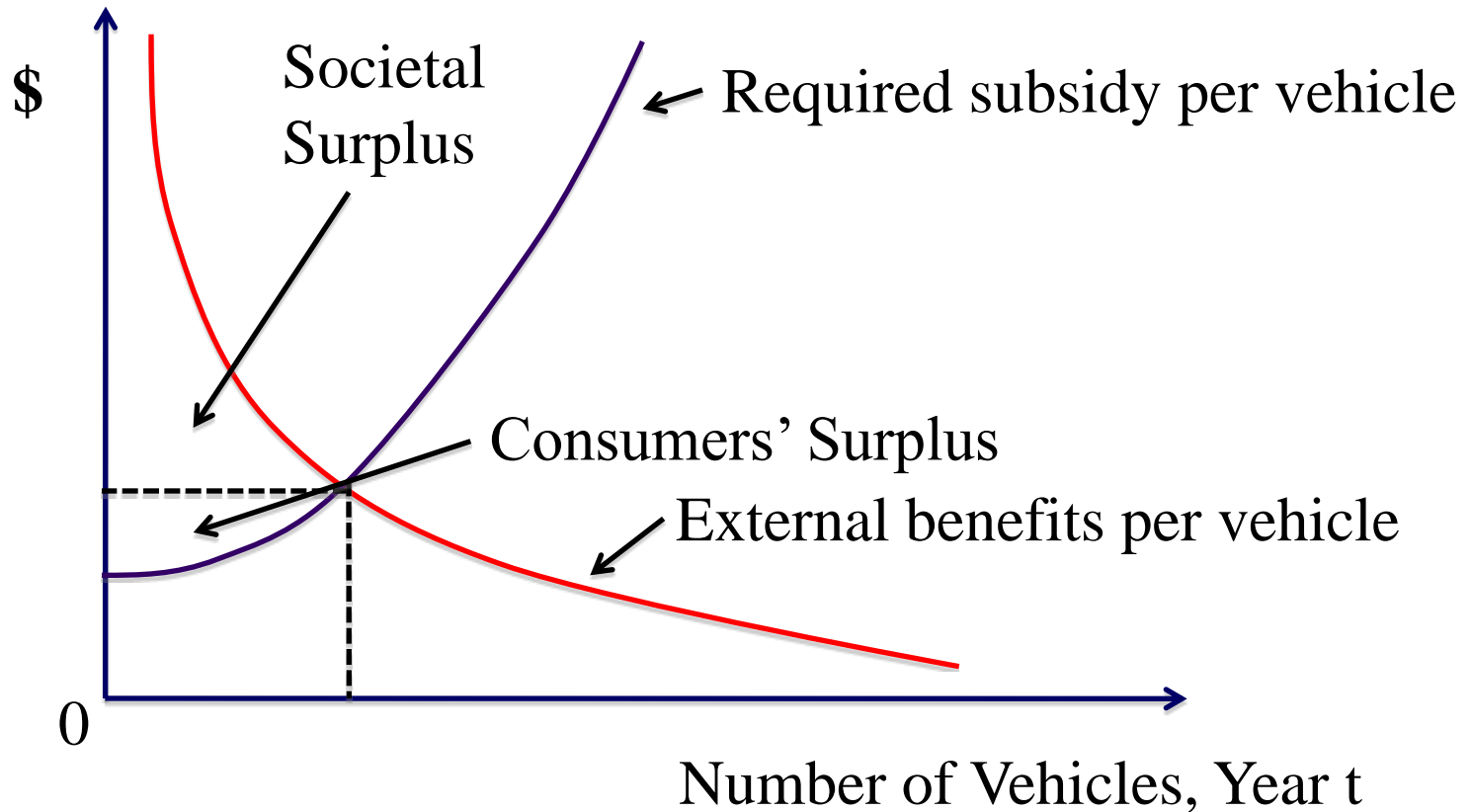


THIS SLIDE IS ENTIRELY NOTIONAL.

Adding the external benefits yields societal willingness to pay.



In a given year, there is a societal willingness to pay for placing more vehicles in operation and a consumer willingness to accept a vehicle. There is an equilibrium price that provides "surplus" to both.



Who should pay for the transition?

❖ Economic theory of public goods

- ❖ Climate protection, energy security, sustainable energy are clearly public goods
- ❖ No definitive answer based on economic efficiency
- ❖ Alternative principles:
 - ❖ Charge based on willingness to pay
 - ❖ Charge users
 - ❖ "Polluter pays"

❖ Polluters pay options

- ❖ Light-duty vehicle users cross subsidize
- ❖ Pay out of C tax or cap-and-trade revenue

If we are to make a transition to hydrogen or electricity, we will need a policy framework like this to guide our decisions.

❖ **Subsidies**

- ❖ How much?
- ❖ For what/whom?
- ❖ When?
- ❖ Why?
- ❖ From whom to whom?

❖ **Uncertainty must be integrated**

- ❖ Does it change society's willingness to pay?
- ❖ Need robust, adaptive strategy (when to quit?)

THANK YOU.

Focus on the early market transition.

- ❖ Research & Development
 - ❖ Expert assessments
 - ❖ Hedging strategies
 - ❖ Analysts have few other good ideas
- ❖ Demonstration and Niche Market Deployment
 - ❖ Protected, special markets
 - ❖ Very limited numbers
 - ❖ Relatively small investments
- ❖ **Early Market Transition**
 - ❖ Significant market barriers
 - ❖ Potentially large investments
 - ❖ Sustained effort over decade or more
 - ❖ **Uncertain success**

What do you mean, “policy framework?”

- ❖ Policies that are:
 - ❖ Necessary
 - ❖ Economically efficient
 - ❖ Realistic
 - ❖ Coherent
 - ❖ Sustainable
 - ❖ Sufficient
 - ❖ Consistent with other national objectives
 - ❖ Economic growth
 - ❖ Energy security
 - ❖ Environmental protection
 - ❖ Energy sustainability

Though details vary, there seems to be a consensus that fuel availability costs are initially very large and become small beyond 10% availability relative to the current gasoline network.

