Policy Options for Hydrogen Vehicles and Infrastructure

Summary based on NREL Task Order NO. KACX-4-44452-02

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1. Background
2. Study methodology
3. Policy options for early transition
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5. Conclusions

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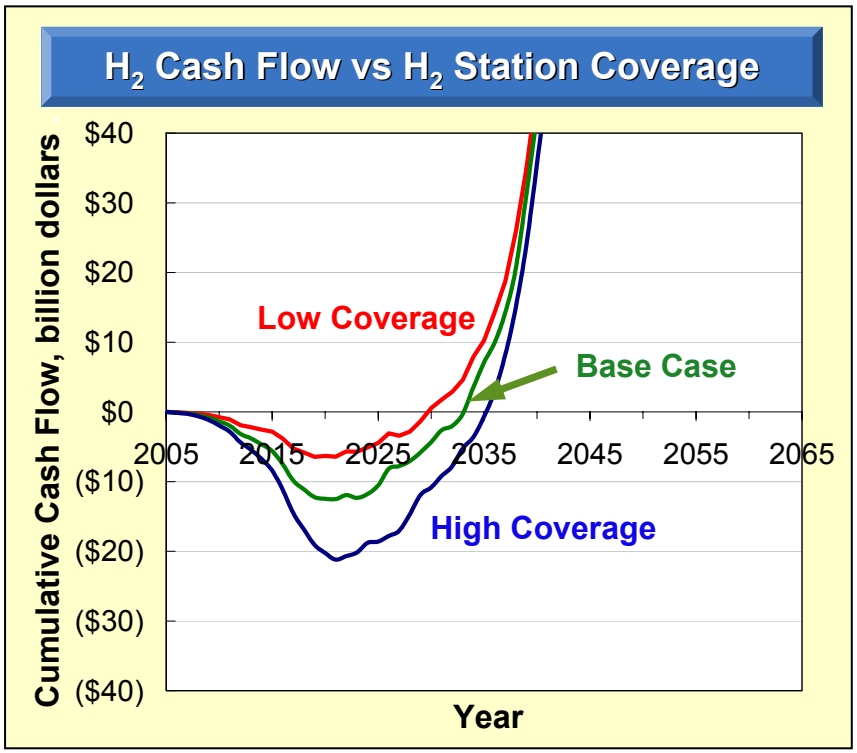
Hydrogen fueled vehicles offer the potential for energy and environmental benefit; however….

- Early introduction costs will be higher than conventional fuels because of low production volumes and learning limited technology evolution
- Vehicle costs may be higher than gasoline vehicles costs even if development goals are met (although improved fuel efficiency could result in more favorable lifecycle costs)
- A hydrogen economy could take another 20 years to evolve without policy support
- The objective of policy support would be to:
  - Reduce financial burden of vehicle and infrastructure during the transition
  - Support H2FCV sales if initial capital costs are higher than gasoline options but still worth the energy and environmental benefits
  - Facilitate safety, customer awareness, and technology adoption

Policies for hydrogen should help manage the investment risk to stakeholders.



The "valley of death" is a challenge to both fuel and vehicle stakeholders.

1. Commercial phase starts 10 years after initial H_2 introduction to each PADD region. 2015 for PADD 5 (West Coast).

Source: TIAX NPV model

- Objective: identify and evaluate policy options to support the introduction of hydrogen vehicles and infrastructure
- Tasks
  - Identify policy options
  - Evaluate options
  - Review analysis with stakeholders

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TIAX evaluated leading policy options that would support the introduction of hydrogen vehicles and infrastructure.

Review Options	Criteria	Policy Metrics
• DOE Scenario Workshop • Brainstorming • Other alternative fuels policy efforts • Legislative initiatives	• Identify a range of options • Fuel, vehicle customer, implementation • Introduction – long term • Carrot – stick • Directed to H2 – neutral	• Identify metric • Assess leakage and competition with other fuels • Evaluate desirability

Pros and Cons

Stakeholder Input

- Interview stakeholders
- Revise pros and cons
- Assess leading policy options

- We identified policy options and examined their strengths weaknesses
- Included innovative aspects and well-known options.
- Next we will consider:
  1. Could it be legislated and implemented?
  2. Does the magnitude of the incentive make a difference?
  3. How would the incentive effect other fuels and industries?

Government policies and incentives cover a wide range of hydrogen implementation needs.

- We analyzed a broad range of leverage points
- Government cost share and tax credits are direct
  - Useful for the program during the transition
  - Well established mechanisms
- In general, easy-to-implement measures are likely to be less effective and less focuses on hydrogen
  - Government fleet requirements appear attractive
  - Such programs tend to get watered down
  - Tax credits/deductions vs direct consumer payment
- Environmentally based fuel neutral options may be more broadly supported than measures targeting hydrogen
  - Important in the commercial period, small $ during transition period
  - Competition from other fuels and energy sectors reduced H2 impact
  - Develop a metric that supports all of the benefits of hydrogen

The leading policy measures cover a range of policy targets.

Type	Target	Measure
Incentives	Fuel	Producer fuel payment Infrastructure support[1] Carbon tax
	Capital costs	50/50 vehicle cost share Consumer tax credit for vehicle Fleet purchase program
Outreach	All	Consumer education
Mandates	Consumer	GHG cap and trade
	Manufacturer	Modified CAFE standards
	Fuel	Renewable H_2 under RFS/RPS

1. Examples include investment tax credits, loan guarantees, tax credits.

The details of each policy measure influence its potential effectiveness and political viability.

The leading policy measures could be implemented in two stages:

Stage	Measure
Early transition (2010-2025)	50/50 vehicle cost share
	Consumer tax credit
	Producer fuel payment
	Renewable H_2 under RFS/RPS
	Fleet purchase program
	Consumer education
Late transition (2025+)	Carbon tax
	Modified CAFE standards
	GHG cap and trade

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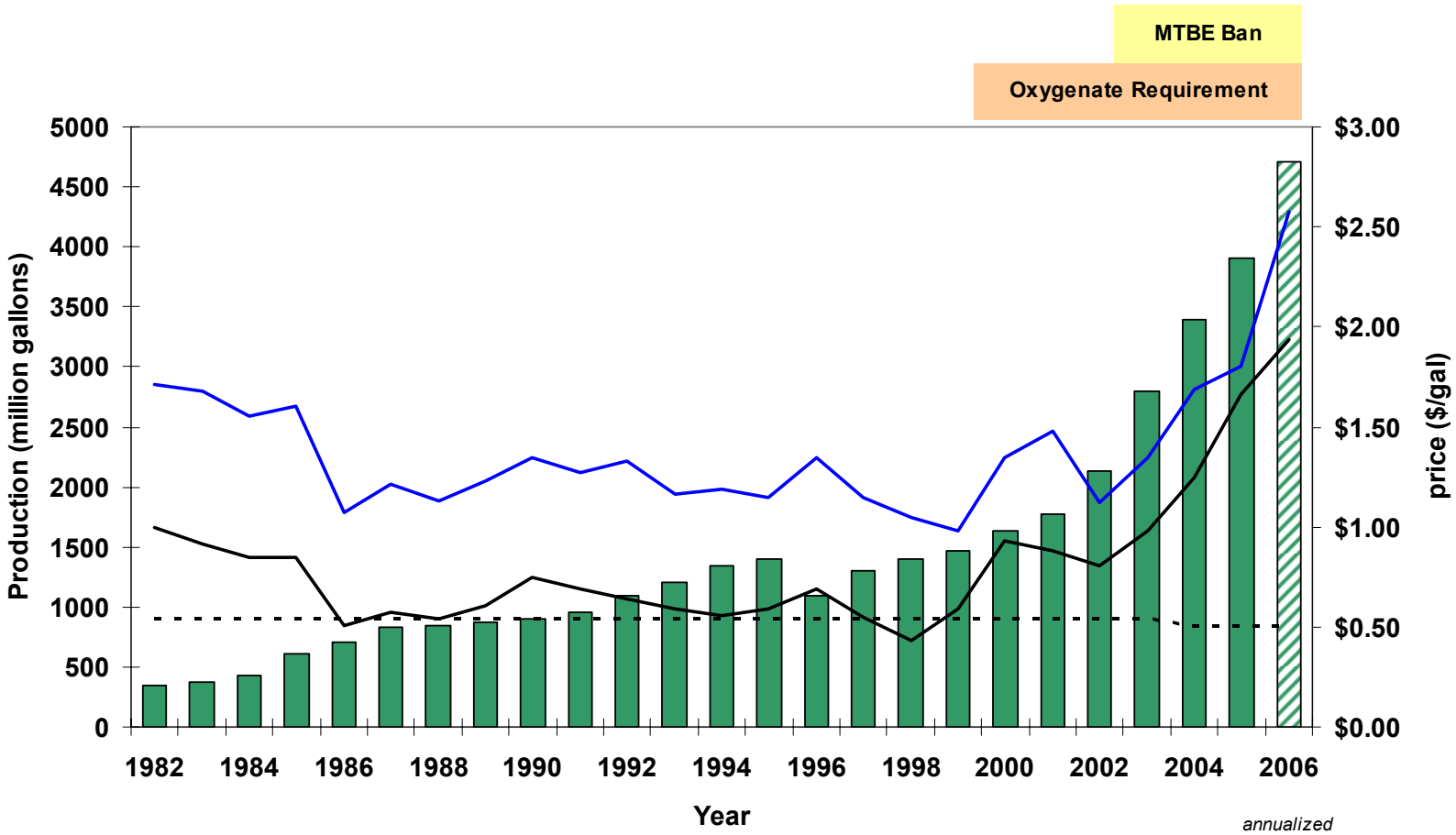
Expand ethanol producer payment to include hydrogen.

- Revise ethanol tax credits to include hydrogen
  - Provide credit in proportion to WTT GHG emissions
  - Make credit dependent on U.S. production (e.g. renewable based hydrogen or CO_2 sequestered in the U.S.)
  - Fund through excise tax on gasoline, with highway trust fund reimbursed for loss of revenue
- Support capital investment in early hydrogen infrastructure
  - Link support to hydrogen sales
- Effects
  - Links program for hydrogen with other U.S. fuel production programs
  - Promotes H2 *production*, not just capacity
  - Provides early revenue source to fuel producers
  - Creates market pull for low CO_2 – H_2 pathways and efficient FCVs

Experience with ethanol suggests that the price of gasoline is an important factor, while government incentives were an important driver.

Ethanol Production versus Fuel Prices, 1982-2006



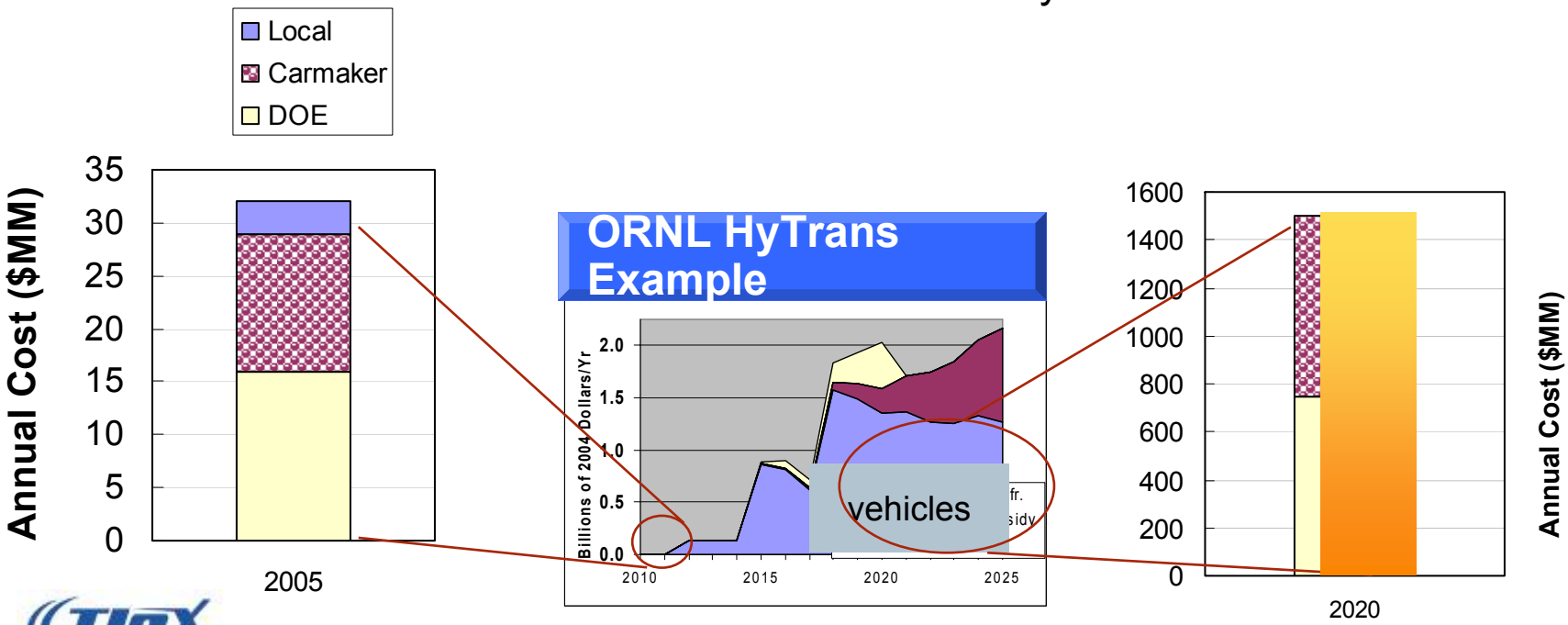
Source: *Renewable Fuels Association, Nebraska Energy Office*

Government cost share of vehicle programs can help cover the cost of vehicles in the near term.

- 50/50 cost share has historically been used to fund vehicle programs
  - Provides a source of funding when FCV costs exceed retail
  - Support participation and funding from state and local agencies
  - Consider phased program for continuity and participation of local funding
- Innovative fleet program participants may be needed
  - 20,000 vehicles per year cannot be placed in traditional fleets
  - Perhaps rental car, travel on government business, Home Depot, etc
  - Carmakers need to demonstrate the type of vehicle sold to the retail customer

Vehicles can cost several billion $ towards the end of the transition.

- 50/50 cost share mechanism is well established
- Cost is significant to carmaker
- Tax credit is well established and does not need to go thought the annual budget process.
- Provide better business case to business and buyer



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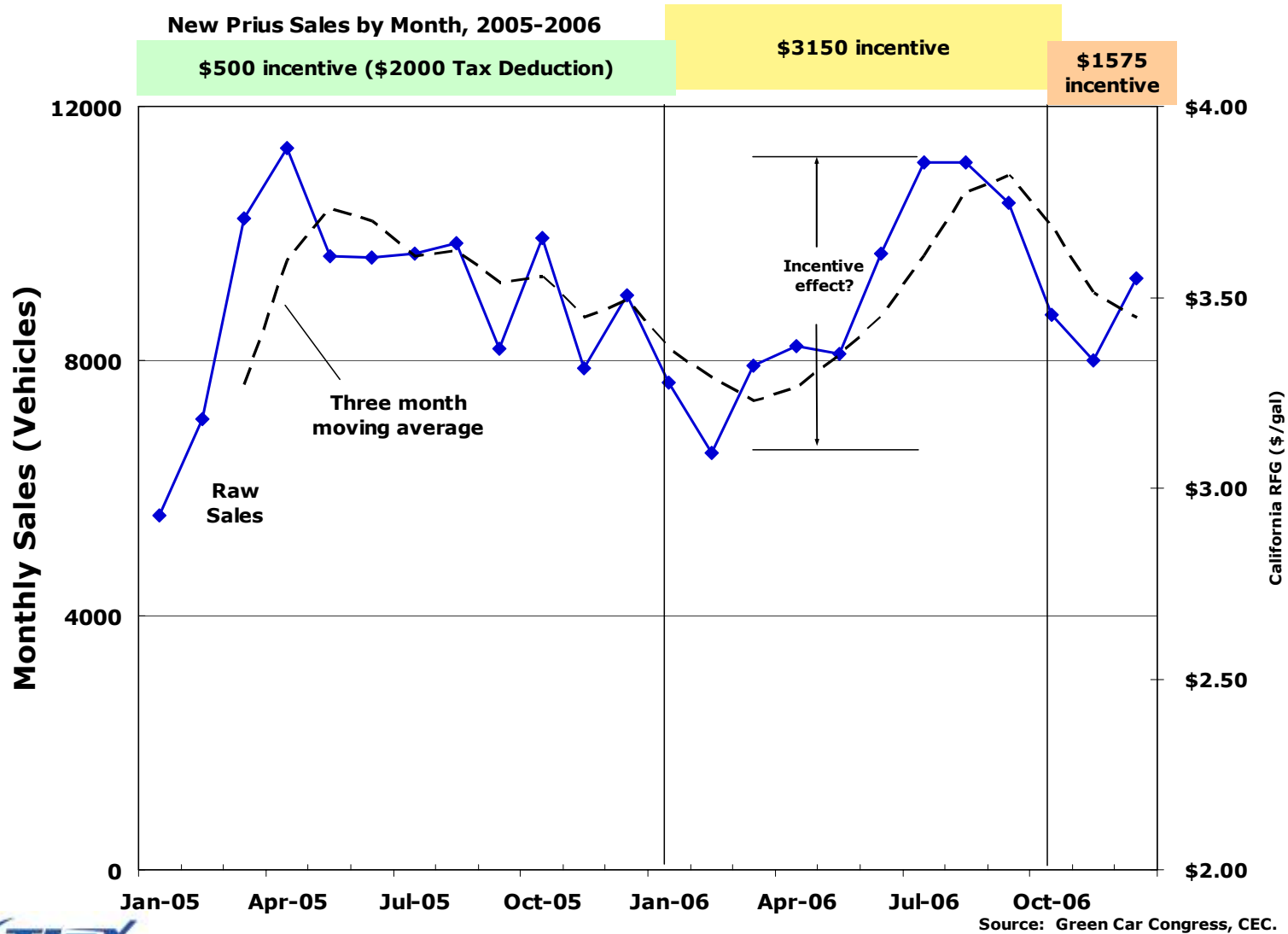
Provide tax credit to purchasers of hydrogen FCVs.

- Credit should be directed towards vehicle with hydrogen attributes
  - up to $10,000 for 100 mi/kg
- Direct payment would be more attractive to consumers at little extra cost to the government, but politics favor tax credit
  - Base credit on WTW GHG, use of renewable energy, U.S. production, etc.
- Effect
  - Creates market pull for H2 FCVs
  - Helps manufacturers to sell more expensive vehicles
  - Some part of incentive lost to “free rider” sales

Effectiveness of the tax credit depends on market conditions.



Source: Green Car Congress, CEC.

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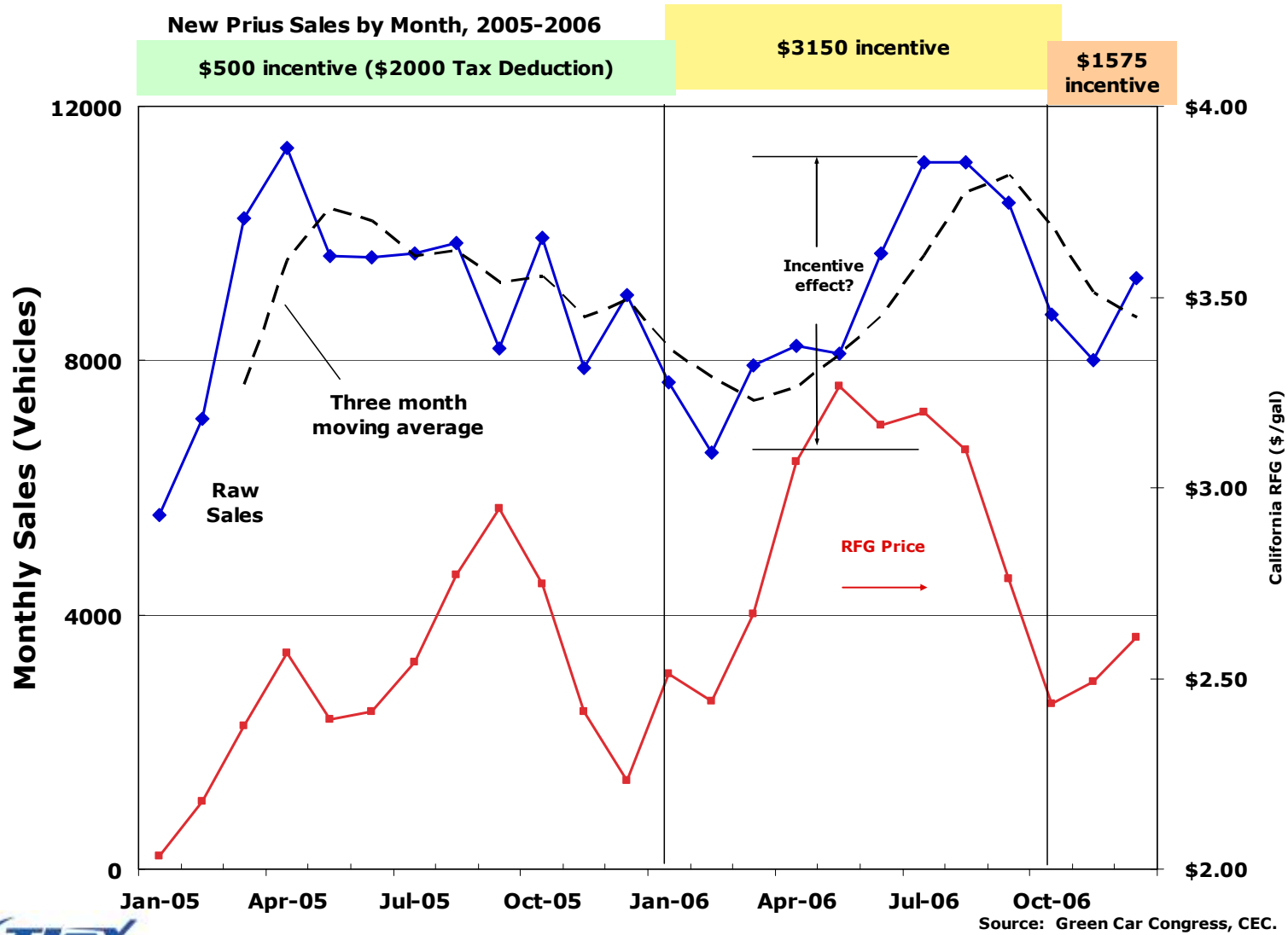
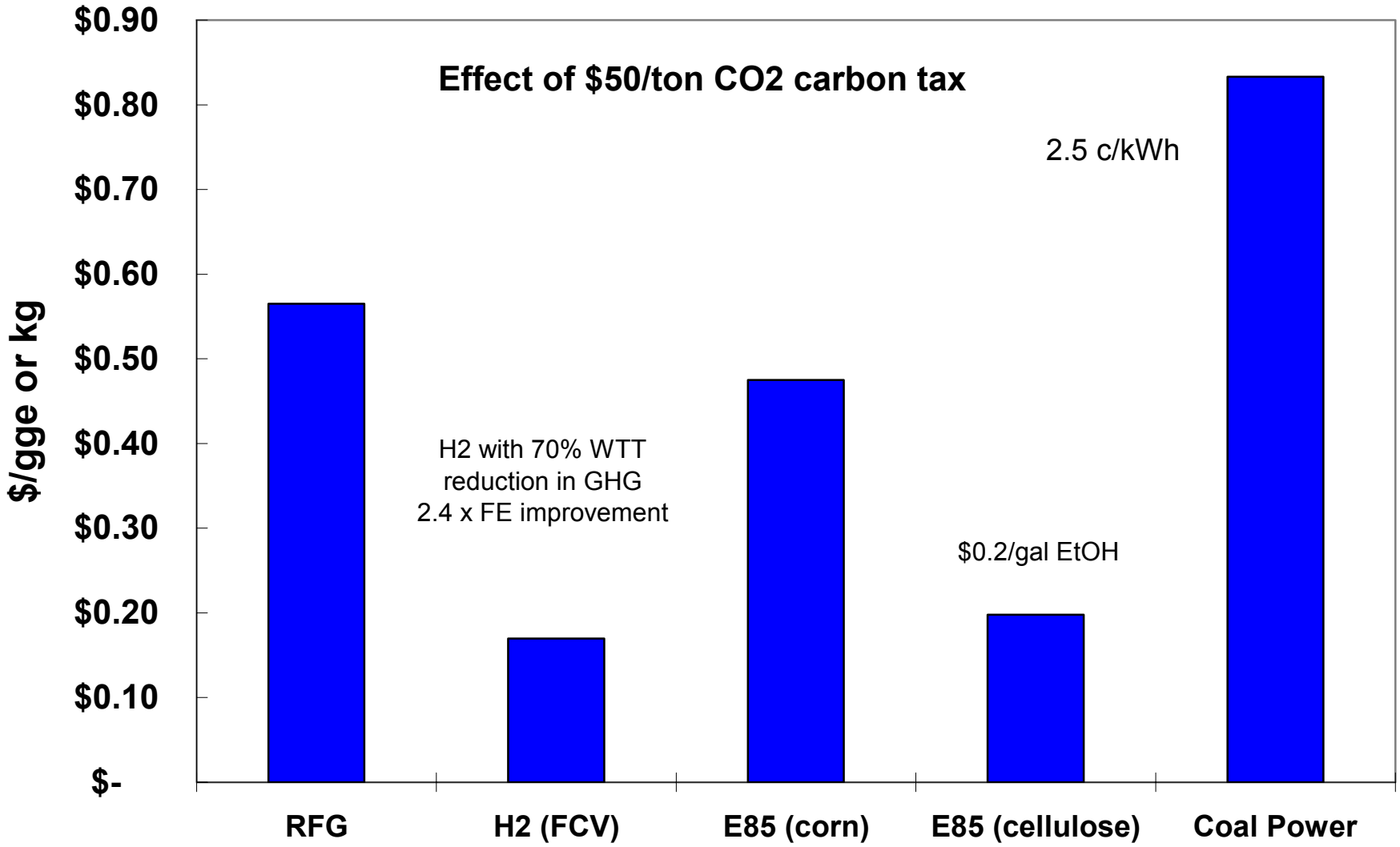


Source: Green Car Congress, CEC.

Revenue neutral carbon tax on energy.

- Tax all primary energy based on non-sequestered, non-biomass carbon content
  - Consider taxing embedded CO_2 of imported products
  - Redistribute tax to affected stakeholders
    1) Equal refund to all U.S. residents over age 18 regardless of driving habits
    2) Tie to other tax reforms to balance concerns about funding non taxpayers
    3) Compensate energy industry for share of lost revenue
- Effect
  - Increases price of fuels with high CO_2 emissions
  - Creates market pull for low CO2 H2 pathways and efficient FCVs

A carbon tax would impact other fuel pathways.

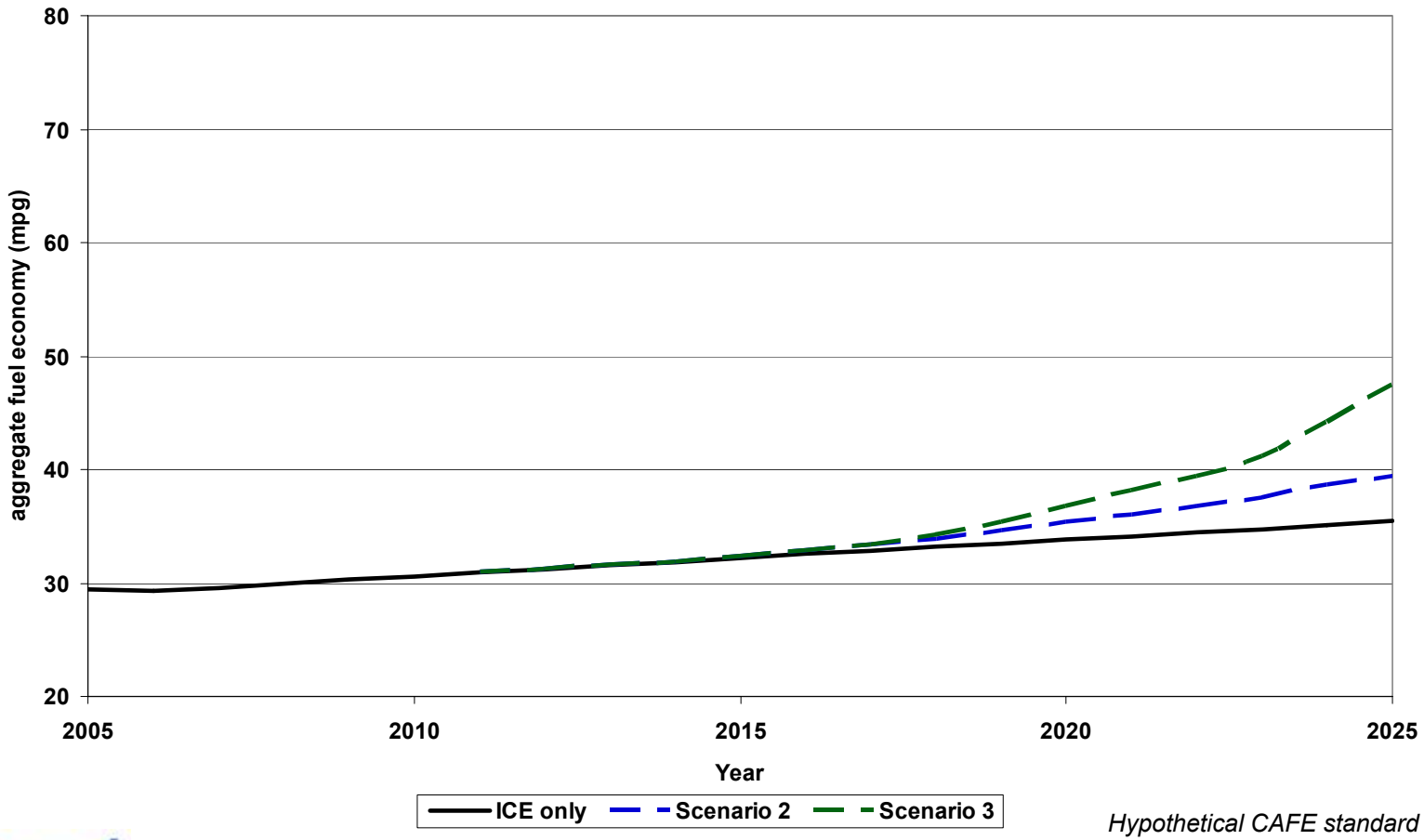


Modify existing CAFE regulations to provide incentive for H2 FCVs

- Use framework of existing regulations as incentive for high efficiency and hydrogen vehicles
  - Provide extra incentive for H2 FCVs with rationale based on low GHG and renewable production (i.e. count 1 kg of hydrogen as 0.1 kg of petroleum)
  - Provide funding to carmakers for anticipated increase in vehicle costs
- Effect
  - Undesirable mandate
  - Economic dislocation
  - Carmaker resistance with and without funding

The introduction of FCVs will impact CAFE standard during the early transition.

CAFE Equivalent Fuel Fconomy for Mid-sized Cars with FCV Introduction, 2005 - 2025



Hypothetical CAFE standard one-forth size of SOTU proposal

Some measures have such significant drawbacks that they need to be considered in a limited way or implemented in an innovative way.

Measure	Drawback
Capital cost payment of fuel infrastructure	Should be limited to early production. Better to link payments to fuel production
Parking/HOV lane/ city driving benefits	Successful for CNG and HEV early transition, but benefit is quickly diluted. Limited number of cities are ideal for city car (NYC, SF, London).
Fleet purchase rule	Unfunded mandate. No positive incentive to consumer. Extensive coordination requirements. Easy to avoid compliance
Manufacturer mandate	Very unpopular: key stakeholder not motivated to succeed
Manufacturer Tax Credit	Value of tax credit varies widely among carmakers due to individual tax situations
Consumer education	Impact impossible to estimate.

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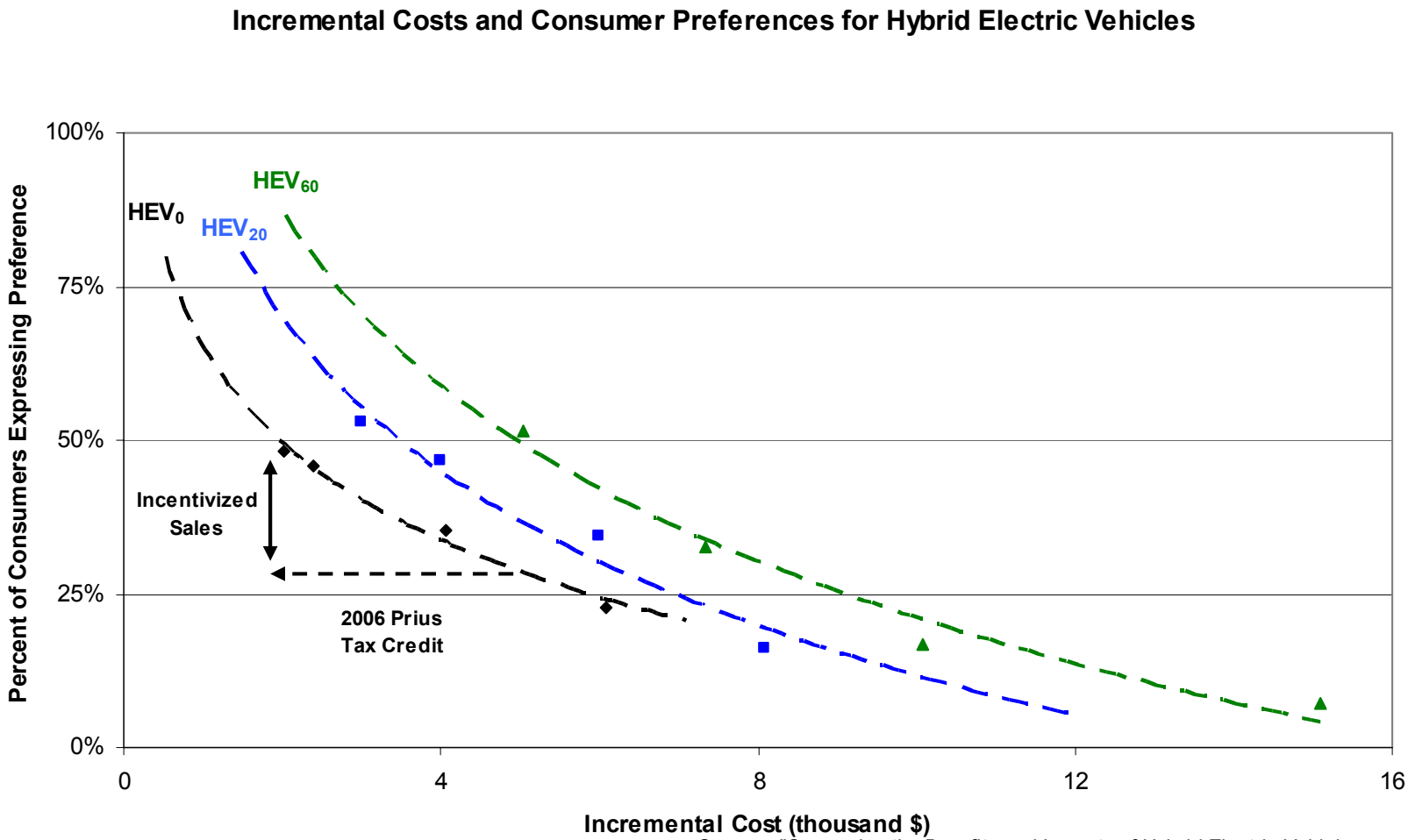
- Tax credits and producer fuel payments can provide a targeted incentive for hydrogen
- Environmentally-based measures accomplish energy security and GHG reduction goals but are prone to "leakage" into other sectors and fuels
  - Most direct impact for a large number of vehicles
- External conditions, including the cost of incumbent transportation fuels and regulatory mandates, will likely influence both H2 availability and demand for FCVs

Extra slides follow

Evidence of effectiveness of tax credit mixed.



Source: "Comparing the Benefits and Impacts of Hybrid Electric Vehicle Options", EPRI, 2001.