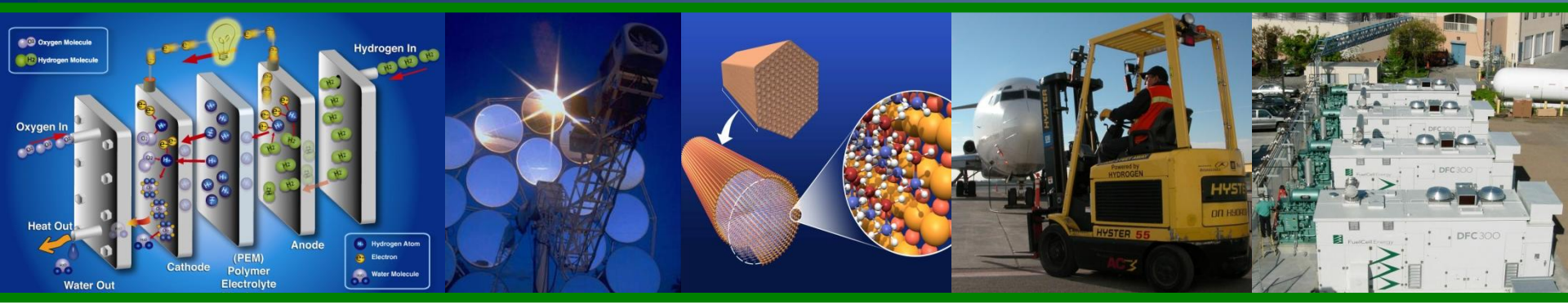
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



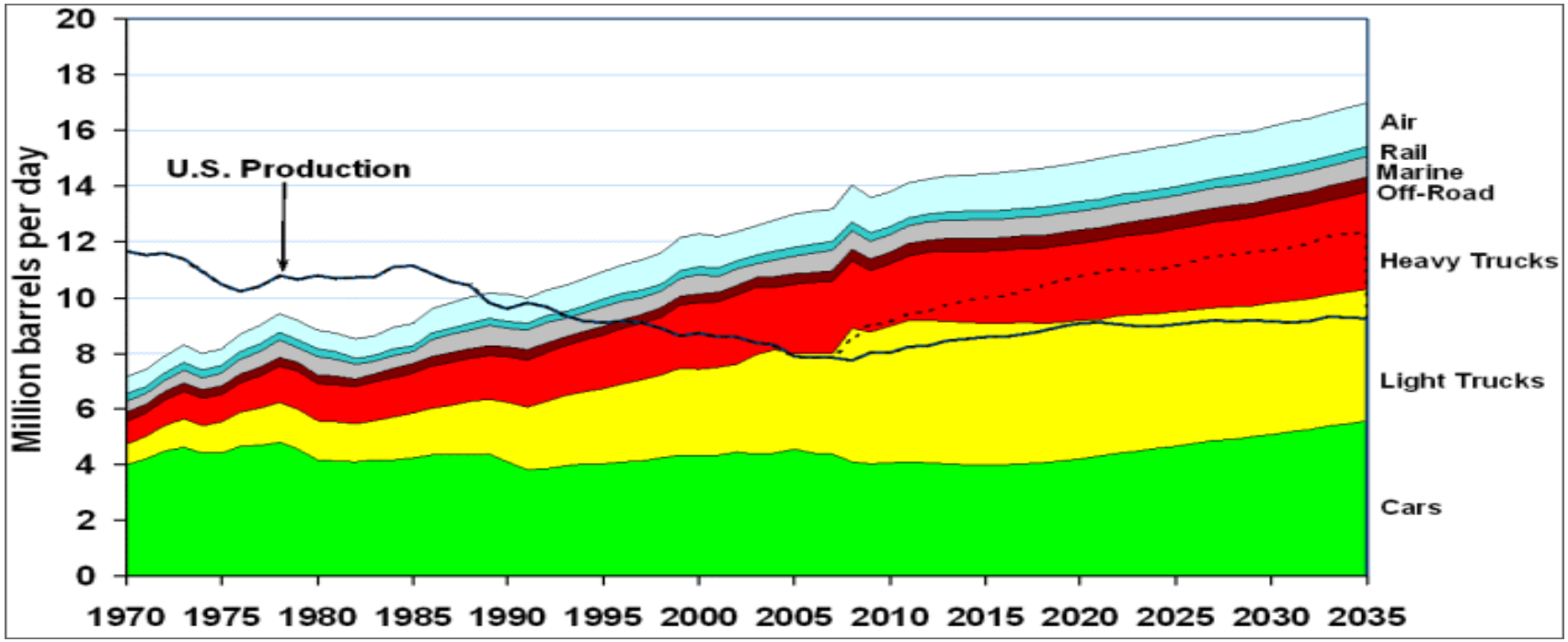
U.S. Department of Energy Efforts in Electrified Vehicle Power

Jason Marcinkoski

IPHE Workshop: Governmental Programs on E-Mobility

(15th of June 2010)

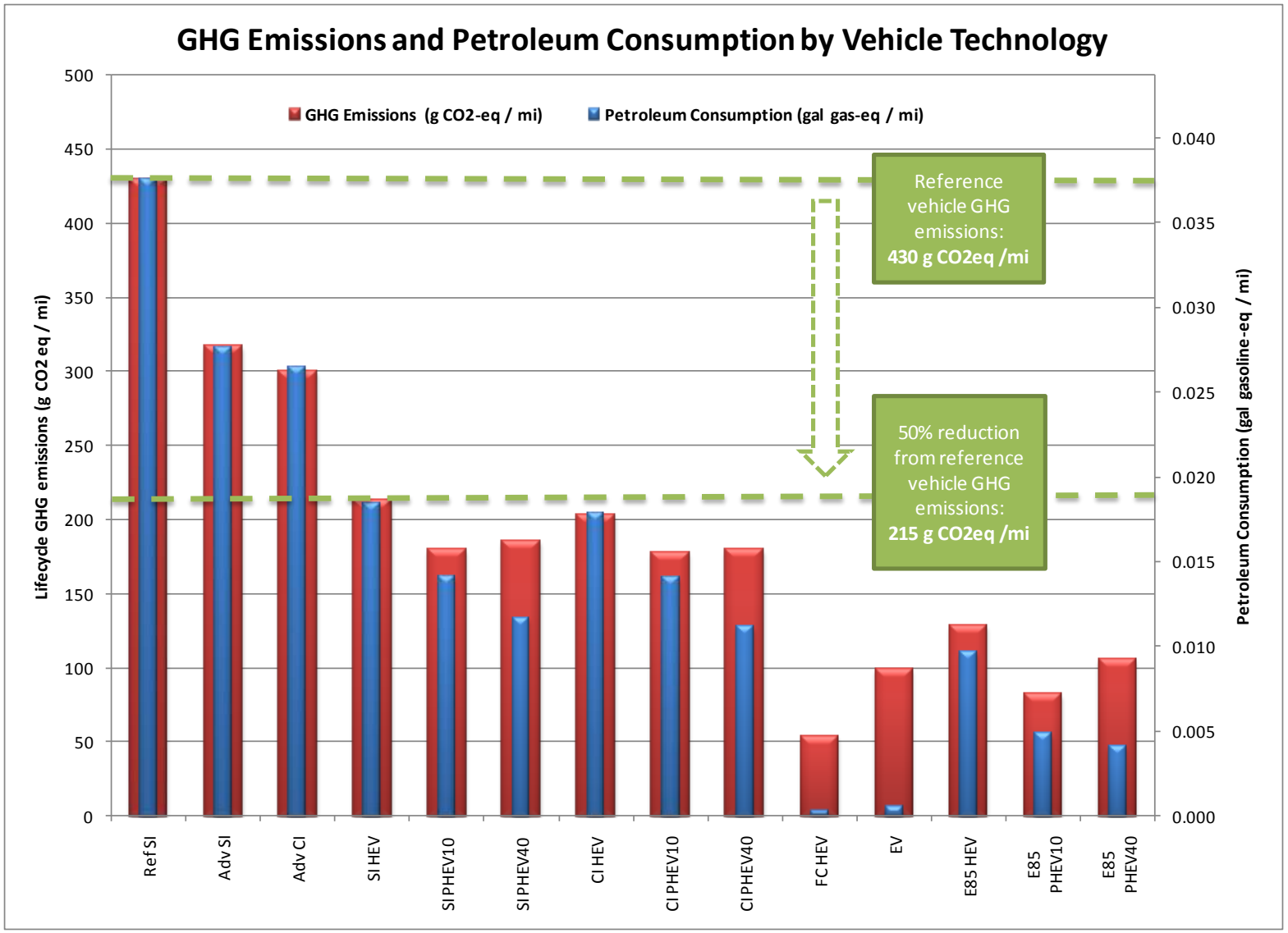
Reliance on Petroleum is **NOT** Sustainable



- Transportation sector uses about 70% of our nation's typical oil consumption. Over 65% of the oil we consume is imported.
- The United States imports over 300 million gallons of oil per day at a cost of over $500 Million/day ($16B/month).
  - ***Oil imports are over twice the amount of our single largest export***
- Current studies estimate the cost impact of transportation related emissions on public health issues to be between $40B to $60B/yr

Analysis Informs Strategy

- Vehicle GHG emissions fall into 3 major groups:
  - Conventional
  - Electric-drive
  - Combination electric-drive & biofuel
- Petroleum consumption loosely mirrors GHG emissions



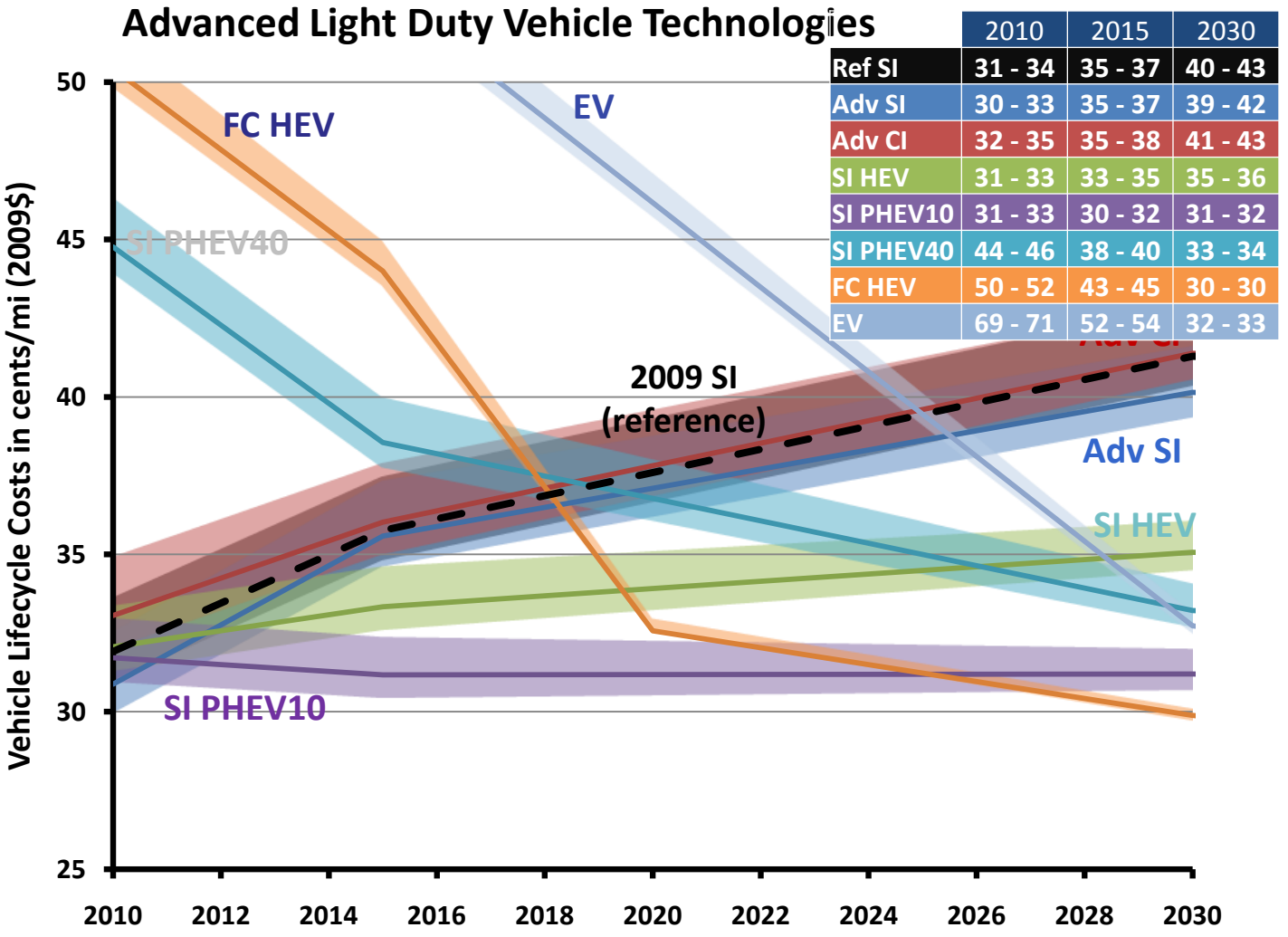
EERE research can make these cost-effective in the near to mid term

2015

- Lifetime cost of diesel vehicle ownership is roughly equivalent to an SI ICE.
- HEVs and PHEV10s are competitive.
- Energy storage requirements and costs are still high for PHEV40s and EVs.

2030

- Hybrid, electrified, and fuel cell vehicles are competitive.
- Diesels cost is still roughly equivalent to an SI ICE.
- **Standard discount rate assumptions** overestimate consumers' value of future fuel savings and, therefore, perceived competitiveness.



	2010	2015	2030
Ref SI	31 - 34	35 - 37	40 - 43
Adv SI	30 - 33	35 - 37	39 - 42
Adv CI	32 - 35	35 - 38	41 - 43
SI HEV	31 - 33	33 - 35	35 - 36
SI PHEV10	31 - 33	30 - 32	31 - 32
SI PHEV40	44 - 46	38 - 40	33 - 34
FC HEV	50 - 52	43 - 45	30 - 30
EV	69 - 71	52 - 54	32 - 33

*** No state, local or utility incentives are included. Federal subsidy policies (e.g., ARRA09 credits for PHEVs) are also excluded. Fuel prices follow AEO09 high oil projections (gases rises from $3.07 in 2010 to $5.47 in 2030; diesel increases from $3.02 in 2010 to $5.57 in 2030); fuel taxes are included in EIA estimates. The vehicle cost range represents a range of potential carbon prices, from $0 to $56 (the centerline is plotted at a carbon price of $20). Technology costs are estimated based on a 50% ("average") likelihood of achieving program goals. Vehicles assume a 15 year, 150000 mile life except FCVs to 2020, which assume 75000 miles.**

The Administration's Clean Energy Goals

- ✓ **Double Renewable Energy Capacity by 2012**
- ✓ **Invest $150 billion over ten years in energy R&D to transition to a clean energy economy**
- ✓ **Reduce GHG emissions 83% by 2050**

Example - Executive Order 13514

On October 5, 2009 President Obama signed Executive Order 13514 – Federal Leadership in Environmental, Energy, and Economic Performance

- **Requires Agencies to:**
  - **Set GHG reduction Targets**
  - **Develop Strategic Sustainability Plans and provide in concert with budget submissions**
  - **Conduct bottom up Scope 1, 2 and 3 baselines**
  - **Track performance**

Examples:

- **Achieve** 30% reduction in vehicle fleet petroleum use by 2020
- **Requires** 15% of buildings meet the *Guiding Principles for High Performance and Sustainable Buildings* by 2015
- **Design** all new Federal buildings which begin the planning process by 2020 to achieve zero-net energy by 2030

http://www1.eere.energy.gov/femp/regulations/eo13514.html

Advanced Technologies for High Efficiency Clean Vehicles

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Hybrid Electric Systems

- Advanced Batteries
- Power Electronics/
- Inverters/Controllers
- & Motors
- Systems Analysis and Testing
- Aerodynamics, Rolling Resistance & Accessory Loads
- Validation

Tech Introduction

- EPAct/EISA
- Rulemaking
- Deployment
- Student Competitions
- Graduate Automotive Technology Education
- Education
- Safety, Codes, & Standards

Advanced Combustion Engine R&D

- Low Temp. Combustion R&D
- Emission Controls
- Light- & Heavy-Duty Engines
- Solid State Energy Conversion
- Health Impacts

Fuels Technology

- Bio-Based Fuels
- Clean/Efficient Combustion Fuel Characteristics
- Fischer-Tropsch Fuels & Blendstocks
- Advanced Lubricants

Materials Technology

- Lightweight Structures
- Composite Development
- Processing/Recycling/ Manufacturing
- Design Data Test Methods
- High Temperature Materials Laboratory

Budget 2010

Activity	FY 2009 Approp	FY 2010 Approp[1]	FY 2011 Request[1]
Batteries and Electric Drive Technology	101,572	101,405	120,637
Vehicle and System Simulations & Testing	21,126	44,328	44,328
Advanced Combustion Engine R&D	39,657	57,600	57,600
Materials Technology	38,786	50,723	50,723
Fuels Technology	19,560	24,095	11,000
Outreach, Deployment & Analysis	46,422	33,214	41,014
TOTAL	267,123	311,365	325,302

[1]Includes SBIR/STTR *Funding -- $ in thousands*

Other FY 2010 DOE-Related Vehicle Activities

- Section 136 Loan Program $25.0 B
- American Recovery and Reinvestment Act $2.8 B
- Office of Science, Advanced Research Projects Agency – Energy (ARPA-E), Office of Electricity

Hybrid-Electric Systems Petroleum Displacement via Fuel Substitution & Improved Efficiency

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Administration Goal:1 Million PHEVs by 2015

Types of Vehicles and Benefits

HEV →  Toyota Prius — 50 MPG

PHEV →  Chevy Volt — 100 MPGe

EV →  Nissan Leaf — All Electric

System Cost

	PHEV Battery Cost per kW·h	APEEM Cost per kW
2008	$1,000 - $1,200	$22
2010	$700 - $950	$19
2012	Goal = $500	Goal = $17
2014	Goal = $300	
2015		Goal = $12

Targets and Status

2014 PHEV: Battery that has 40-mile all-electric range and costs $3,400

2015 PEEM: Cost for electric traction system no greater than $12/kW peak by 2015

Status: $8,000-$11,000 for PHEV 40-mile range battery

Status: Current cost of electric traction system is $40/kW

PHEV Battery Targets & Challenges

Key Challenges

- Weight and volume for the PHEV-40
- Extending life (while operating in 2 discharge modes)
- Reducing cost

Battery Attribute	Current Status	Goals	
		2012	2014
Available Energy	3.4 kWh	3.4 kWh (10 mile)	11.6 kWh (40 mile)
Cost	$800^{+}/kWh	$500/kWh	$300/kWh
Cycle Life (EV Cycles)	2,000^{+}	5,000	3000-5000
Cycle Life (HEV Cycles)	300,000	300,000	200,00-300,000
Calendar Life	3^{+} years	10^{+} years	10^{+} years
System Weight	80-120 kg	60 kg	120 kg
System Volume	70 liters	40 liters	80 liters

Li-ion Batteries for HEVs

R&D focus remains on cost reduction and improved abuse tolerance

Significant Progress

- Most HEV performance requirements have been met by Li-ion batteries developed with DOE/USABC support.
  - Mature Li-ion chemistries have demonstrated more than 10-year life through accelerated aging and 300,000 cycles through testing
- Li-ion batteries for HEVs are ready for commercialization.
  - Johnson Controls/Saft to supply HEV batteries to Mercedes, BMW
  - A123Systems is developing prototype HEV & PHEV lithium-ion batteries through contracts supported by DOE

APEEM Research Targets, Challenges, and Research Areas

Reduce Dependence on Oil

Via Electrification of Vehicle Drives

Requirements: 55 kW peak for 18 sec; 30 kW continuous; 15-year life

Technology Targets

	Traction Drive System				Power Electronics			Motors		
Year	($/kW)	(kW/kg)	(kW/l)	Efficiency	($/kW)	(kW/kg)	(kW/l)	($/kW)	(kW/kg)	(kW/l)
2010	19	1.06	2.6	>90%	7.9	10.8	8.7	11.1	1.2	3.7
2015	12	1.2	3.5	>93%	5	12	12	7	1.3	5
2020	8	1.4	4	>94%	3.3	14.1	13.4	4.7	1.6	5.7

Challenges

size cost weight

Research Areas

Power Electronics

- Innovative topologies
- Temperature-tolerant devices
- Packaging
- Capacitors
- Vehicle charging

Electric Machines

- Permanent magnet (PM) motors
- Magnetic materials
- High-performance non-PM motors
- New materials

PEEM Thermal Management

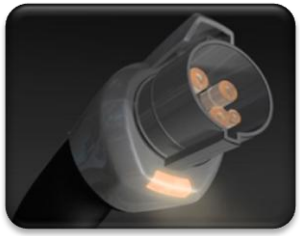
- Thermal system integration
- Heat transfer technologies
- Thermal stress and reliability

Traction Drive System

- Benchmarking technologies
- Innovative system designs

Demonstrate market readiness of grid-connected vehicles, create market demand for EVs





Targets and Status

2012 Goal: 62 Million miles of on-road HEV/PHEV/BEV testing. Finalized standards for grid-connected vehicle energy consumption measurement, communication, and safety practices.
2014 Goal: 107 Million miles of on-road HEV/PHEV/BEV testing.
2015 Goal: Accumulate 112 Million miles of on-road HEV/PHEV/BEV testing

Status: Completed total of 15 Million miles of on-road operational performance and cost data on more than 1,600 electric drive vehicles

Accomplishments

- Collected operational performance and cost data on 292 electric drive vehicles over 1.6 Million miles in 2009
- Collected operational performance and cost data on 238 electric drive vehicles over 775,000 miles in 2010
- Modeling and Simulation: Completed initial development of future industry standard modeling tool (Autonomie) in cooperation with General Motors
- Codes and Standards: Completed HEV/PHEV testing standards work and Level 2 charging connector standards in partnership with industry

Recommended Practices for Plug-in Vehicles, Charging Equipment and Grid Connectivity

Standards support

1. SAE J1711 Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid Electric Vehicles
2. SAE J1772 SAE Electric Vehicle Conductive Charge Coupler
3. SAE J2836/1/2/3 Use Cases for Communication between Plug-in Vehicles and the Utility Grid/EVSE/Reverse Power Flow
4. SAE J2847/1/2/3 Communication between Plug-in Vehicles and the Utility Grid/EVSE/Reverse Power Flow
5. NFPA 70E NEC-part 625, paragraph 13 Evaluate “permanently connected” to allow low-cost EVSE options

Plus National Recommended Practices for permitting and installation of charging equipment (streamlined/automated process)

EcoCAR: The NeXt Challenge

Student teams just finished their second year of competition in May at the Desert Proving Grounds in Yuma, AZ.

Progressive Automotive X PRIZE:

Inspiring a new generation of super-efficient vehicles that dramatically reduce oil dependence and greenhouse gas emissions.

Green Racing

DOE, EPA and SAE International initiative, adopted by the American Le Mans Series in 2009. Biobutanol, cellulosic ethanol and hybrid powertrains were introduced in the 2009, 2010 seasons.

Clean Cities

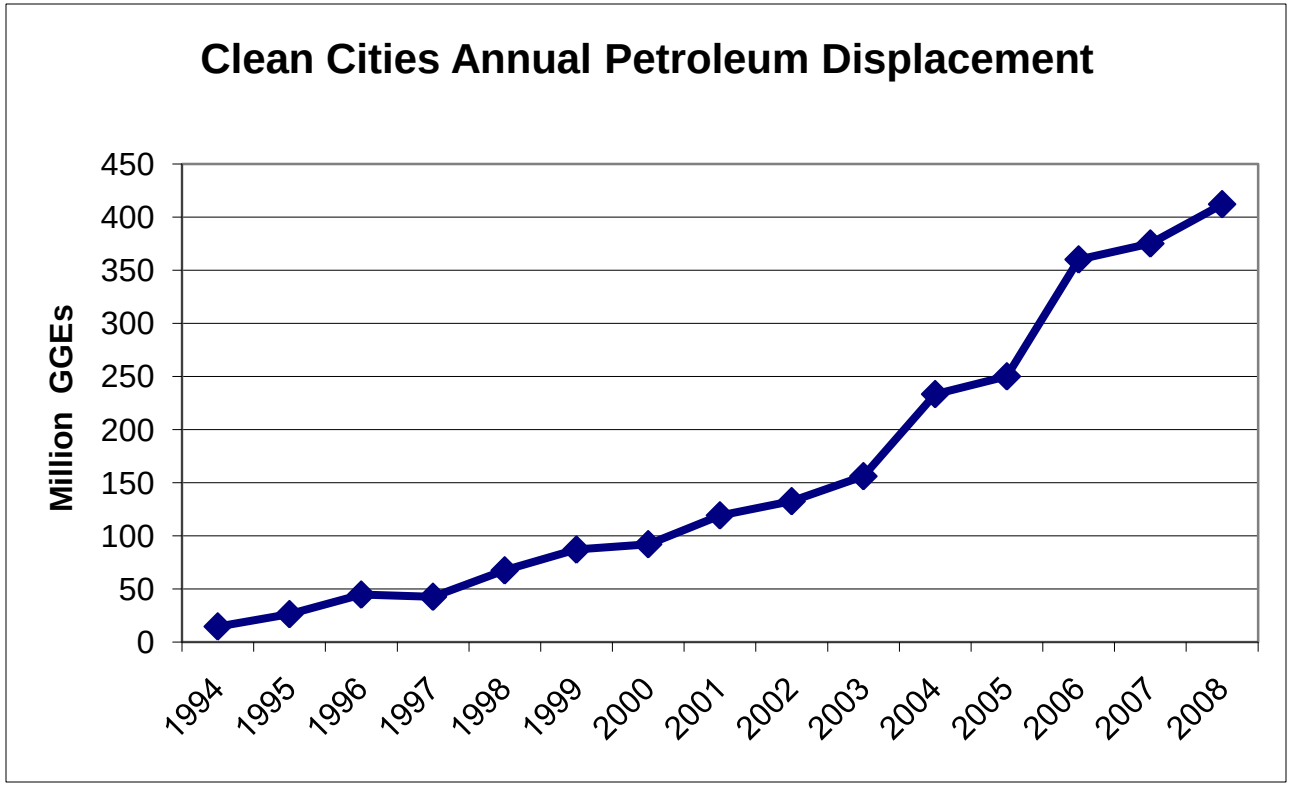
Improving the speed and scale of market penetration for alternative fuel vehicles and infrastructure

2.4 Billion Gallons of Petroleum Displaced Since 1993

Clean Cities
U.S. Department of Energy

Recovery Act Results

- New Vehicle Distribution: more than 9,000 vehicles, displacing an estimated 38 million gallons of petroleum/year
  - Approximately 5,500 light duty vehicles
  - More than 3,500 medium and heavy duty vehicles
- More than 2,100 new fueling and charging stations



Worksheet available at www.afdc.energy.gov/afdc/data

Recovery Act :
> $2.8 Billion More than 98 projects awarded

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$1.5 Billion in funding to accelerate the manufacturing and deployment of the next generation of U.S. batteries

$500 Million in funding for electric-drive components manufacturing

$400 Million in funding for transportation electrification

Facilities and Equipment Upgrade up to $105 Million: User Centers, offer expert staff and unique equipment capabilities that no one industrial entity can afford to maintain.

Clean Cities: Petroleum Displacement through Alternative Fuel Vehicles and Expanded Alternative Fuel Infrastructure

SuperTruck and Advanced Combustion R&D $104.4 Million Solicitation:

Heavy-duty trucks are emphasized because they rapidly adopt new technologies and account for 20% of the fuel consumed in the United States.

Recovery Act Funding

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

$1.5 Billion for Advanced Battery Manufacturing for Electric Drive Vehicles
"Commercial Ready Technologies"

Material Supply	Cell Components	Cell Fabrication	Pack Assembly	Recycling
Lithium Supply 1 award	Cathode Prod. 3 awards	Iron Phosphate 1 award	Iron Phosphate 1 award	Lithium Ion 1 award
	Anode Prod. 2 awards	Nickel Cobalt Metal 3 awards	Nickel Cobalt Metal 3 awards	
	Electrolyte Prod. 2 awards	Manganese Spinel 2 awards	Manganese Spinel 2 awards	
	Separator Prod. 2 awards		Advanced Lead Acid Batteries 2 awards	
	Other Component 1 award			
$28.43 M	**$259 M**	**$735 M**	**$462 M**	**$9.55 M**

Recovery Act Funding

$500 Million for Electric Drive Components

Power Electronics – Power inverters and converters for electric drivetrains

Awards:

- ***Delphi***
- ***Powerex***

Electric Motors – Hybrid and Plug-in Hybrid capable designs

Awards:

- ***Remy***
- ***General Motors***

DC Bus Capacitor – Improved technology reduces inverter size, weight, volume and cost

Awards:

- ***Kemet***
- ***SBE***

Traction Drive Systems – Enables all-electric operation for vehicles

Awards:

- ***Ford***
- ***Magna***
- ***Allison***
- ***UQM***

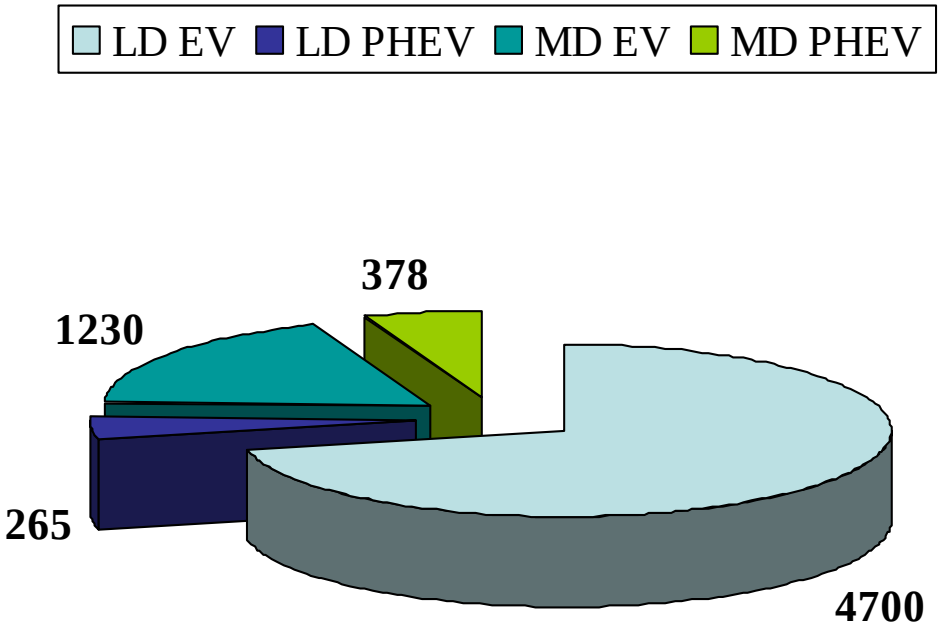
Recovery Act Funding

$400 Million Transportation Electrification Projects

Demonstration projects include:

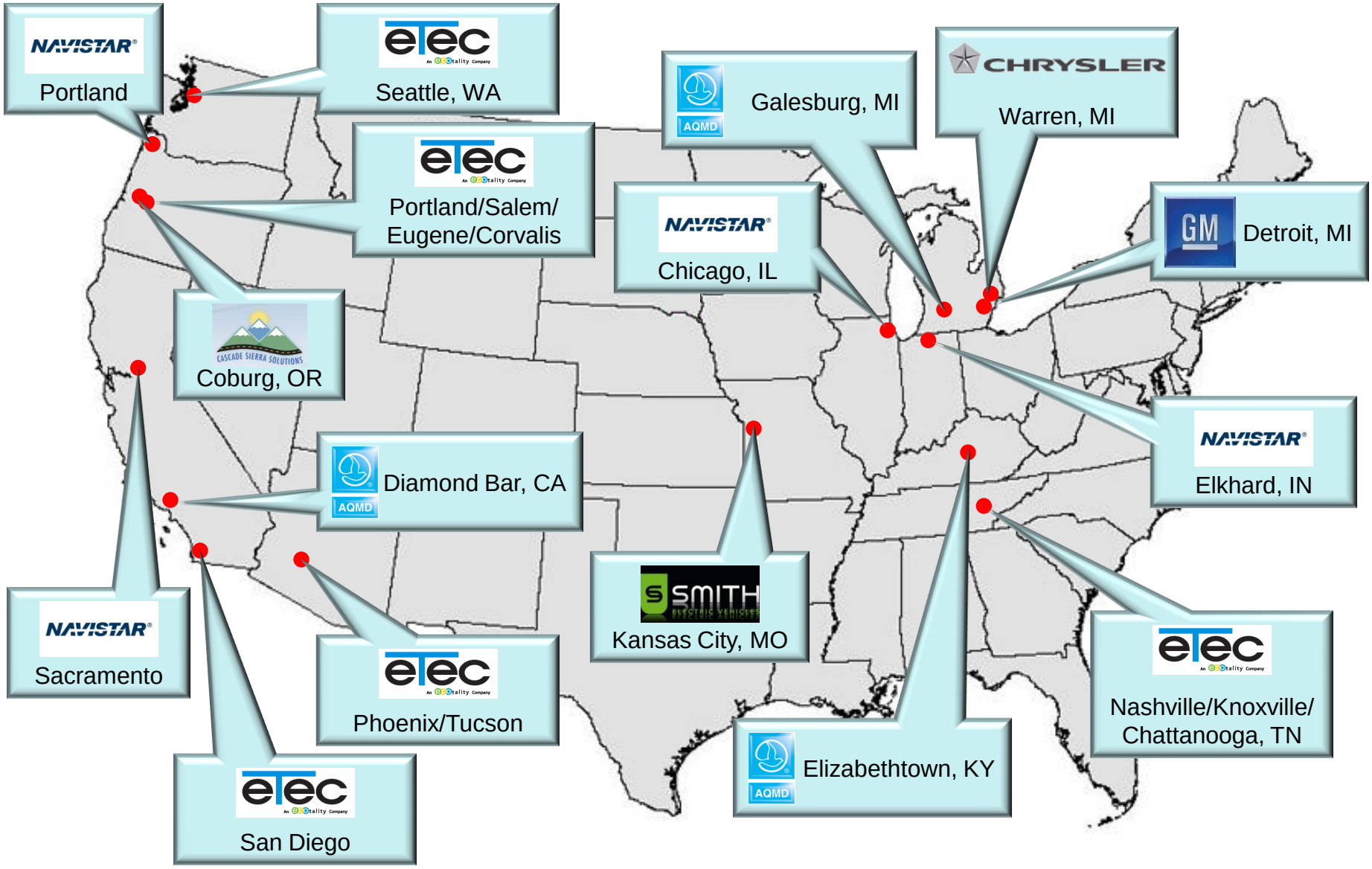
- Collection of in-use, operational, and charging data on more than 6,500 EVs and PHEVs – the largest number of plug-in vehicles ever on the road in the U.S.
- Installation of over 13,000 charging sites, more than have ever been installed in the U.S. The majority will be concentrated around Phoenix, San Diego, Smyrna and Nashville (Tennessee), and Seattle
- 10 Education Grants including the first programs to educate first responders and emergency personnel in how to deal with accidents involving EVs and PHEVs
- 5,015 Idle Reduction Units on Heavy Trucks and 50 TSE Sites

Vehicle Quantity by Type



Total: 6,573

Transportation Electrification Demonstration Activities – Geographic Distribution



Fuel Cell Technologies

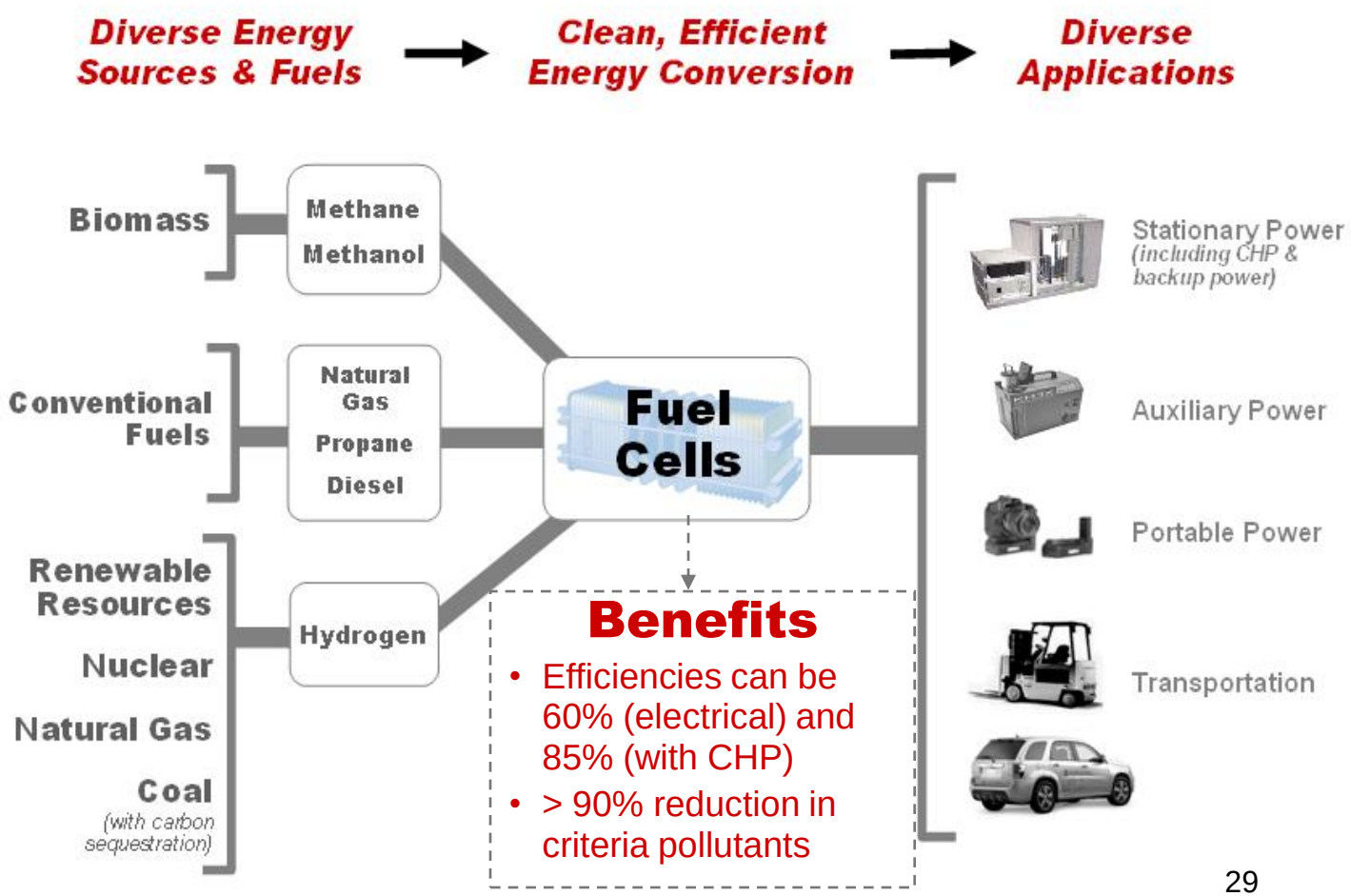
Fuel Cells Address Key Energy Challenges

Increasing Energy Efficiency and Resource Diversity

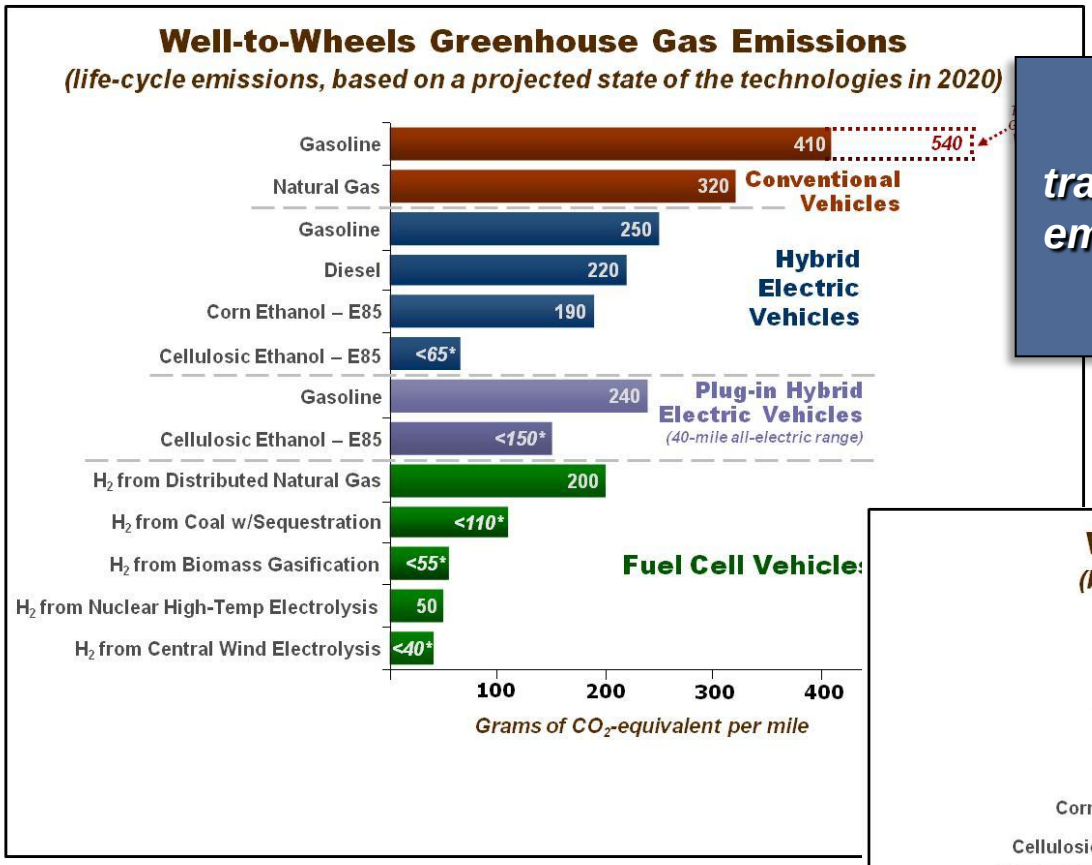
→ Fuel cells offer a highly efficient way to use diverse fuels and energy sources.

Reducing Greenhouse Gas Emissions and Air Pollution:

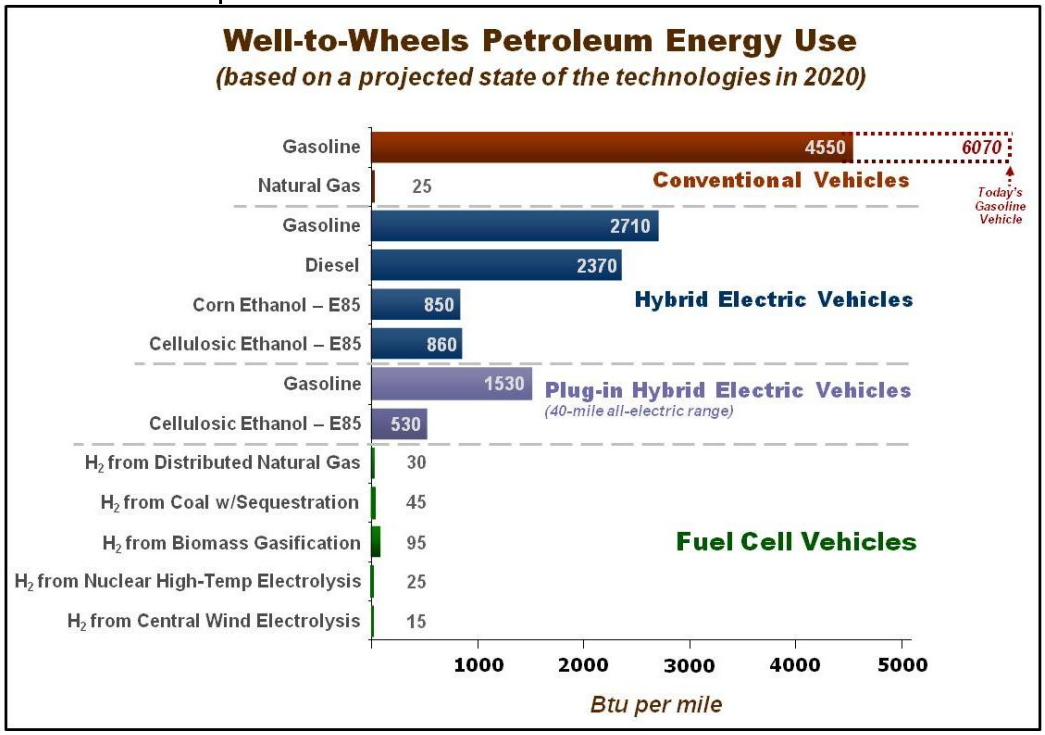
→ Fuel cells can be powered by emissions-free fuels that are produced from clean, domestic resources.



Systems Analysis — *Examples of Benefits*



Analysis shows DOE's portfolio of transportation technologies will reduce emissions of greenhouse gases and oil consumption.



DOE Program Record #9002,
www.hydrogen.energy.gov/program_records.html.

Key Challenges

The Program has been addressing the key challenges facing the widespread commercialization of fuel cells.

Technology Barriers*

Fuel Cell Cost & Durability

*Targets**:

Stationary Systems: $750 per kW, 40,000-hr durability

Vehicles: $30 per kW, 5,000-hr durability

Hydrogen Cost

Proposed target*: ~ $6 / gge (dispensed and untaxed)

Hydrogen Storage Capacity

Target: > 300-mile range for vehicles—without compromising interior space or performance

Technology Validation:

Technologies must be demonstrated under real-world conditions.

Economic & Institutional Barriers

Safety, Codes & Standards Development

Domestic Manufacturing & Supplier Base

Public Awareness & Acceptance

Hydrogen Supply & Delivery Infrastructure

Market Transformation

Assisting the growth of early markets will help to overcome many barriers, including achieving significant cost reductions through economies of scale.

*Metrics available/under development for various applications

Policies Promoting Fuel Cells

Some tax credits affecting fuel cells were expanded. Through new financing mechanisms, these credits can help facilitate federal deployments.

Hydrogen Fueling Facility Credit	**Increases the hydrogen fueling credit from 30% or $30,000 to 30% or $200,000.**
Grants for Energy Property in Lieu of Tax Credits	**Allows facilities with insufficient tax liability to apply for a grant instead of claiming the Investment Tax Credit (ITC) or Production Tax Credit (PTC). Only entities that pay taxes are eligible.**
Manufacturing Credit	**Creates 30% credit for investment in property used for manufacturing fuel cells and other technologies**
Residential Energy Efficiency Credit	**Raises ITC dollar cap for residential fuel cells in joint occupancy dwellings to $3,334/kW.**

Funding for Fuel Cells and Hydrogen
DOE FY11 Budget Request

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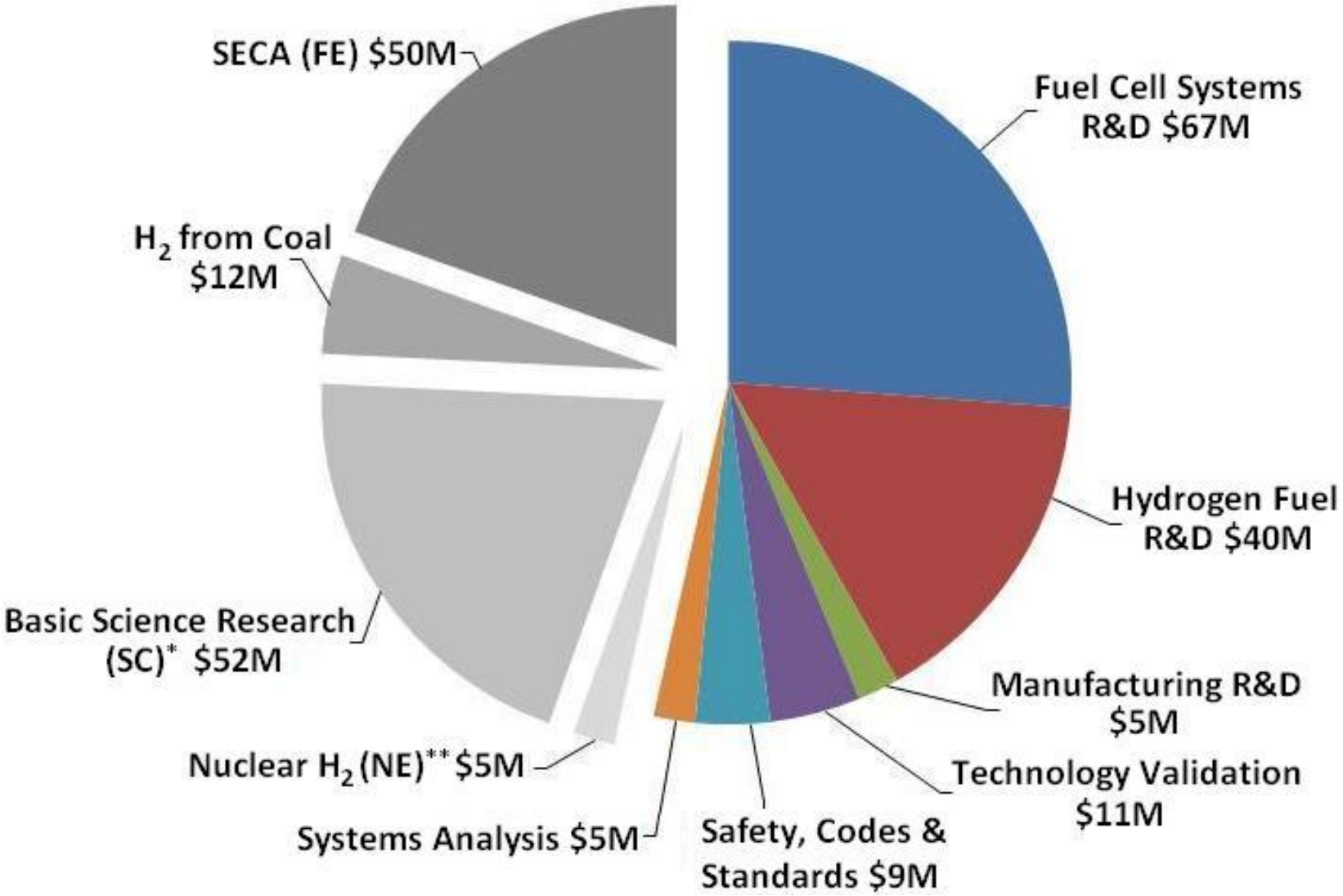
Total Requested Funding: ~$256 Million



* SC funding includes BES and BER
** NE FY11 Request TBD (FY10 funding was $5M)

Fuel Cells for Stationary Power, Auxiliary Power, and Specialty Vehicles

The largest markets for fuel cells today are in stationary power, portable power, auxiliary power units, and forklifts.

~75,000 fuel cells shipped worldwide

~24,000 fuel cells shipped in 2009 (> 40% increase over 2008)

Fuel cells can be a cost-competitive option for critical-load facilities, backup power, and forklifts.

Production & Delivery of Hydrogen

In the U.S., there is currently:

- **~9 million metric tons of H_2 produced annually**
- **>1,200 miles of pipelines**

Fuel Cells for Transportation

In the U.S., there are currently:

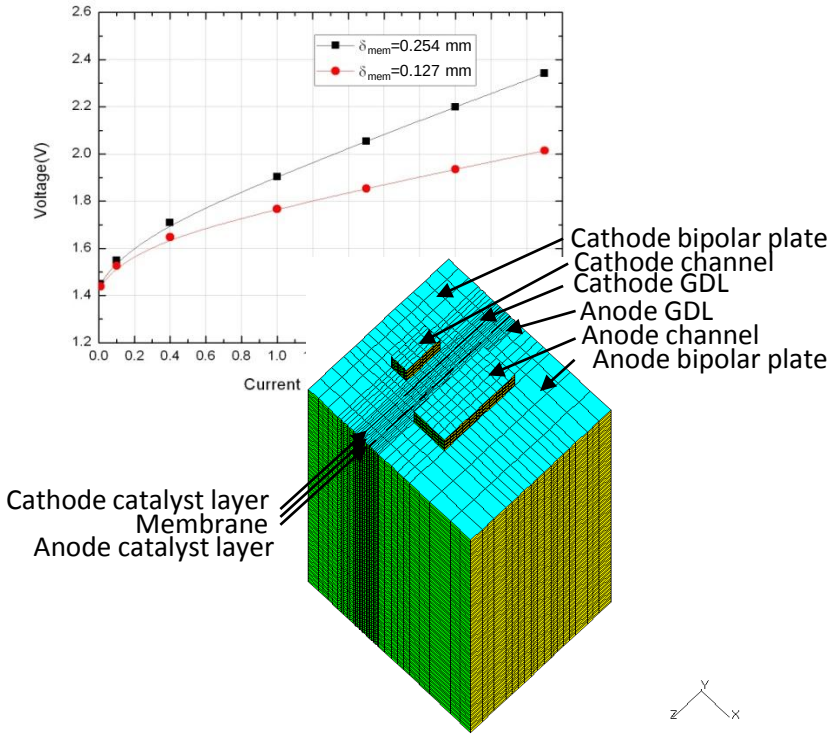
- ***> 150 fuel cell vehicles***
- ***~ 15 active fuel cell buses***
- ***> 50 fueling stations***

Sept. 2009: Auto manufacturers from around the world signed a letter of understanding supporting fuel cell vehicles in anticipation of widespread commercialization, beginning in 2015.

The key objective is to reduce cost of H_2 (delivered, dispensed & untaxed)

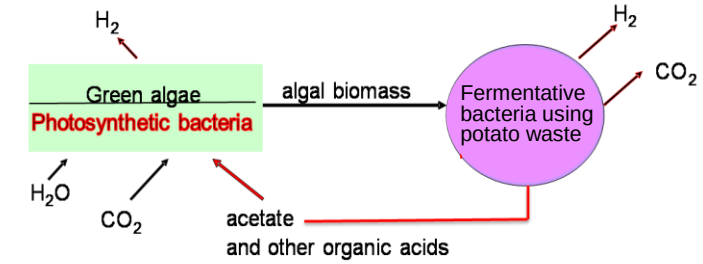
Electrolysis

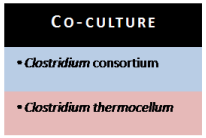
> 20% reduction cost of electrolyzer cell via a 55% reduction in catalyst loading from new process techniques (Proton Energy)

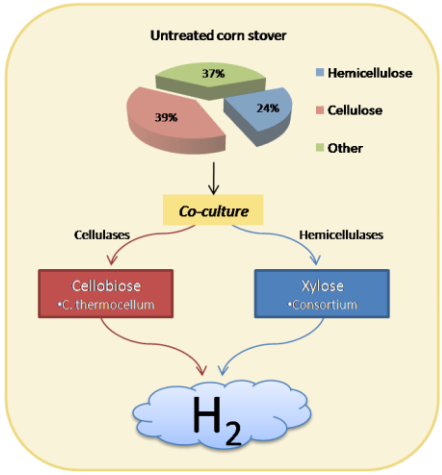


Algae

Continuous fermentative / photobiological H_2 production from potato waste achieved a maximum molar yield of 5.6 H_2 / glucose (NREL)

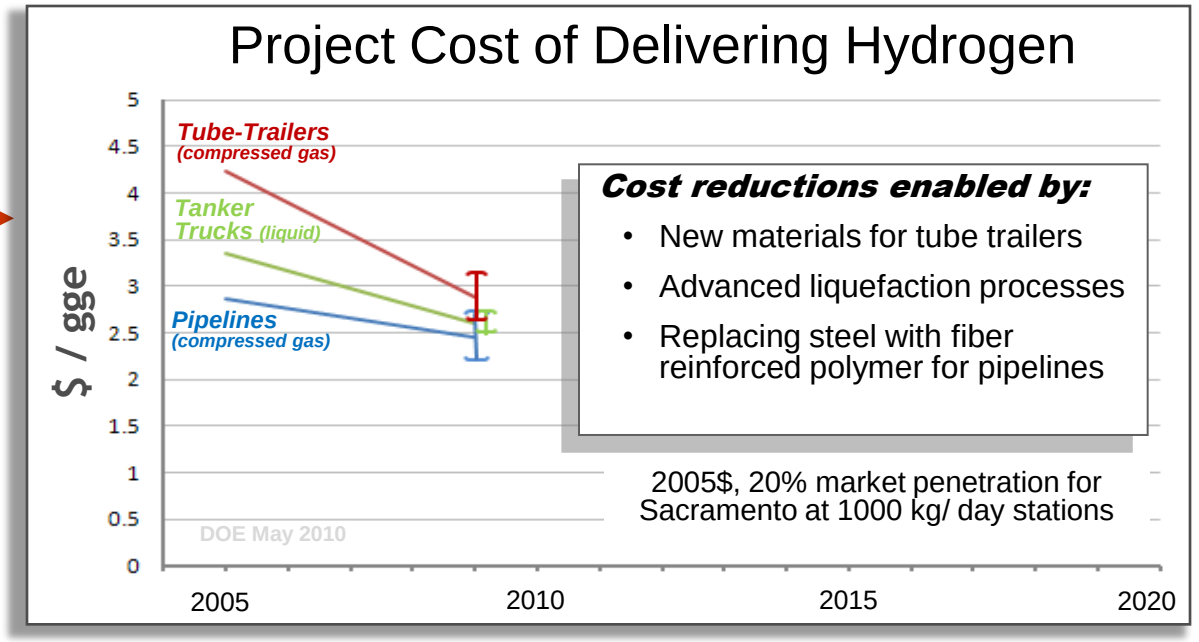






We've reduced the cost of hydrogen delivery* —

- *~30% reduction in tube trailer costs*
- *>20% reduction in pipeline costs*
- *~15% reduction liquid hydrogen delivery costs*



**Projected cost, based on analysis of state-of-the-art technology*

RECENT ACCOMPLISHMENTS

- Testing demonstrated Cryopump flow rates up to 2 kg / min exceeding targets (BMW, Linde, LLNL)
  - Provides lowest cost compression option for a station and meets the challenges of sequential vehicle refueling
- Demonstrated manufacturability and scalability of glass fiber wrapped tanks through sequential prototypes (3 to 24 to 144 inches in length) (LLNL)
- Completed design criteria and specifications for centrifugal compression of hydrogen which are projected to meet or exceed DOE targets. Compressor designed using off-the-shelf parts is in testing (Concepts NREC)

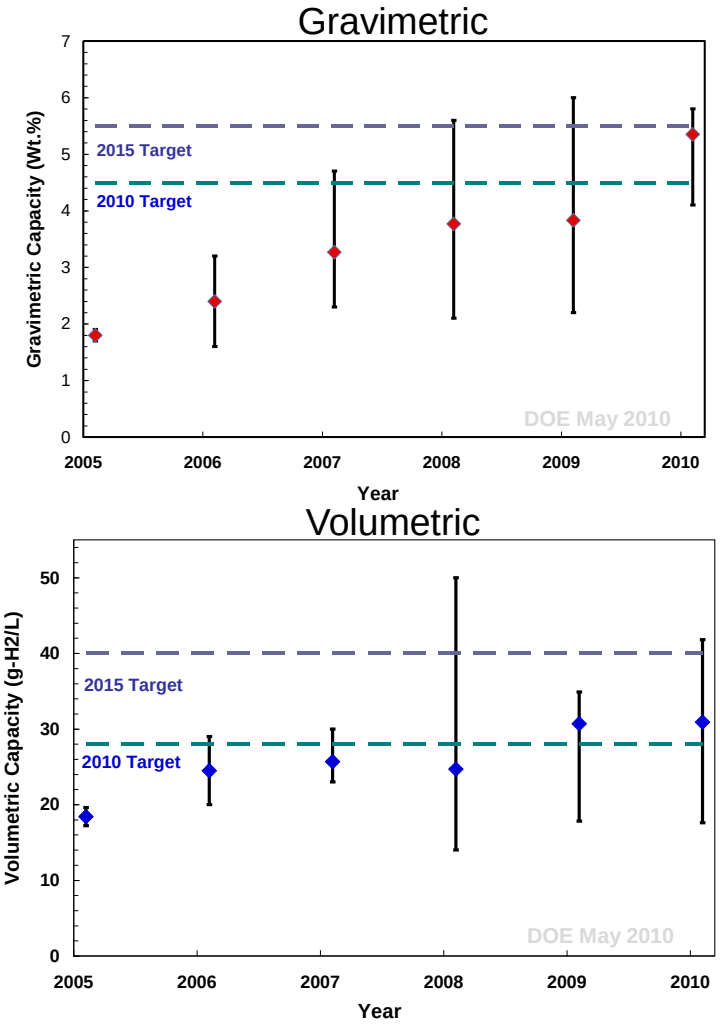
In just *five years* of accelerated investment, DOE has made significant progress in near- and long-term approaches.

RECENT ACCOMPLISHMENTS

- Centers of Excellence
  - Developed "one-pot" hydrazine method to regenerate spent material from ammonia-borane (H_3NBH_3) dehydrogenation (CHSCoE)
  - Demonstrated 2 methods to rehydrogenate alane (AlH_3) under mild conditions (MHCoE)
  - Confirmed experimentally that boron-doped carbon has increased hydrogen binding energies (HSCoE)
- Systems Analysis
  - Finalized performance and cost projections for 350 & 700 bar compressed storage
  - Completed preliminary analysis of MOF-177 sorbent-based material system
  - Completed preliminary analysis of a cryo-compressed system with potential to meet 2015 targets

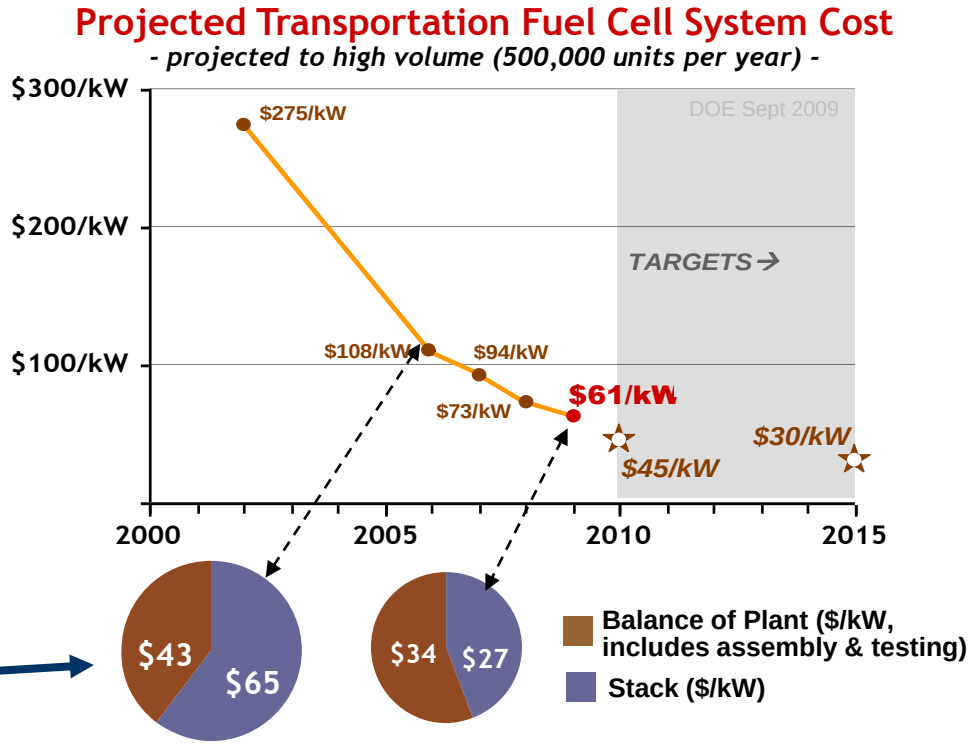
Gravimetric and volumetric capacities continue to show year-to-year improvements

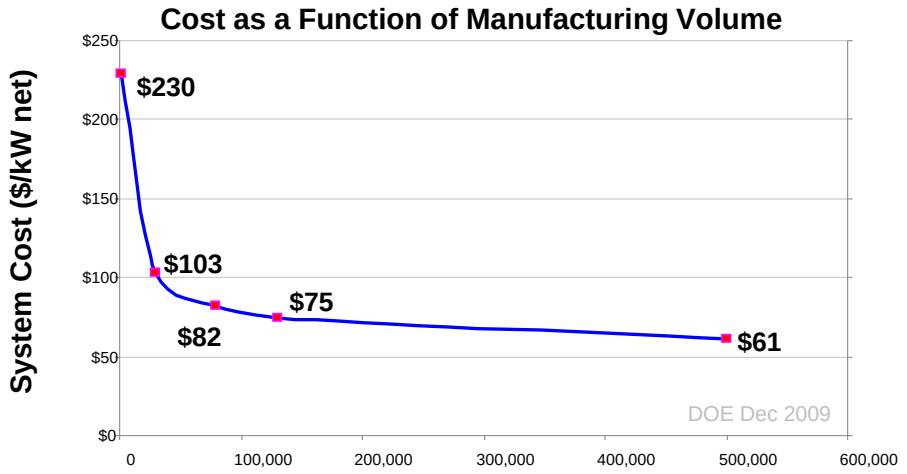
Projected Capacities for Complete 5.6-kg H_2 Storage Systems



We've reduced the cost of fuel cells to $61/kW*

- *More than 35% reduction in the last two years*
- *More than 75% reduction since 2002*
- *2008 cost projection was validated by independent panel***
- **As stack costs are reduced, balance-of-plant components are responsible for a larger % of costs.**



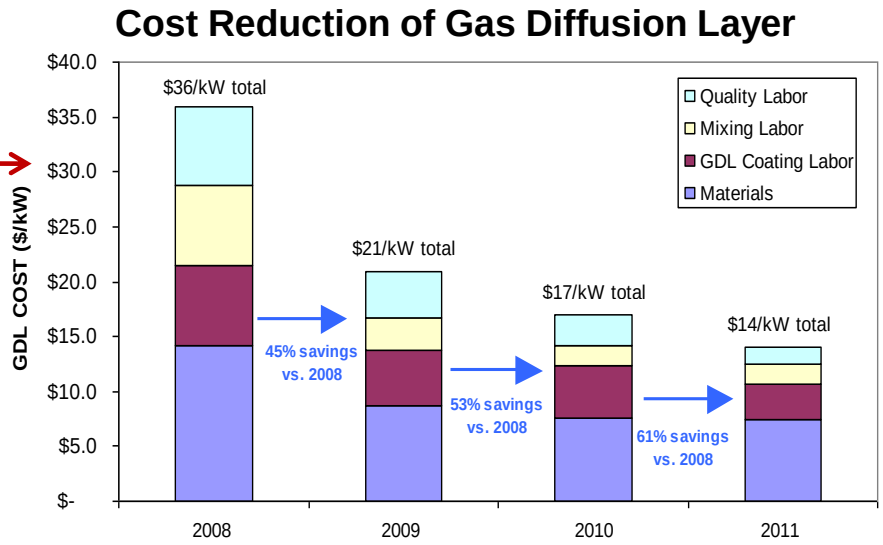


*Based on projection to high-volume manufacturing (500,000 units/year).

**Panel found $60 – $80/kW to be a "valid estimate": http://hydrogendoedev.nrel.gov/peer_reviews.html

RECENT ACCOMPLISHMENTS

- Developed process model for controlling GDL coating conditions (Ballard)
  - Significant improvement in quality yields and GDL cost reduction estimated at 53% to-date
- Manufacturing of Low-Cost, Durable MEAs Engineered for Rapid Conditioning (Gore)
  - Cost model results indicate that a new three layer MEA process has potential to reduce MEA cost by 25%
- Adaptive process controls and ultrasonics for high temp PEM MEA manufacturing allows for more than 95% energy savings during the sealing process (RPI)
- Developed an innovative online XRF for high-speed, low-cost fabrication of gas diffusion electrodes (BASF)



This is the first time a scanning XRF has been used on GDEs – BASF

Demonstrations are essential for validating the performance of technologies in integrated systems, under real-world conditions.

RECENT ACCOMPLISHMENTS

Vehicles & Infrastructure

- Fuel cell durability of 2,500 hrs projected (~ 75K miles)
- Vehicle Range ~196 - 254 miles
- Fuel cell efficiency 53-59%
- Over 2.5 million miles traveled
- Over 106 thousand total vehicle hours driven
- Over 150,000 kg- H_2 produced or dispensed*
- 144 fuel cell vehicles and 23 hydrogen fueling stations have reported data to the project

Buses

- DOE is evaluating real-world bus fleet data (DOT collaboration)
  - H_2 fuel cell buses have a range of 39% to 141% better fuel economy when compared to diesel & CNG buses

Forklifts

- Forklifts at Defense Logistics Agency site have completed more than 10,000 refuelings

Recovery Act

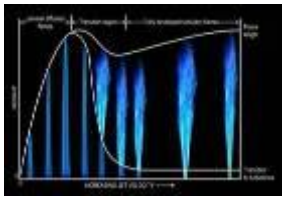
- NREL is collecting operating data from deployments for an industry-wide report

* Not all hydrogen produced is used in vehicles

Safety, Codes & Standards *and* Education

Safety, Codes & Standards

- *Facilitating the development & adoption of codes and standards for fuel cells*
- *Identifying and promoting safe practices industry-wide*



ACTIVITIES

- Develop data needed for key codes & standards (C&S)
- Harmonize domestic and international C&S
- Simplify permitting process
- Promote adoption of current C&S and increase access to safety information

PROGRESS *(key examples)*

- Developed hydrogen release behavior data
- Incorporated risk assessment approach for separation distances into the National Fire Protection Association (NFPA) hydrogen code in 2010
- Published: *Hydrogen Safety Best Practices Manual; Permitting Hydrogen Facilities* (web-based)
- Through R&D, enabled harmonized domestic and international Fuel Quality Specifications
- Developed safety course for researchers and held permitted workshops that reached >250 code officials

Education: *We are working to increase public awareness and understanding of fuel cells.*

ACTIVITIES

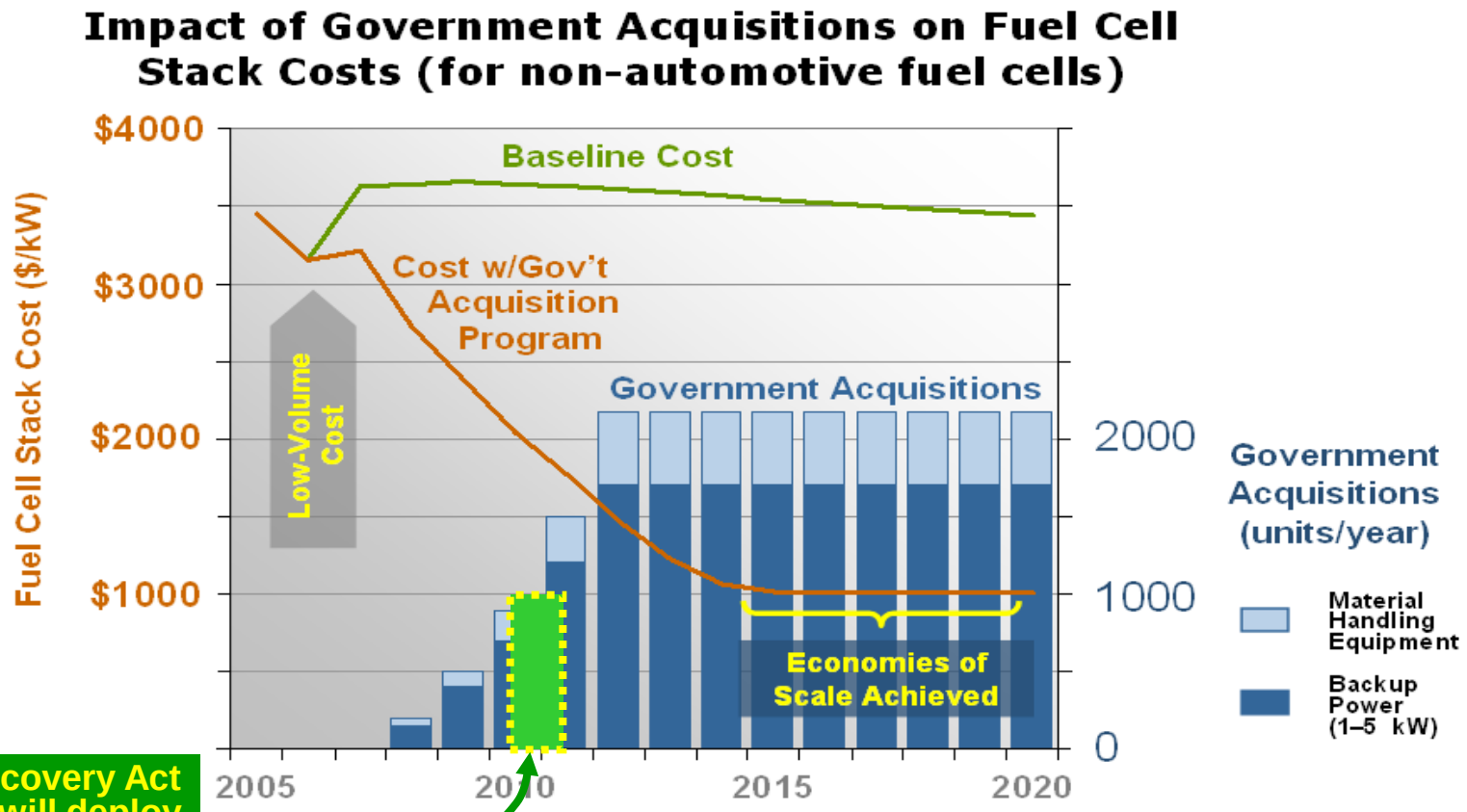
- Educate key audiences to facilitate demonstration, commercialization, and market acceptance

PROGRESS *(key examples)*

- Launched courses for code officials and first responders (>7000 users)
- Conducted seminars and developed fact-sheets and case studies for end-users
- Conducted workshops to help state officials identify deployment opportunities

Market Transformation

Government acquisitions could significantly reduce the cost of fuel cells through economies of scale, and help to support a growing supplier base.



Recovery Act funding will deploy up to 1000 fuel cells, in the private sector, by 2012.

Source: ORNL

We are facilitating the adoption of fuel cells across government and industry:

- **100 fuel cells are being deployed, through interagency agreements.**
- **More interagency agreements under development.**

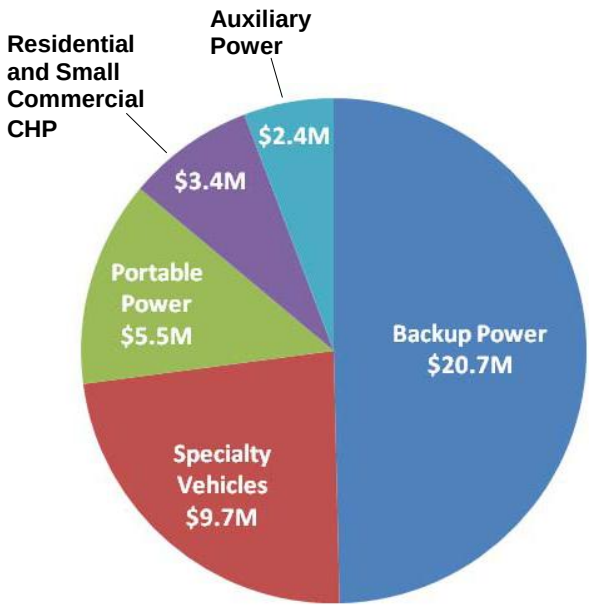
Recovery Act Funding for Fuel Cells

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

DOE announced ~$42 million from the American Recovery and Reinvestment Act to fund 12 projects, which will deploy up to 1,000 fuel cells — to help achieve near term impact and create jobs in fuel cell manufacturing, installation, maintenance & support service sectors.

FROM the LABORATORY to DEPLOYMENT:

DOE funding has supported R&D by all of the fuel cell suppliers involved in these projects.



Approximately $51 million in cost-share funding from industry participants—for a total of about $93 million.

COMPANY	AWARD	APPLICATION
Delphi Automotive	$2.4 M	Auxiliary Power
FedEx Freight East	$1.3 M	Specialty Vehicle
GENCO	$6.1 M	Specialty Vehicle
Jadoo Power	$2.2 M	Backup Power
MTI MicroFuel Cells	$3.0 M	Portable
Nuvera Fuel Cells	$1.1 M	Specialty Vehicle
Plug Power, Inc. (1)	$3.4 M	CHP
Plug Power, Inc. (2)	$2.7 M	Backup Power
Univ. of N. Florida	$2.5 M	Portable
ReliOn Inc.	$8.5 M	Backup Power
Sprint Comm.	$7.3 M	Backup Power
Sysco of Houston	$1.2 M	Specialty Vehicle

Example: California

- **Hydrogen Fueling Stations**
  - **> 20 stations currently operating**
  - **~ 10 additional stations planned**

- **Hydrogen Fuel Cell Vehicle Deployments: CA Fuel Cell Partnership is assessing the potential to deploy over**
  - **4,000 vehicles by 2014**
  - **50,000 vehicles by 2017**

Potential H2 Communities in Southern California

http://www.fuelcellpartnership.org/

Vielen Dank für Ihre Zeit

(Thank you for your time)