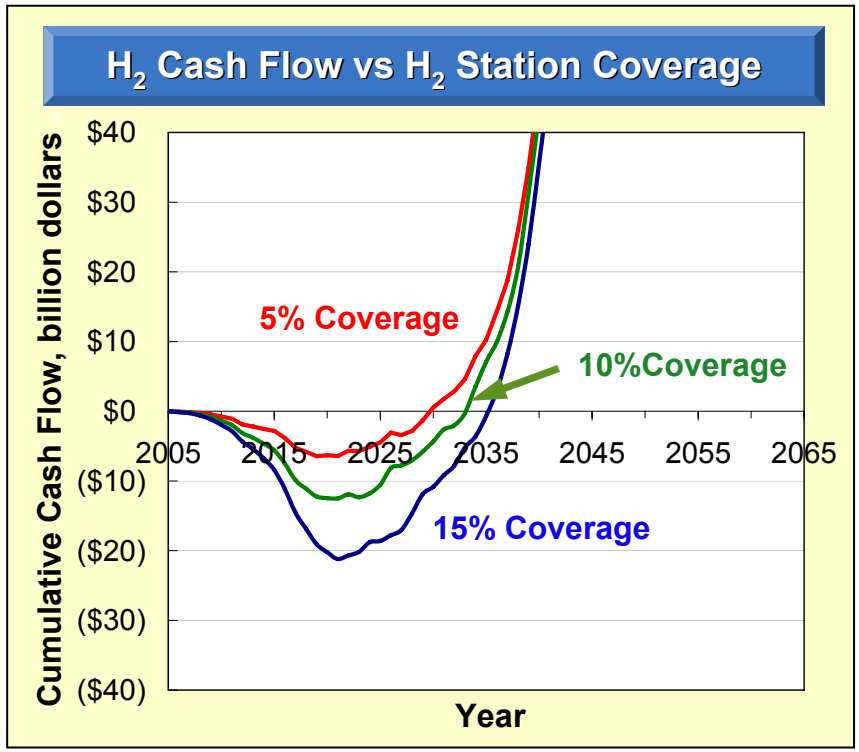
2007 DOE Hydrogen Program Annual Merit Review

Stefan Unnasch
(408) 517-1563
Unnasch.stefan@tiaxllc.com

Daniel Rutherford, Ph.D.
(408) 517-1555
Rutherford.daniel@tiaxllc.com



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

This poster does not contain any proprietary, confidential, or otherwise restricted information.

Overview

Timeline

- Start: November, 2006
- Finish: March, 2007
- 100% complete

Budget

- Total budget: $50,000
- Budget provided under NREL Task Order NO. KACX-4-44452-02
- No continuing budget for FY 07 or beyond

Barriers

- Costs of hydrogen transition
- Competition with other alternative fuels

Partners

- National Renewable Energy Laboratory
- Oak Ridge National Lab
- Other participants of the DOE Hydrogen Transition Analysis Workshops

TIAX

- 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

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 • Existing programs • Expected GHG measures	• 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?

The leading policy measures cover a range of policy targets.

Phase	Target	Measure
Incentives	Fuel	Producer fuel payment Infrastructure support[a]
	Vehicles	50/50 vehicle cost share Consumer tax credit for vehicle Fleet purchase program Feebates
Outreach	All	Educate state and local governments, consumers, emergency responders
Mandates	All	GHG cap-and-trade Carbon tax Modified CAFE standards Renewable H2 under RFS/RPS

[a] Examples include cost share, investment tax credits, loan guarantees, tax credits

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

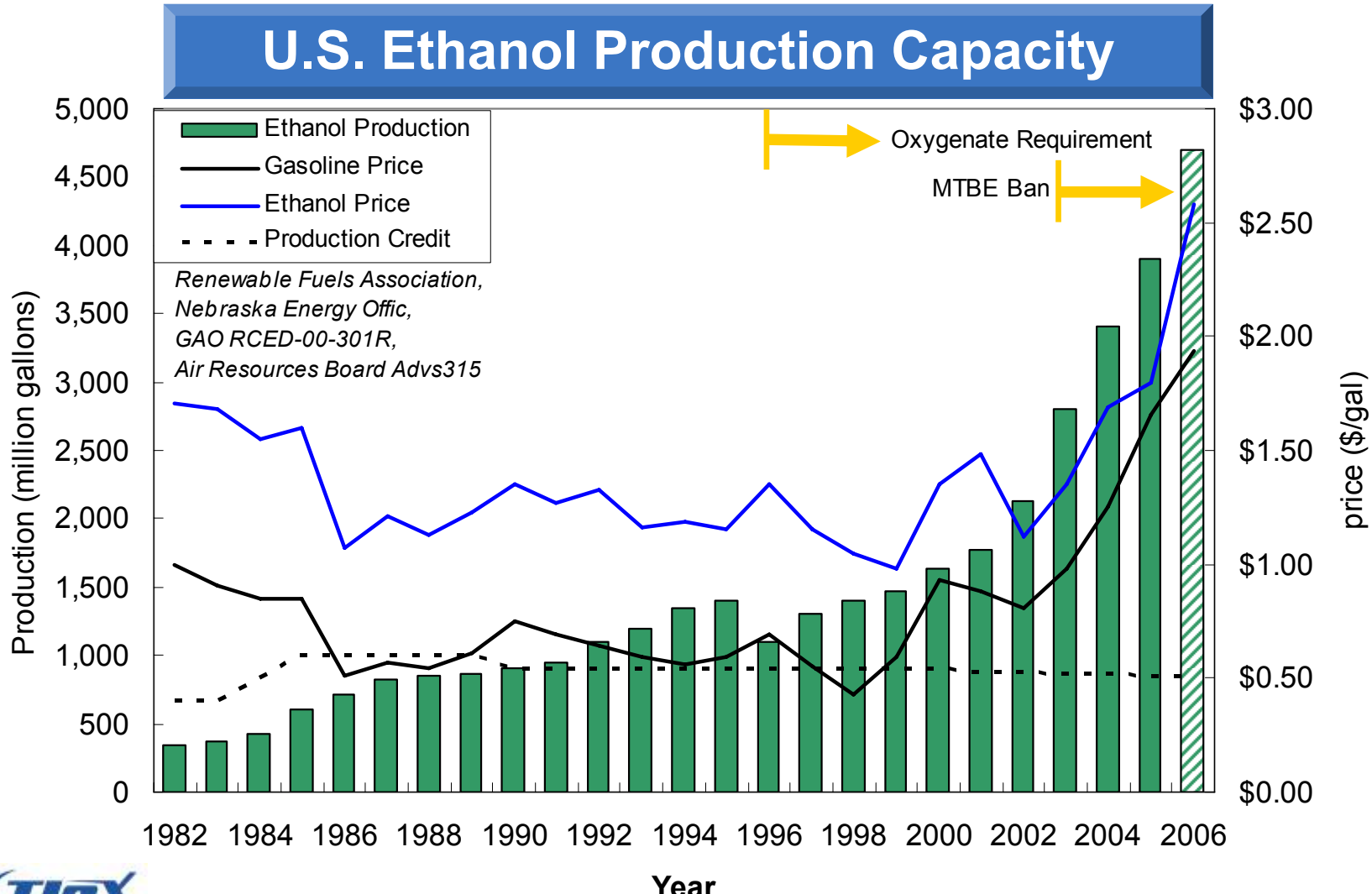
The leading policy measures could be implemented in two stages:

Stage	Measure
Early-Transition (2010-2017)	50/50 vehicle cost share
	Infrastructure loan guarantees
	Accelerated depreciation
	Infrastructure support
	Producer fuel payment
	Fleet purchase program
Late-Transition (2018-2025)	Consumer tax credit
	Producer fuel payment
	Renewable H_2 under RFS/RPS
Commercial Stage (2025+)	Carbon Tax
	Modified CAFÉ standards
	GHG cap and trade

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 H_2 *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.

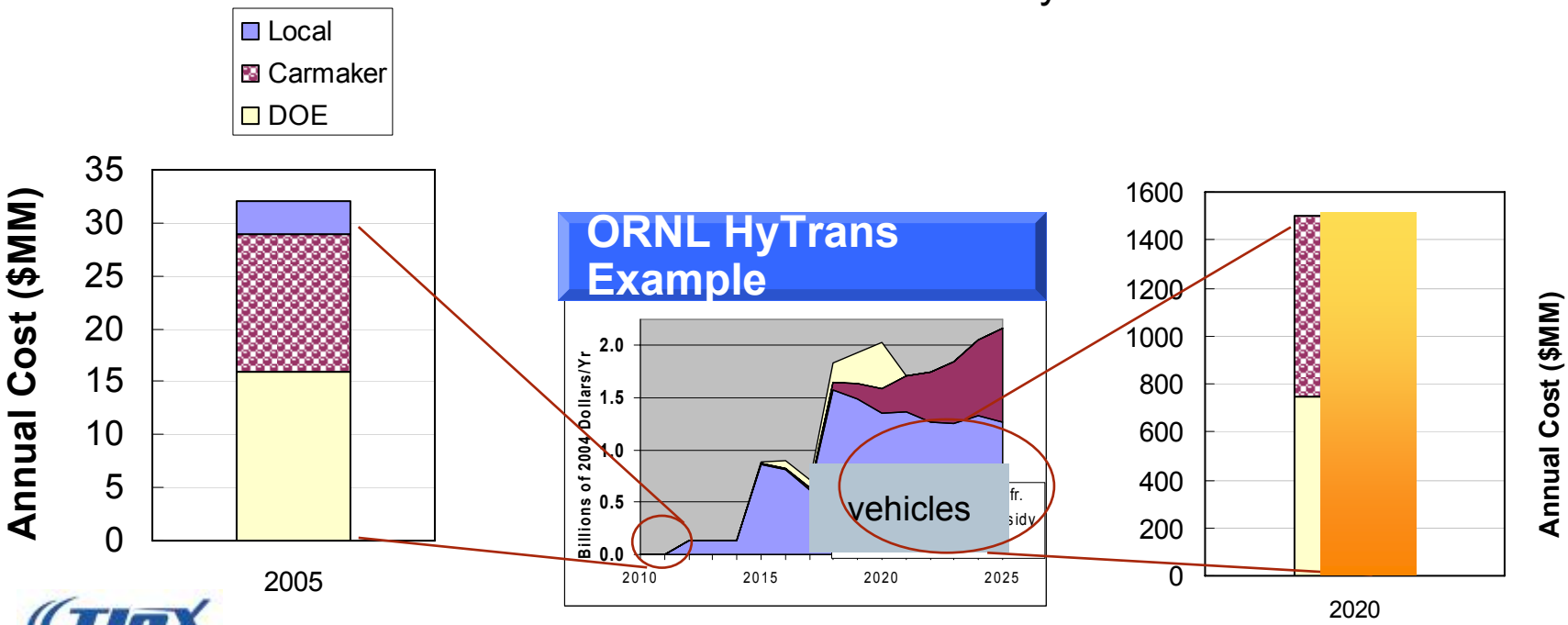


Government cost share of vehicle programs can help cover the cost of vehicles in the near term.

- 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.

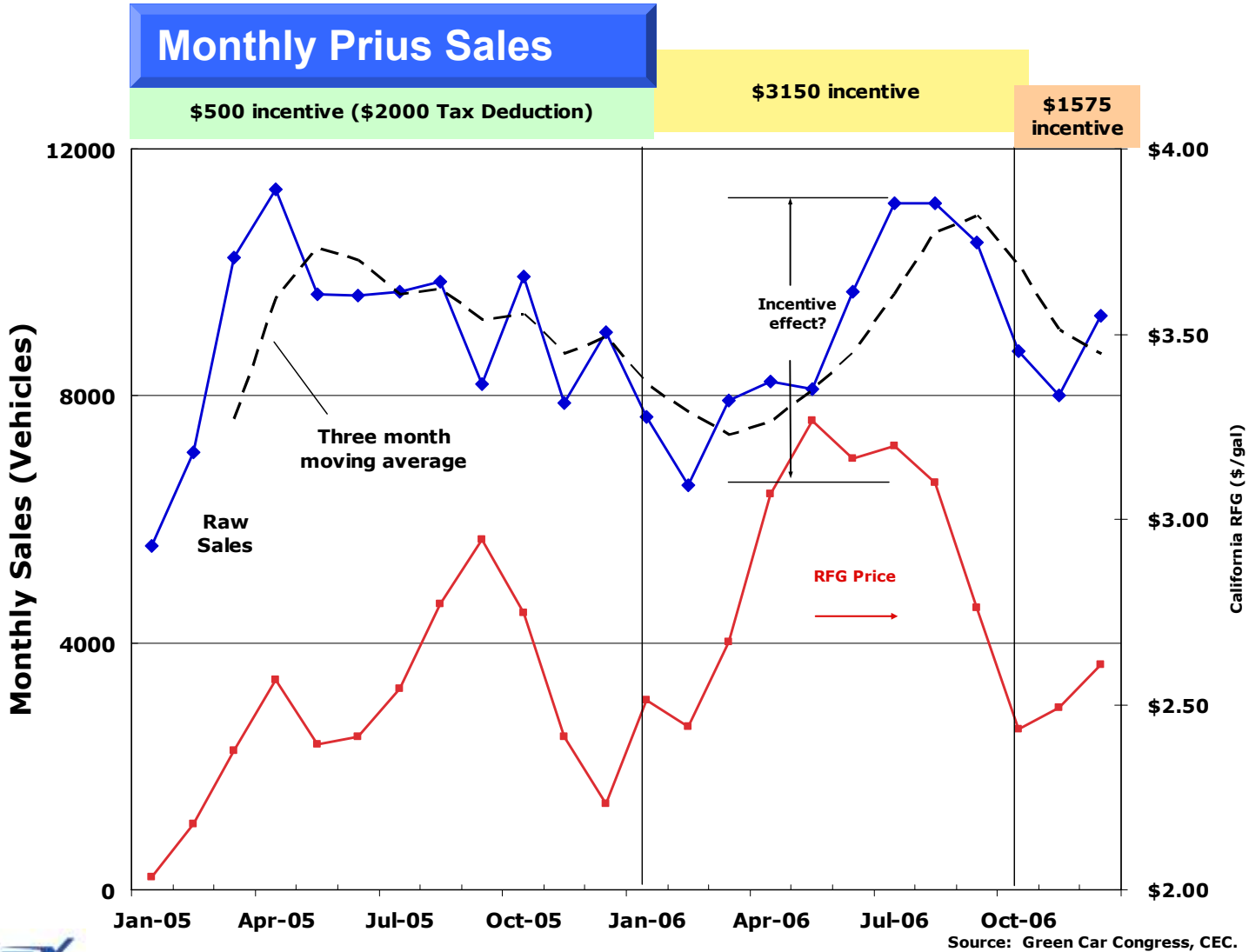
- Total transition cost is significant to carmaker
- Tax credit is well established and does not need to go thought the annual budget process.
- 50/50 cost share mechanism is well established
- Provide better business case to business and buyer



Provide tax credit to purchasers of hydrogen FCVs.

- Credit directed towards vehicle with hydrogen attributes
  - Rationale could be energy efficiency, fuel produced in U.S., potential use of renewables, etc.
- Direct payment would be more attractive to customers at little extra cost to the government, but politics favor tax credit
  - Tax credit does not require annual Congressional reauthorization
  - Some customers will be affected by current AMT constraints
- Effect
  - Creates market pull for H_2 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.

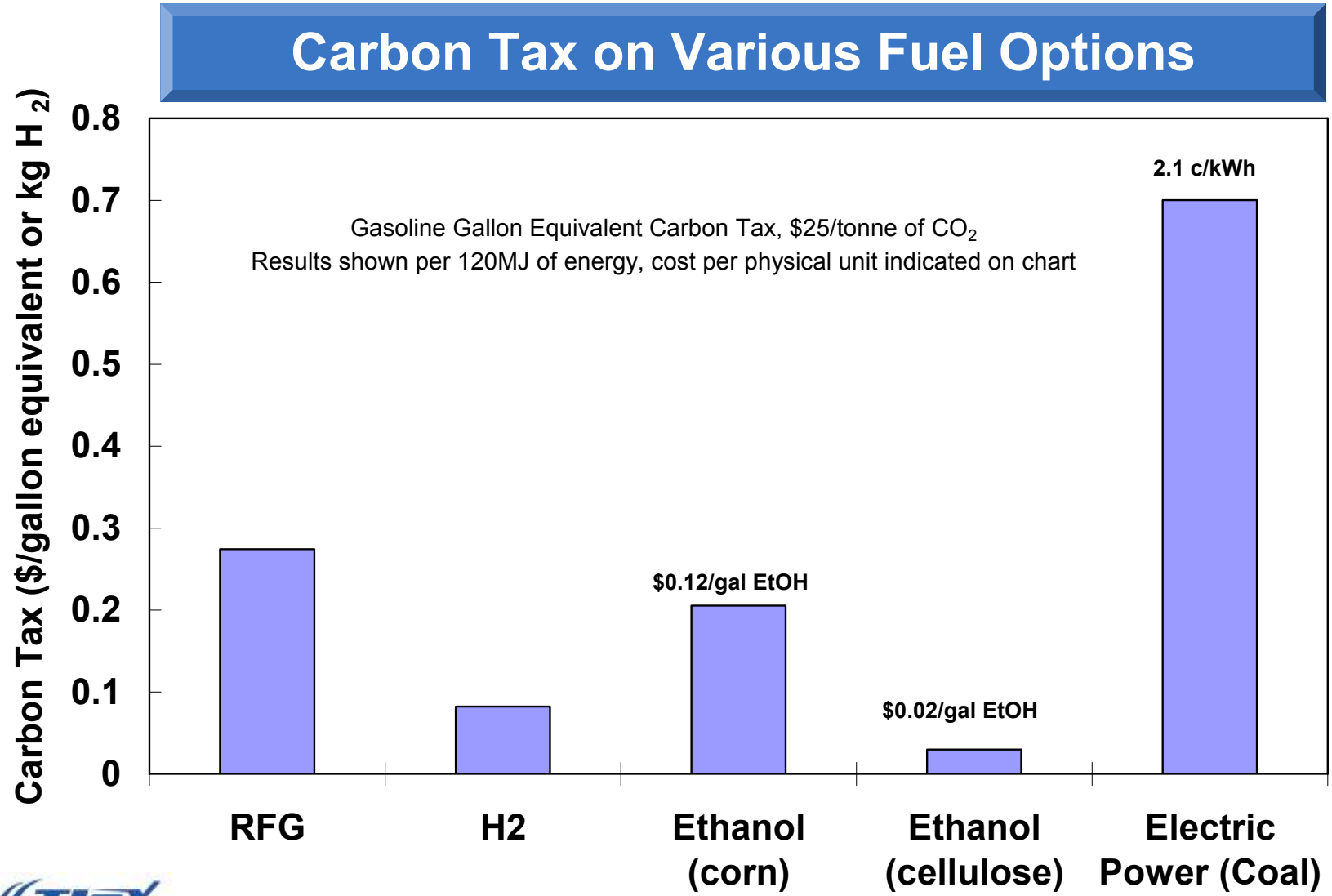


Source: Green Car Congress, CEC.

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 CO_2 H_2 pathways and efficient FCVs
  - Consistent with achieving other environmental goals. Implementation is not likely to be driven by hydrogen options.

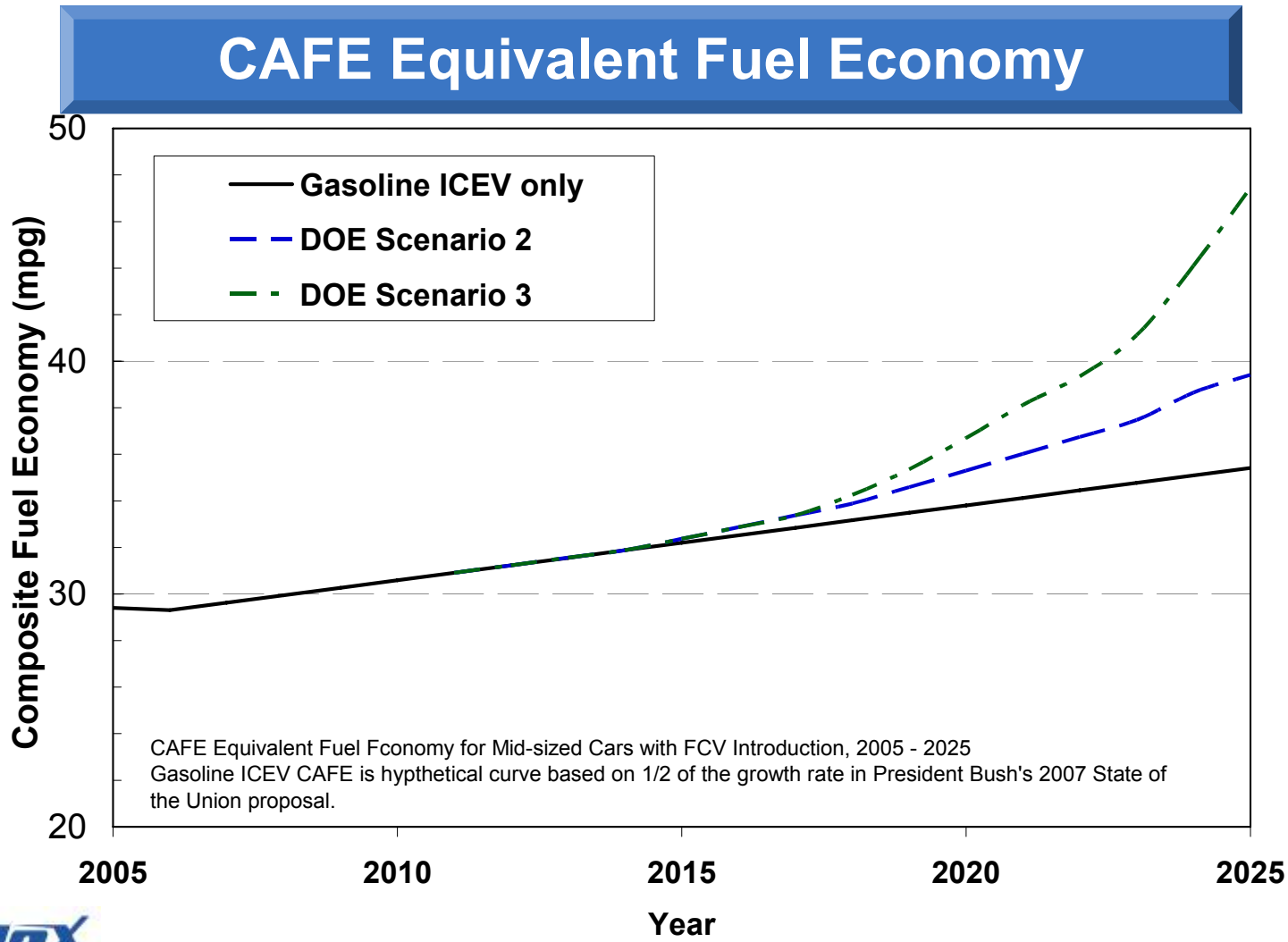
A carbon tax would impact other fuel pathways.



Modify existing CAFE regulations to provide incentive for H_2 FCVs

- Use framework of existing regulations as incentive for high efficiency and hydrogen vehicles
  - Provide extra incentive for H_2 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.



Conclusions

- 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
  - Economic impact is not enough to drive early transition
- External conditions, including the cost of incumbent transportation fuels and regulatory mandates, will likely influence both H_2 availability and demand for FCVs

A variety of future projects could build upon the findings of this work.

- Validate assumptions of the HYTRANS model regarding sensitivity of customer preference for hydrogen and other vehicles to public incentives using real-world data
- Identify tactics to coordinate state and federal policy efforts to promote hydrogen
- Design incentives for generation of hydrogen via new renewable energy and carbon sequestered coal power generation capacity
- Analyze the impact of CA's "four caps" (Car and Lt. Truck GHG emission standard, low-carbon fuel standard, Cap and Trade, and electricity GHG limit) on H_2 fuel, FCV fuel economy, and consumer transportation demand (AB1493, Executive Order S-01-07 , AB32, and SB1368)

Summary

Relevance: Clarified key characteristics of policy options to support the transition to a hydrogen-based transportation system

Approach: Quantitative and qualitative evaluation of policy measures

Technical accomplishments and progress: Identified that fuel specific incentives such as 50/50 cost share and a producer payment are likely to be effective during the early transition. Environmental incentives (e.g. carbon tax, GHG cap and trade system) are appropriate for the late transition, when hydrogen is cost-competitive with other alternative fuels and AF vehicles.

Technology transfer/collaborations: Project was completed with the cooperation of NREL and ORNL and the participants of DOE's Hydrogen Transition Analysis Workshops

Proposed future research: Work on the design of incentive programs to promote hydrogen production, along with the impact of CA state policy on the availability of hydrogen and HFCVs

Stefan Unnasch
408-517-1563
unnasch.stefan@TIAXLLC.com

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