U.S. Department of Energy
Energy Efficiency and Renewable Energy

Technical Targets of the President's Freedom Car and Hydrogen Fuel Initiative

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Resources to Support the President's Hydrogen Fuel Initiative

Major Line Items and Key Activities	FY 04 Appropriation ($K)	FY 05 Request ($K)
Fuel Cell Technologies : system components, stack components, fuel processors, technology validation	$65,187	$77,500
Hydrogen Technologies : distributed natural gas and renewable production, delivery, storage, safety and codes/standards, infrastructure technology validation, education/analysis	$81,991	$95,325
Coal-based Hydrogen Production : gasification, gas separation	$4,889	$16,000
Nuclear-based Hydrogen Production : high temperature reactions	$6,377	$9,000
Basic Science : production, storage and use	$0*	$29,183
Department of Transportation : safety, codes/standards	$555	$832
Total	$158,999**	$227,840

* Excludes about $8 million of baseline activities not counted as part of the Initiative.
** FY 04 Request = $181.7 M
Note: Some FY 04 numbers vary slightly due to RESCISSIONS AFTER appropriation and other reductions.

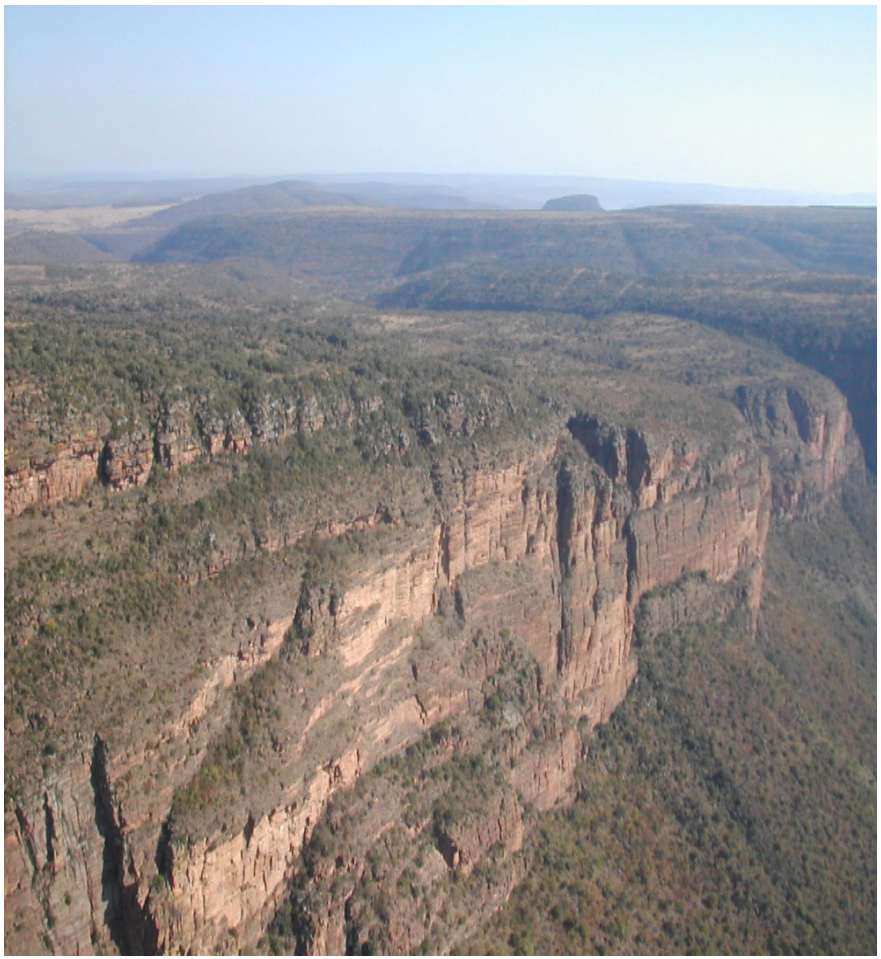
Separation Membranes for Hydrogen Production with Palladium Membranes

Current Technical Targets Based on Ongoing Research
2015 Targets For Multiple Membrane Systems – H2A Analysis

Membrane Characteristics	Units	2003	2005	2010
Flux Rate	scfh/ft^2	60	100	200
Cost	$/ft^2	$150-$200	$100-$150	<$100
Durability	hours	<1,000	50,000	100,000
Operating Temperature	Degrees C	300-600	300-600	300-600
Parasitic Power	kWh/1,000 scfh	3.2	3.0	2.8

Challenge: Apply Membrane to Small-Scale Distributed Production in One-Step Shift Reactor that is Feedstock Flexible

FY 04 Separations Portfolio



- Ceramic Membrane Reactor ITM Syngas – APCI
- Pyrochlore/Perovskite PTM – ORNL
- Inorganic Membrane Porous Support Tubes – ORNL
- Defect-Free Thin Films – SNL
- Photopolymerization/Pyrolysis and Membrane Microstructure Development – LANL
- WGS Membrane Reactor Studies – NETL

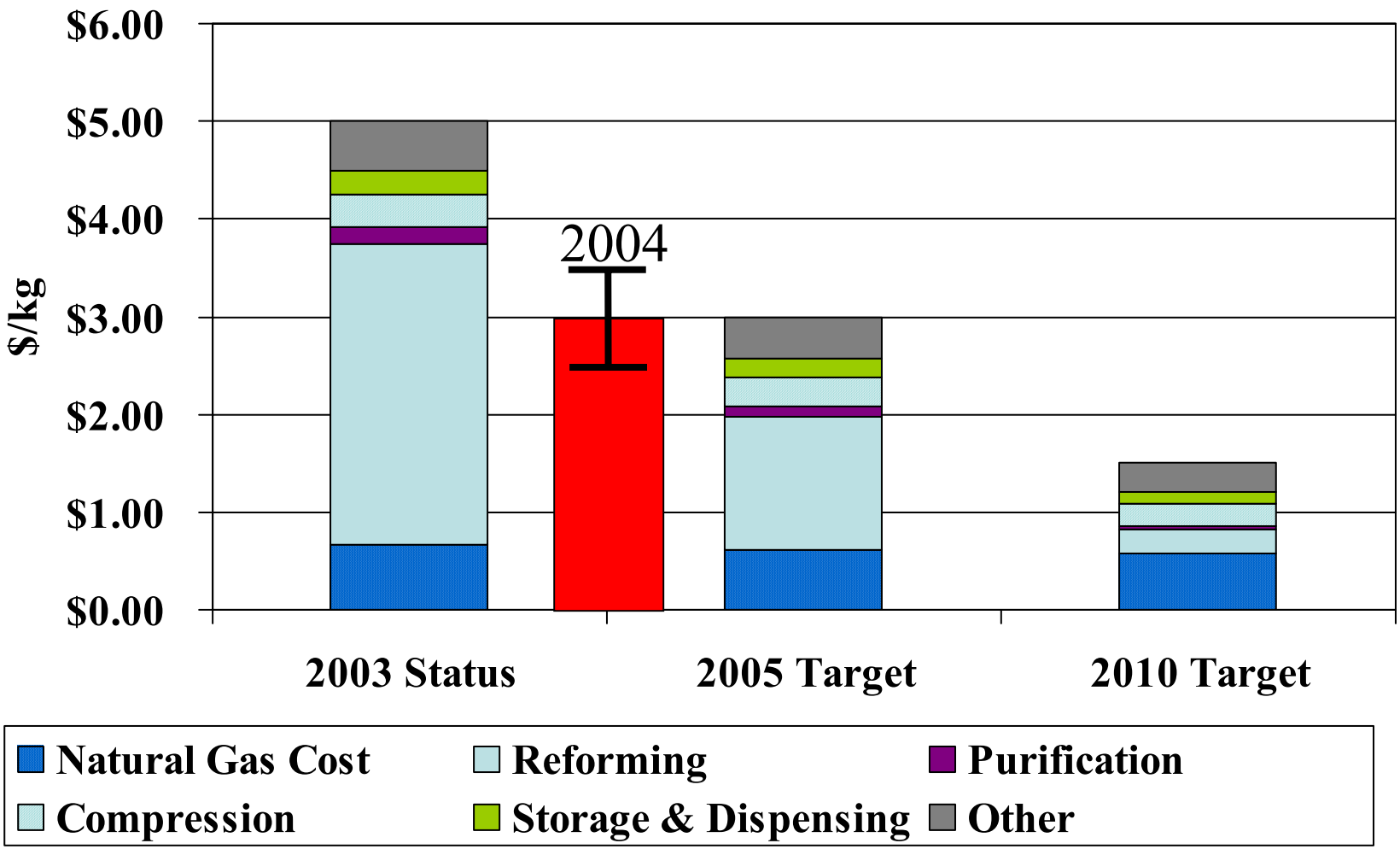
NRC Recommendations for Transition to a Hydrogen Economy

- Distributed hydrogen production systems deserve increased R&D investments by DOE.
- Increased R&D efforts and accelerated program timing could decrease the capital cost and increase the energy efficiency of small-scale natural gas reformers and water electrolysis systems.
- Initiate a program to develop new concepts in distributed hydrogen production systems that have the potential to compete—in cost, energy efficiency, and safety—with centralized systems.

Production Scales

Central Plant	1,200,00 Kg per day	90% Capacity	2 million cars
Midsize Plant	24,000 Kg per day	90% Capacity	40,000 cars
Distributed Plants	1,500 Kg Per day	90% Capacity	3000 cars

Distributed Production of Hydrogen From Natural Gas and Liquid Fuels (up to 1,500 kg/day)



Distributed Hydrogen Production From Natural Gas On Target

- APCI validated $3.60/gge hydrogen – delivered, untaxed, co-producing electricity at 8¢ per kWh.
- $3.00/gge target in 2005 within reach
- Reformer research
  - Optimized desulfurization, reformer, and shift catalysts
  - Improved heat recovery system
- PSA research
  - 99.999% pure H_2
  - 3x cost reduction compared to commercial units
  - Decreased size
  - 82% efficiency (64% in 2003)

Las Vegas station

PSA Unit

In 2025, assuming FCVs represent 12% of LDV inventory, EIA estimates only 2.8% increase in natural gas demand compared to reference case

NEW Hydrogen and Fuel Cell Projects

Hydrogen Storage - $150M over 5 years

- Three Centers of Excellence for exploratory research; individual projects to explore new materials for hydrogen storage ($25M in cost share)

Vehicle and Infrastructure "Learning" Demonstration - $190M over 5 years

- Automobile/energy company teams will demonstrate integrated and complete system solutions in real world environments ($190M in cost share)

Fuel Cell Research - $13M over 2 years **in addition to $75M awarded in FY2003*

- Consumer electronics, fuel cells for auxiliary power generation, and off-road fuel cell R&D ($9.5M in cost share)

Hydrogen Education - $4.5M over 5 years

- Curricula and teacher professional development, education materials, co-sponsorship of events ($800K in cost share)

Active DOE Solicitations

Production and Delivery:	August, 2004 - SELECTIONS
Hydrogen from Nuclear:	September, 2004 - SELECTIONS
Codes and Standards:	October, 2004 - SELECTIONS
Basic Research:	2005 SELECTIONS
Hydrogen from Coal:	OPEN Until October

For More Information

DOE Hydrogen Production Team

Arlene Anderson: Hydrogen Separations, Distributed Production from Natural Gas

Mark Paster: Distributed, Regional and Central Production from Biomass, Hydrogen Delivery

Roxanne Danz: Photobiological Production

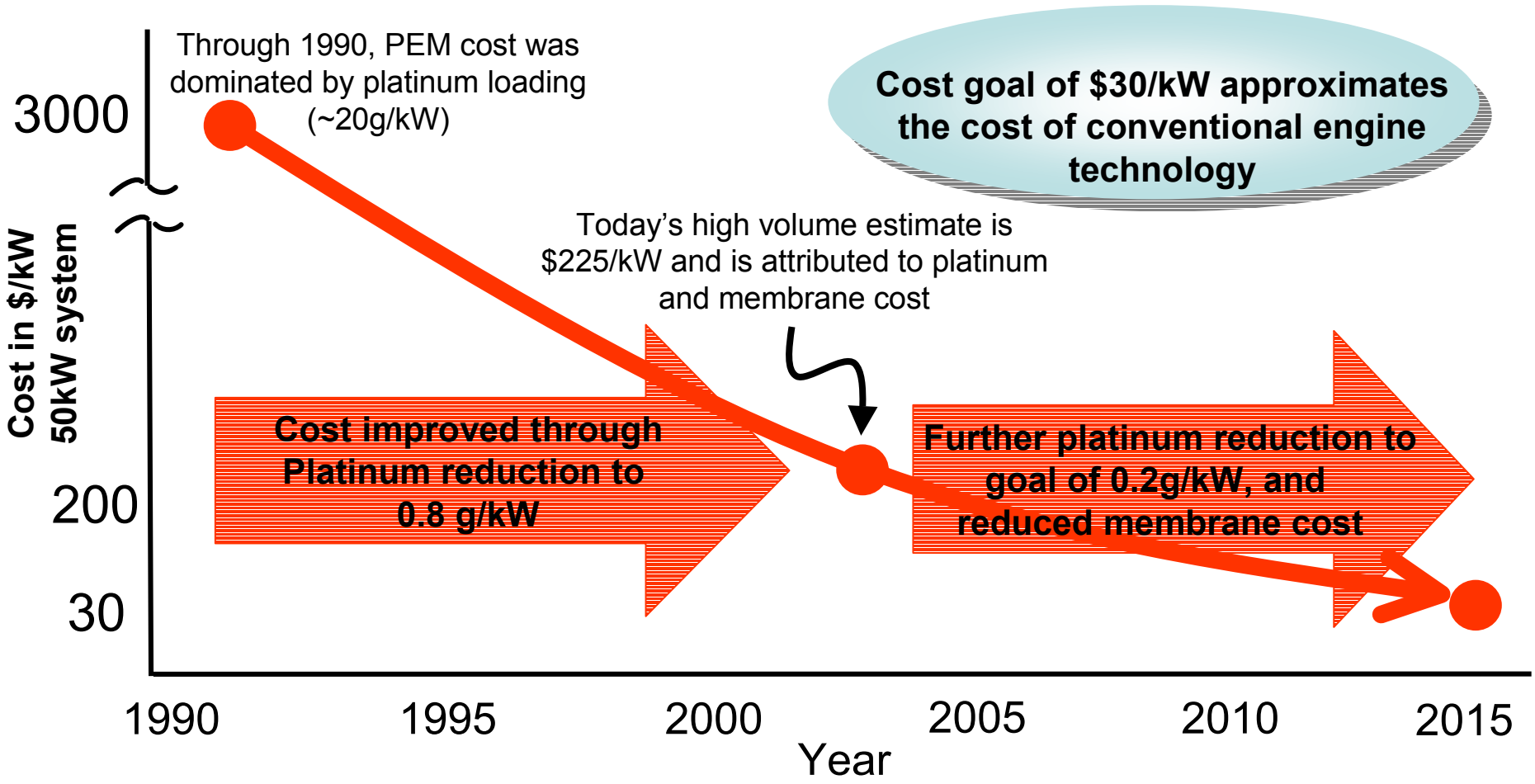
Peter Devlin: Team Leader

www.eere.energy.gov/hydrogenandfuelcells

- THE FOLLOWING ARE BACKUP OVERHEADS

PEM Fuel Cell Cost
7X gap between today's high volume cost & our target

Cost of a fuel cell prototype remains high (~$3,000/kW), but the high volume[1] production cost of today's technology has been reduced to $225/kW



1. High volume production defined as 500,000 units per year Cost estimated by Tiax with enhanced hydrogen storage.