DOE Hydrogen Program

Modeling the Transition to Hydrogen

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Overview

Timeline

- Start: October, 2005
- End: September, 2009
- Percent complete: 70%

Barriers

- Lack of understanding of the Transition of a Hydrocarbon-Based Economy to a Hydrogen-Based Economy.
- Lack of an integrated market model of all major components of the Hydrogen Fuel and Vehicle System

Budget

- Total project funding: $1.8M
  - DOE share: 100%
- FY07: $400K
- Funding for FY08: $600K

Partners

- NREL, ANL, DTI
- GM, Ford, D-C
- UTC, PlugPower, Ballard
- Energy & Environmental Analysis, Inc.
- Collaboration with U.C. Davis Hydrogen Pathways Program
- Project management by ORNL

Objectives

- Complete development of an integrated market model of the hydrogen transition.
- Construct and publish credible scenarios of the transition to hydrogen fuel cell vehicles.
- Collaborate with IPHE/IEA to develop joint EU and North America transition scenarios.
- Analyze the potential for a federal acquisition program to establish a sustainable North American non-automotive PEM fuel cell industry.
- Update and improve the HyTrans integrated market model.

Milestones

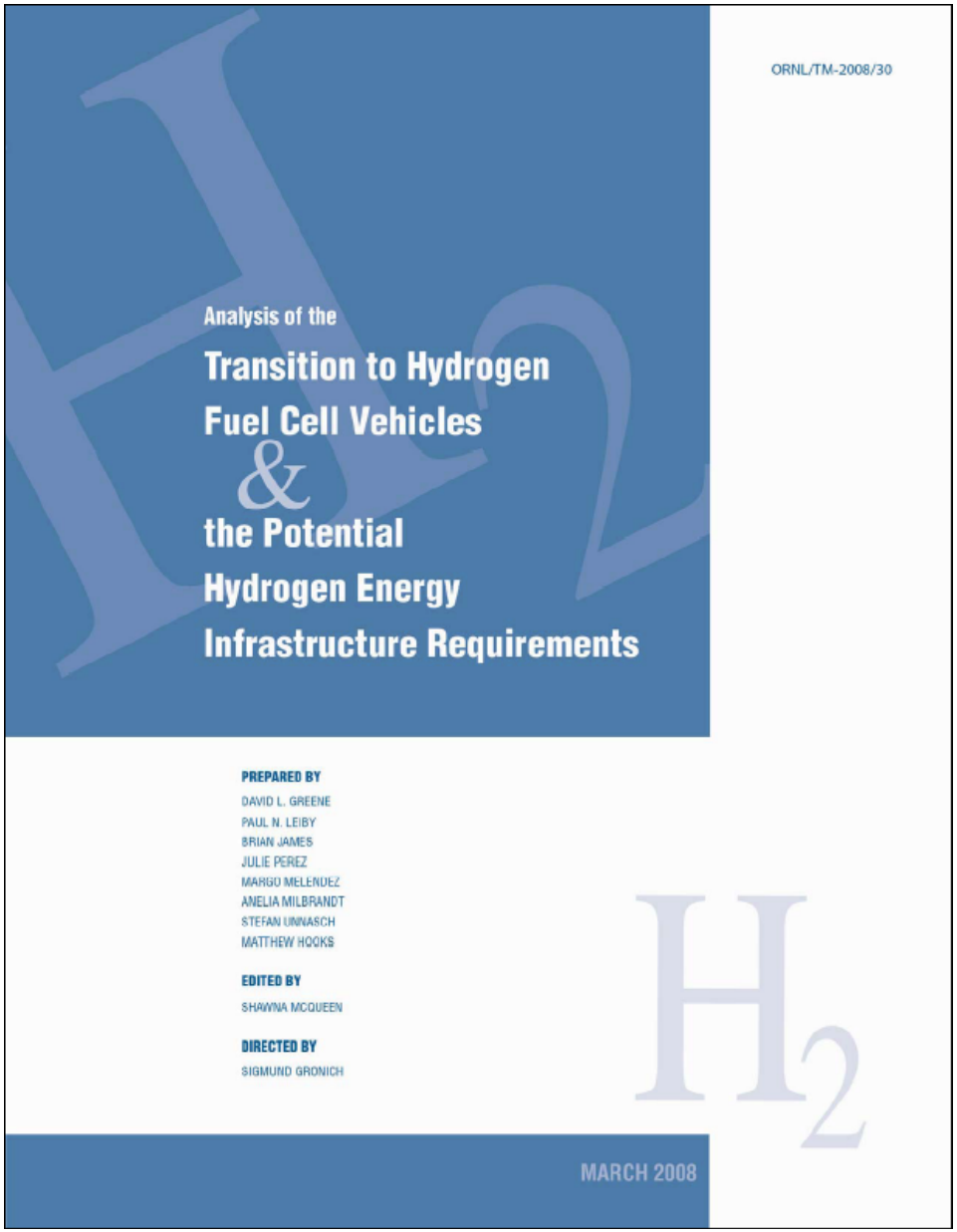
- *Publish results of hydrogen transition analyses.*
  - *ORNL HyTrans Report: June, 2007*
  - *Transition Scenarios Report: March, 2008*
- *Complete joint IPHE/IEA report on US/EU hydrogen transition scenario coordination: April, 2008*
- *Develop preliminary estimates of the impacts of the hydrogen transition on GHG emissions and oil dependence: July, 2007*
- *Conduct rapid assessment of the potential for a federal non-automotive fuel cell acquisition program to create a sustainable North American PEM fuel cell industry: April, 2008 (draft & briefing to Interagency Task Force).*
- *Updated and enhanced HyTrans: September, 2008*

Approach

- Market Simulation Model Development
  - **HyTrans market simulation model integrates hydrogen supply, fuel cell vehicle manufacturing, choice of vehicle technology and hydrogen fuel use in a multi-period non-linear optimization framework. (Solves the "chicken or egg" problem.)**
- International Collaboration
  - **With EU colleagues, compared and contrasted premises, methodologies and assumptions, surveyed H2 transition models and developed typology, developed new advanced vehicle technology characterizations based on PSAT simulations.**
- Extension to Stationary Applications:
  - **Based on available literature and in-depth interviews, constructed a non-automotive PEM cost model including learning-by-doing and scale economies.**

In FY 2008 we are focusing on disseminating results of the transition scenarios establishing international partnerships and building towards future assessments.

- Communicating the results and implications of the first integrated national hydrogen transition analysis.
- Completing the first phase of international collaboration on hydrogen transition analysis.
- Enhancing and updating HyTrans for calculating GHG and oil dependence benefits and for future scenario analyses.
- Using methods developed for HyTrans to conduct a rapid assessment of the potential for a non-automotive PEM industry in N.A.

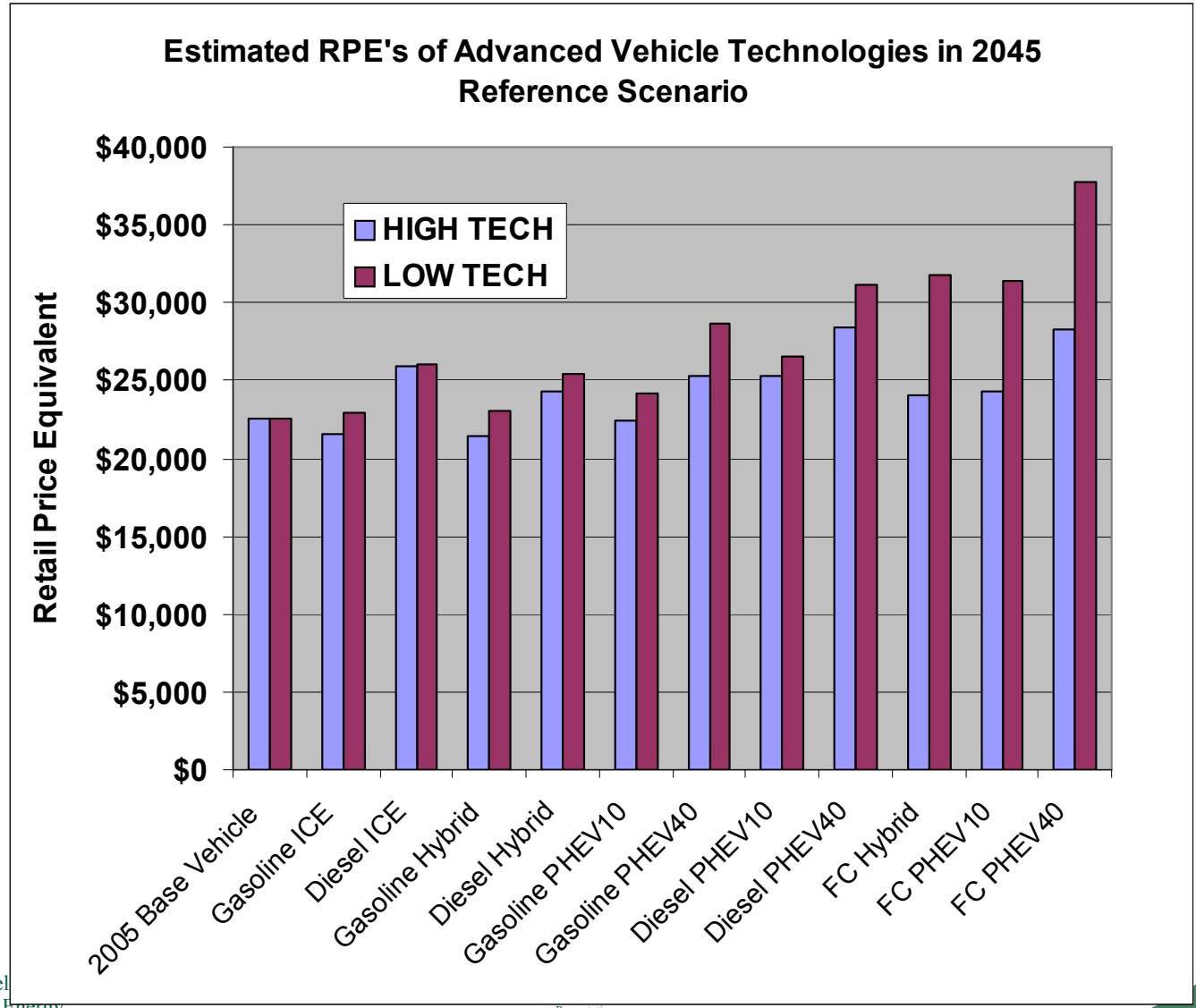


Accomplishments

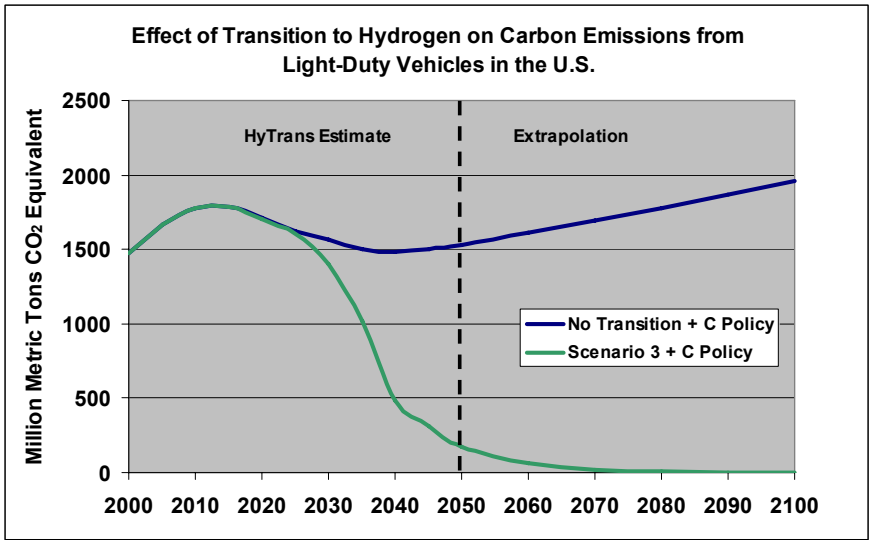
The report of the first integrated national hydrogen transition analysis was published and reported on in testimony to California ARB.

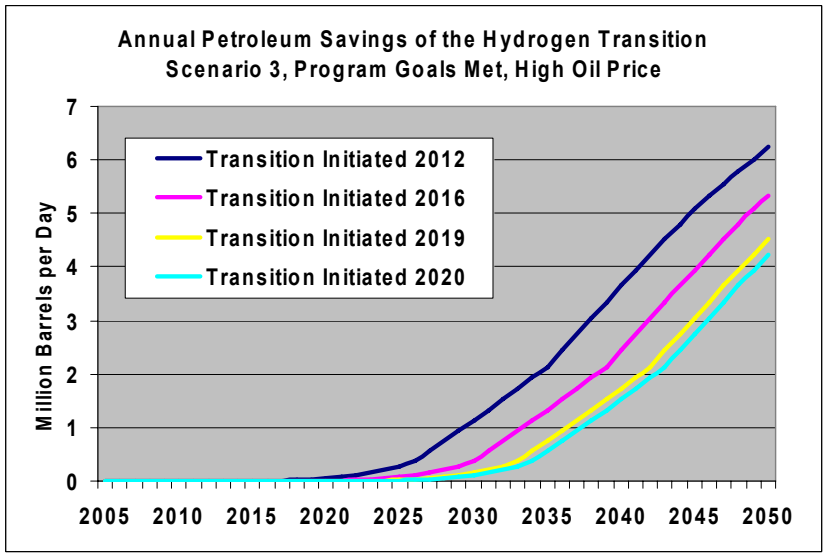
cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2008_30.pdf

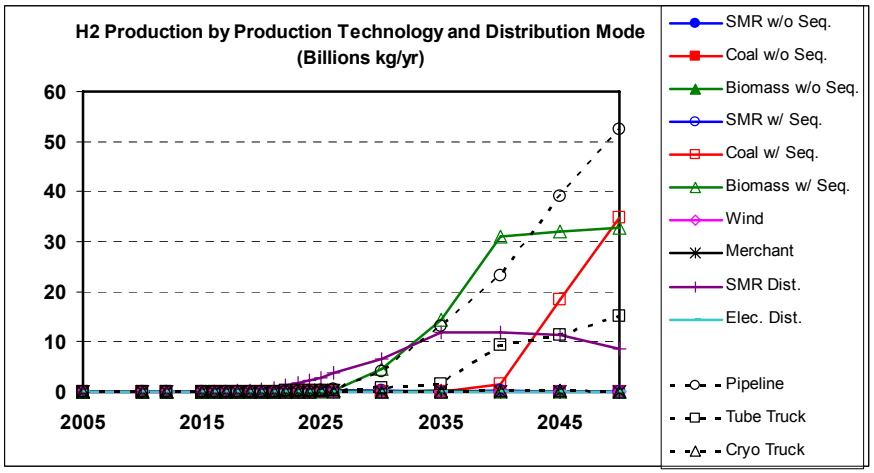
As part of the IPHE/IEA analysis, we developed new component-based estimates of the performance and cost of advanced technologies (including PHEVs) in collaboration with Argonne and EEA, Inc.



We developed initial estimates of the impacts of a transition to hydrogen on oil use and GHG emissions. More precise estimates will be made after the FY 08 HyTrans updates and enhancements.







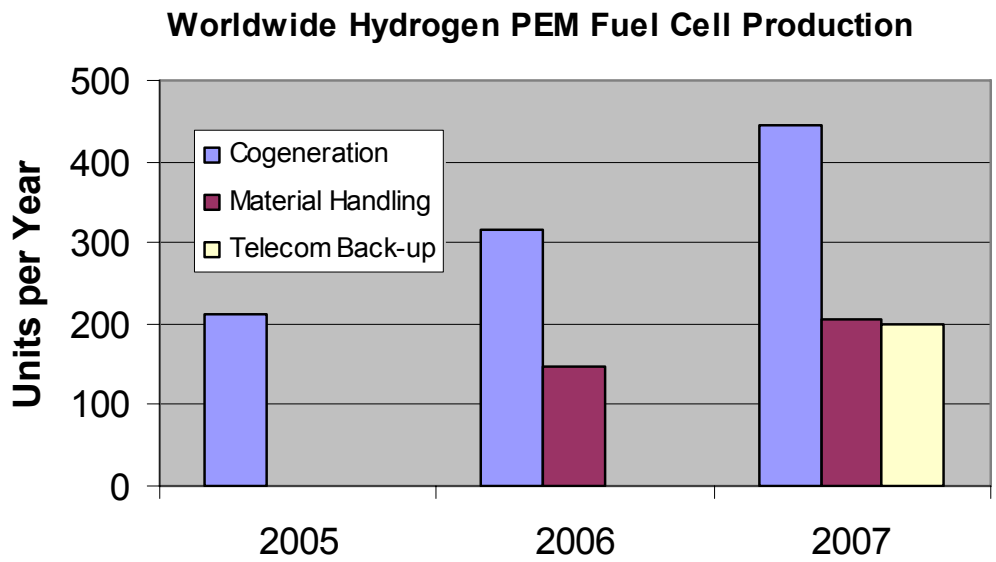
- "No Transition" scenario assumes high technological progress – e.g., all FreedomCar program goals are met.
- Carbon-constraining policy has strong effect on evolution of H2 production sources

Could a government acquisition program for non-automotive PEM fuel cells create a sustainable North American market?

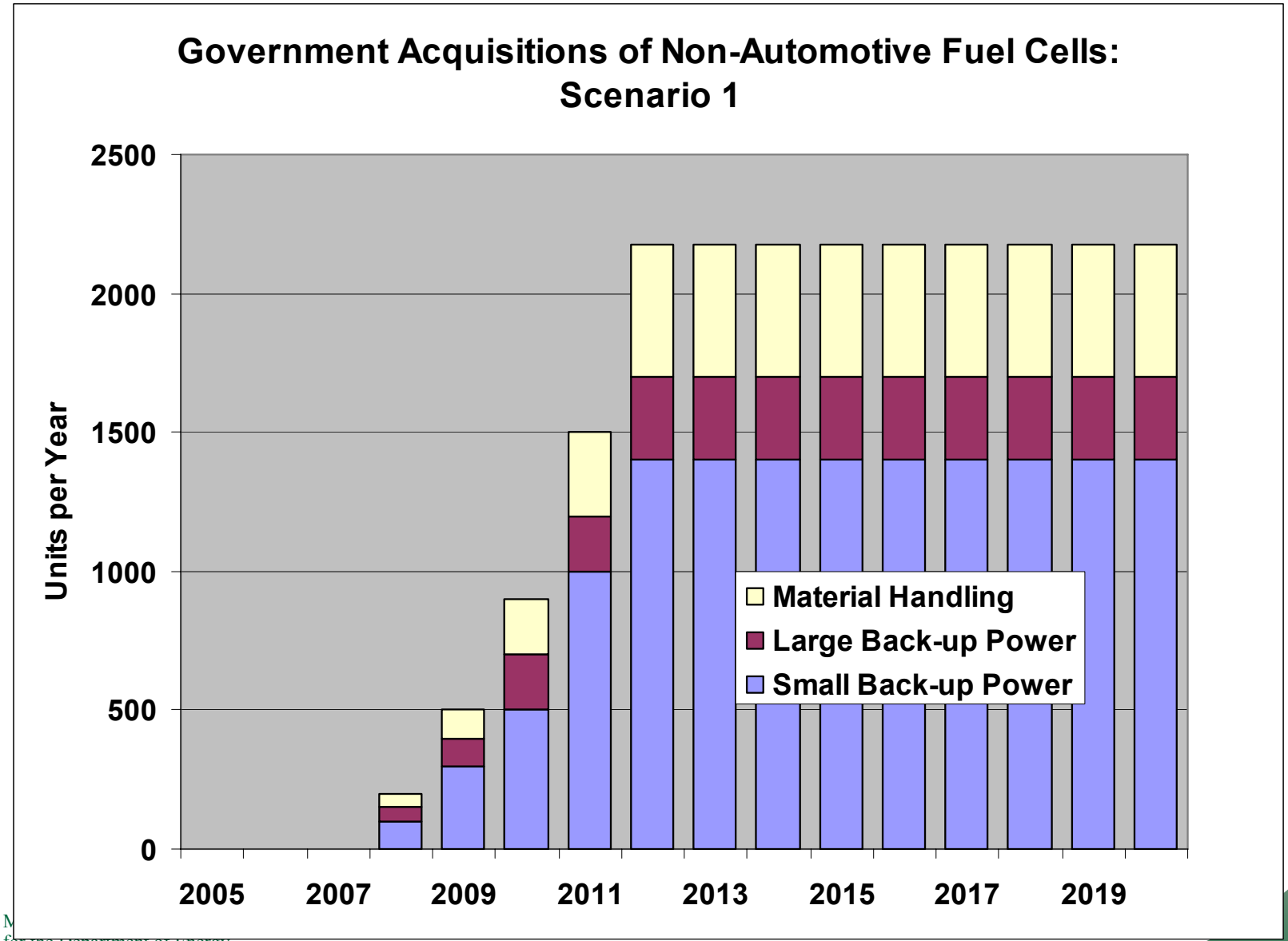
- **A rapid study for DOE/HFCIT drawing on existing market studies and interviews with engineers and marketing analysts of three firms:**
  - **UTC**
  - **Plug-Power**
  - **Ballard**
- **Could a feasible federal acquisitions program drive down costs to a level that could sustain a viable domestic market?**
  - **Scale economies**
  - **Learning-by-doing**
  - **The answer appears to be, YES.**
  - **Production capacity exists to begin now.**
- **Proposed time period for federal program: 2011-2015**
- Loud and clear message from manufacturers: *Don't wait until 2011. They may not be there. Start now at whatever level is possible.*

Our assessment focused on three markets.

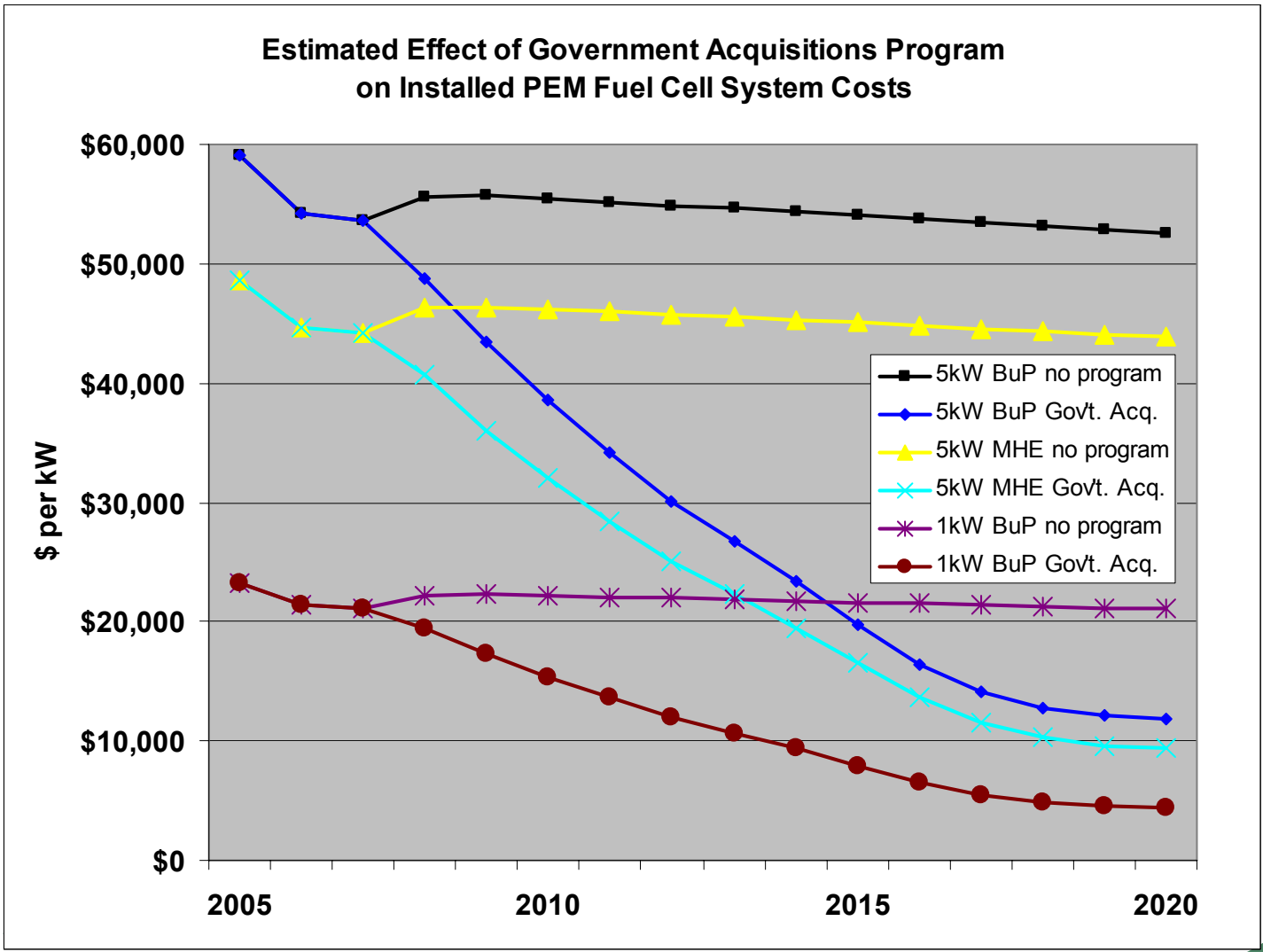
- 1 kW BuP market size 125,000 units, 5% replacement per year, 2%/yr. growth.
- 5 kW BuP market size 125,000 units, 5% replacement per year, 2%/yr. growth.
- 5 kW MHE market size 250,000 units, annual replacement of 5% per year, 2% growth.



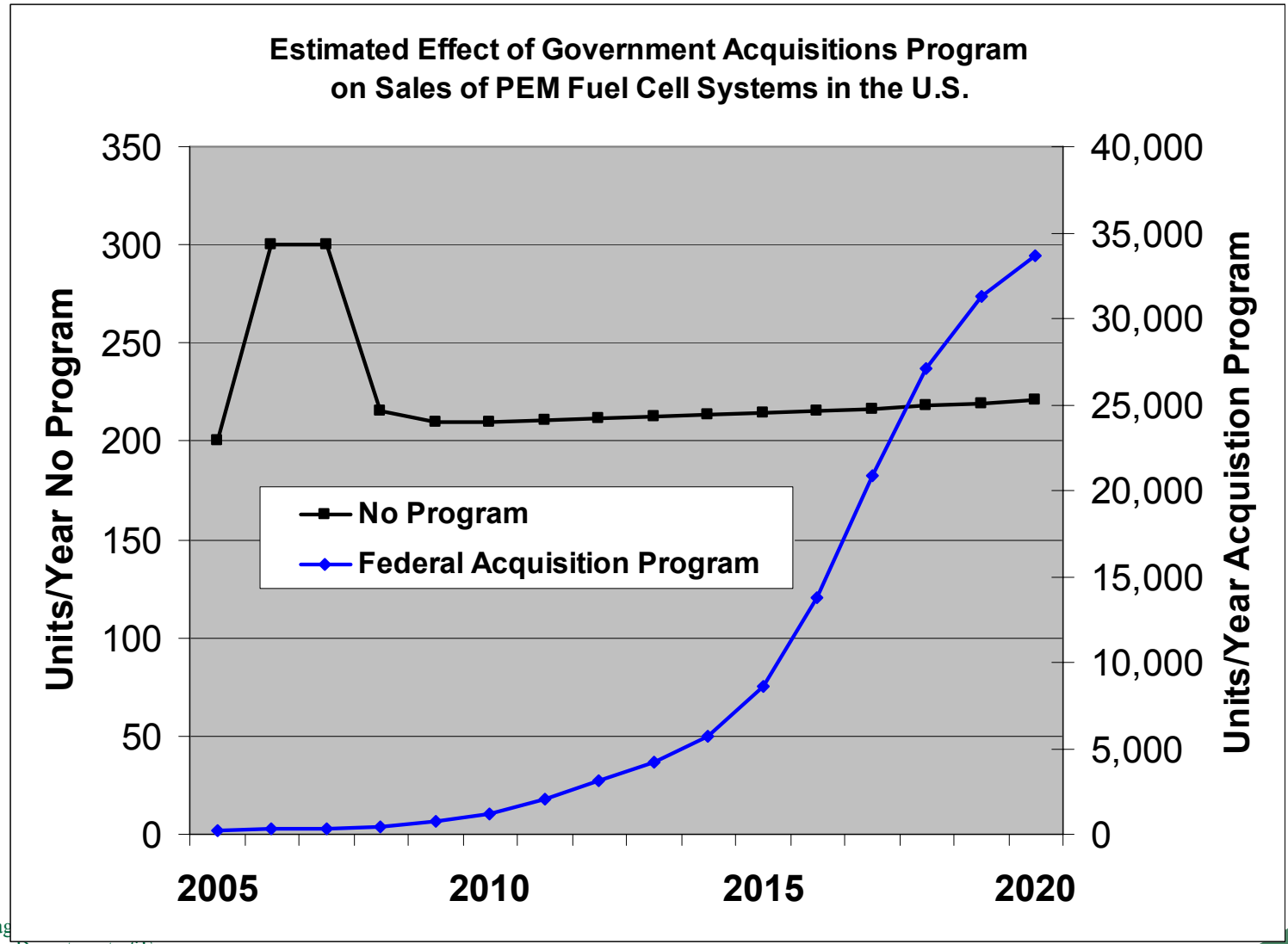
A detailed evalution by NREL estimated a potential federal market of over 2,000 units per year.



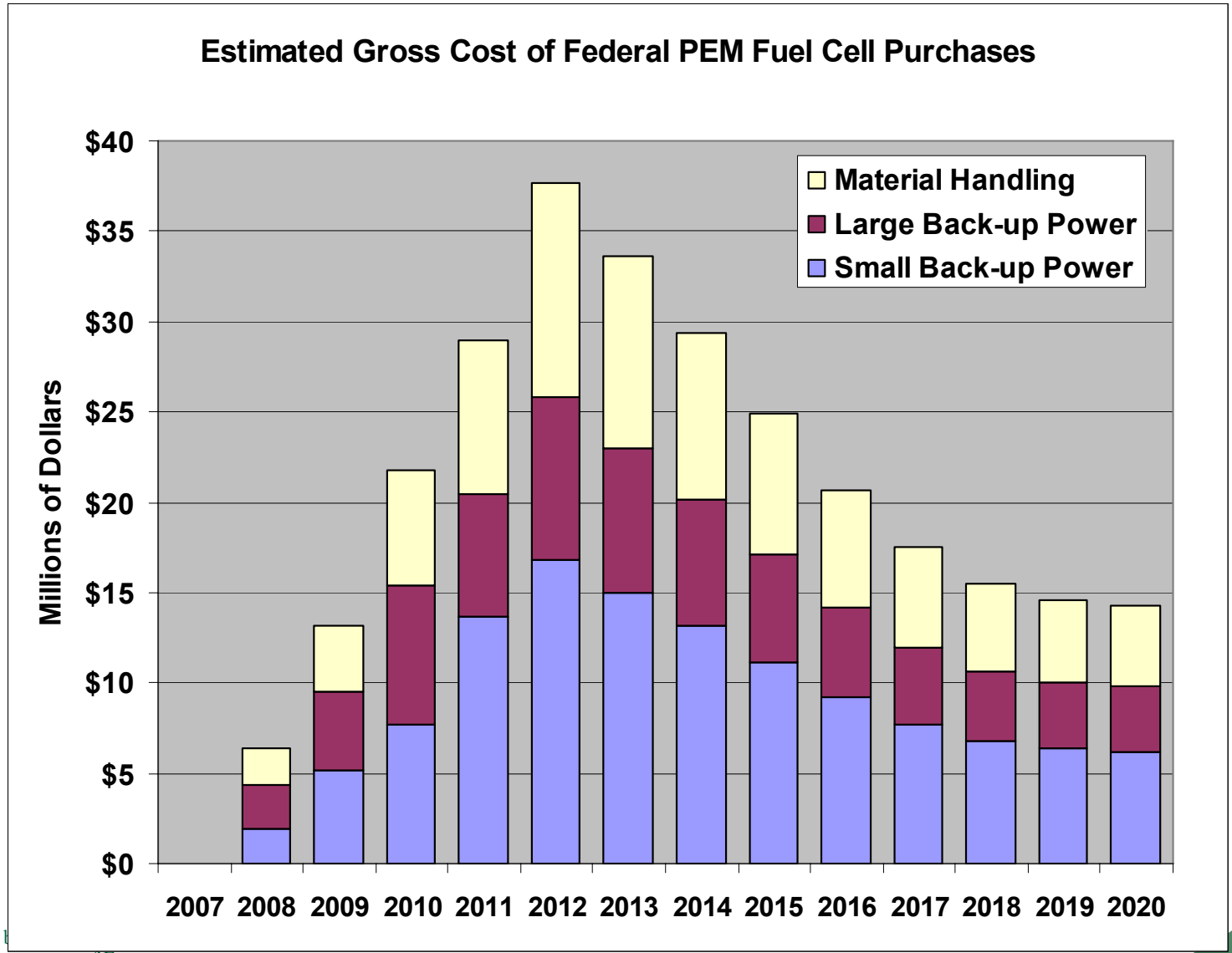
Assuming conservative rates of learning and moderate scale economies, a federal program of that size should be large enough to have a significant impact on fuel cell system costs.



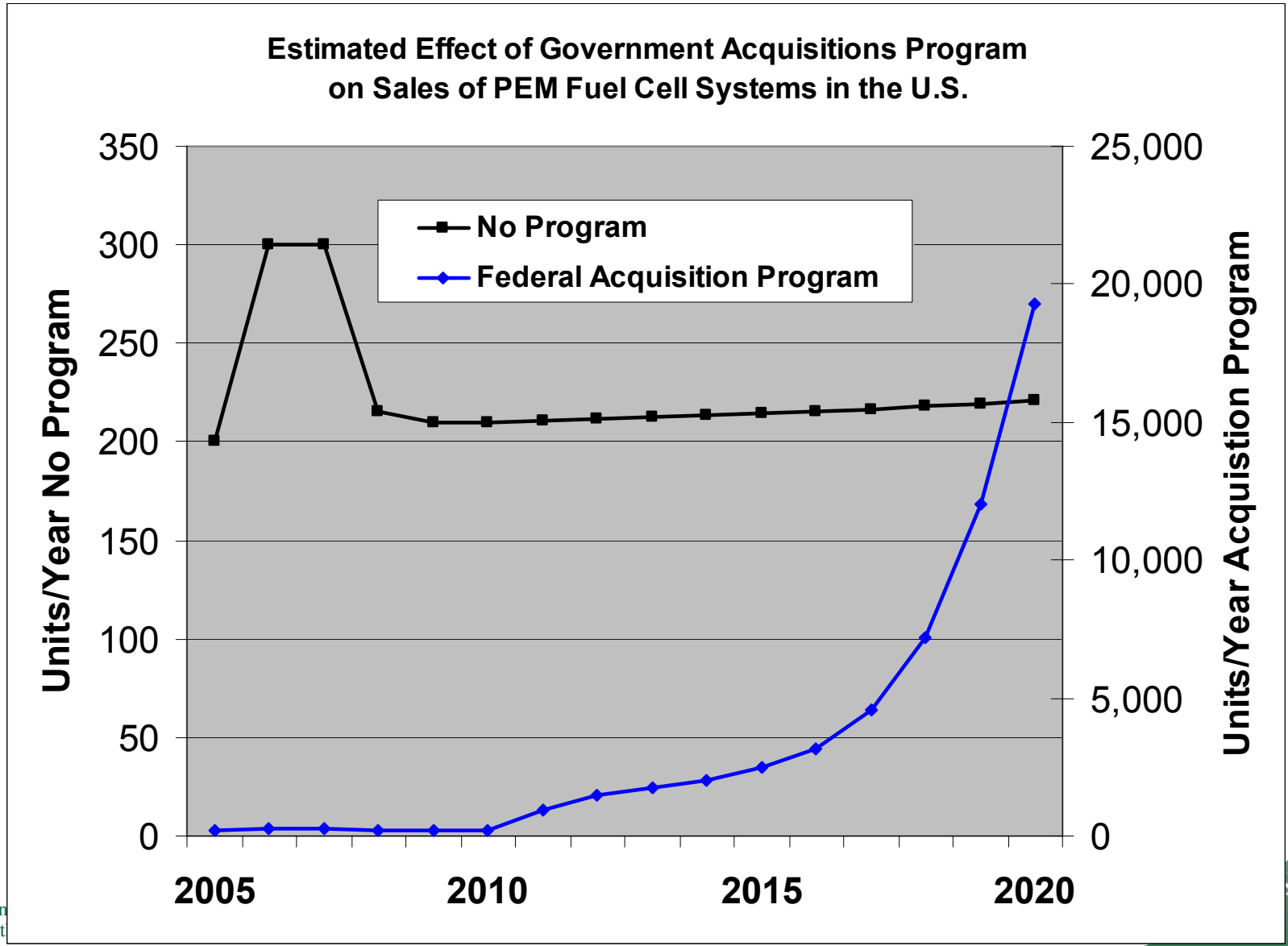
It appears likely that a federal acquisition program could stimulate enough learning-by-doing and scale economies to create a moderately sized, sustainable North American PEM fuel cell industry.



Gross federal expenditures would rise to $35 million in 2012 but then decline as learning and scale economies drive down costs.



Delaying a program until 2011 and cutting purchases in half probably would not work because the industry would not last that long.



This quick analysis suggests that a federal acquisition program could catalyze a sustainable North American PEM fuel cell industry.

- Conservative assumptions were used for scale economies and learning-by doing.
- The production capacity to begin such a program exists now and more can be added, as needed.
- Given the assumptions for the scenario presented, federal purchases would be adequate to drive down costs levels that would allow OEMs to compete effectively in private sector markets before 2015.
- A delayed scenario with half the number of federal acquisitions did not lead to a successful industry by 2015.
- In the industry's view federal acquisitions should begin as soon as possible to avoid a loss of capacity that could be irreversible.

Future Work

- Enhance and update HyTrans
  - Calibrate to AEO 2008
  - Incorporate new vehicle technology data including PHEVs
  - Incorporate explicit representation of uncertainty
  - Facilitate alternative assumptions and sensitivity analysis
  - Update to new versions of H2-A, and GREET
- Continue work with IPHE/IEA toward joint US/EU hydrogen transition scenario analyses.
- Publish peer-reviewed report on the GHG and oil dependence impacts of the transition to hydrogen-powered transportation.
- Participate in IPCC Global Assessment of Renewable Energy Resources (if approved).
- Publish documentation for updated and enhanced HyTrans, make model available to other modelers.