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The U.S. Department of Energy Initiative on Battery Manufacturing

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Meeting Global Challenges:
US-German Innovation Policy

1 November 2010
The National Press Club
529 14th Street, NW
Washington, DC

DOE Vehicle Technologies Program Goals

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Decrease petroleum dependency ***Reduce greenhouse gases***

- Develop more energy efficient and environmentally friendly highway transportation technologies that enable America to use less petroleum
- Develop technologies that provide Americans with greater freedom of mobility and energy security, with lower costs and lower impacts on the environment

We are Highly Dependent on Oil

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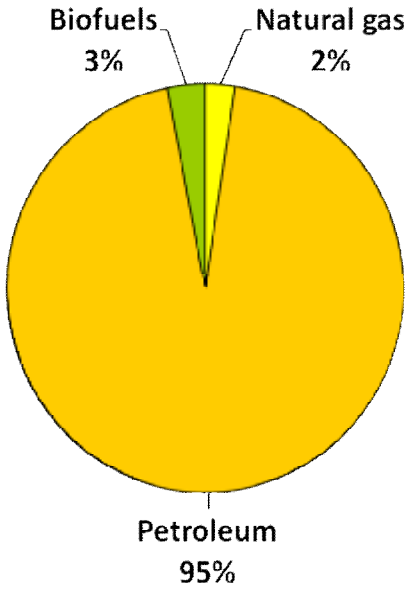

U.S. transportation fuel share (2008)

- Transportation is responsible for 2/3 of our petroleum usage
- On-Road vehicles responsible for ~80% of transportation petroleum usage

U.S. Vehicle Market

- > 240 Million vehicles on the road
- Approximately 11M new cars & light trucks for 2010; average is 15.7 M/yr 2002-2007
- Hybrid vehicles now <3% of sales

New Oil Reserves are Harder to Find

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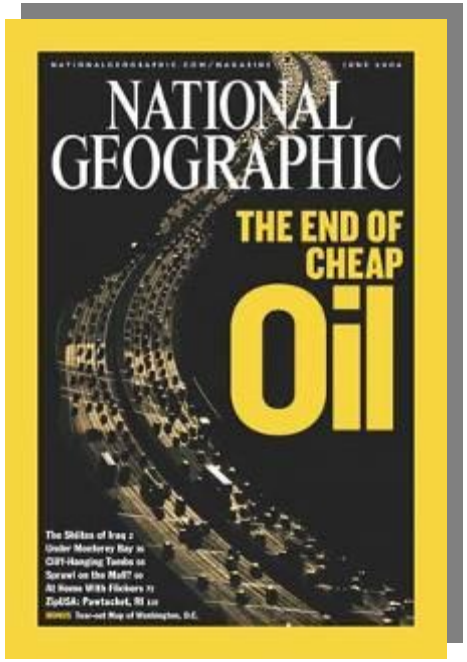
- Global discovery of new oil fields peaked in 1966.
- U.S. oil *production* peaked in 1971.
- World oil production has hardly grown at all since 2005.

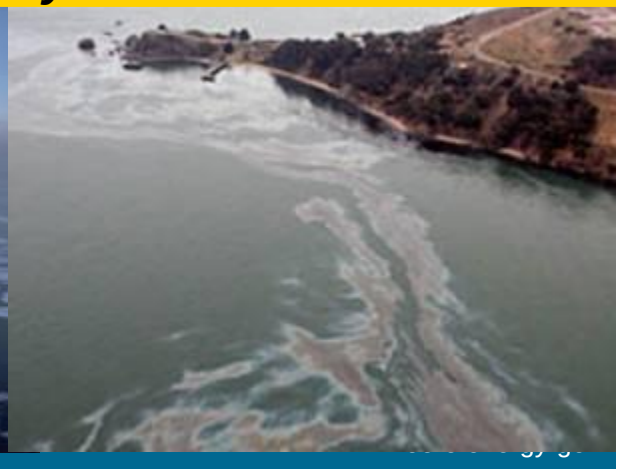
Source: Jeff Rubin, "Why the World is About to Get a Whole Lot Smaller"

World Oil Production

2005: 84.58 mbpd
2006: 84.54 mbpd
2007: 84.40 mbpd
2008: 85.37 mbpd
2009: 84.24 mbpd



The Cost of Oil is More than Monetary



Analysis Informs Strategy

Projected Vehicle Technology for 2030

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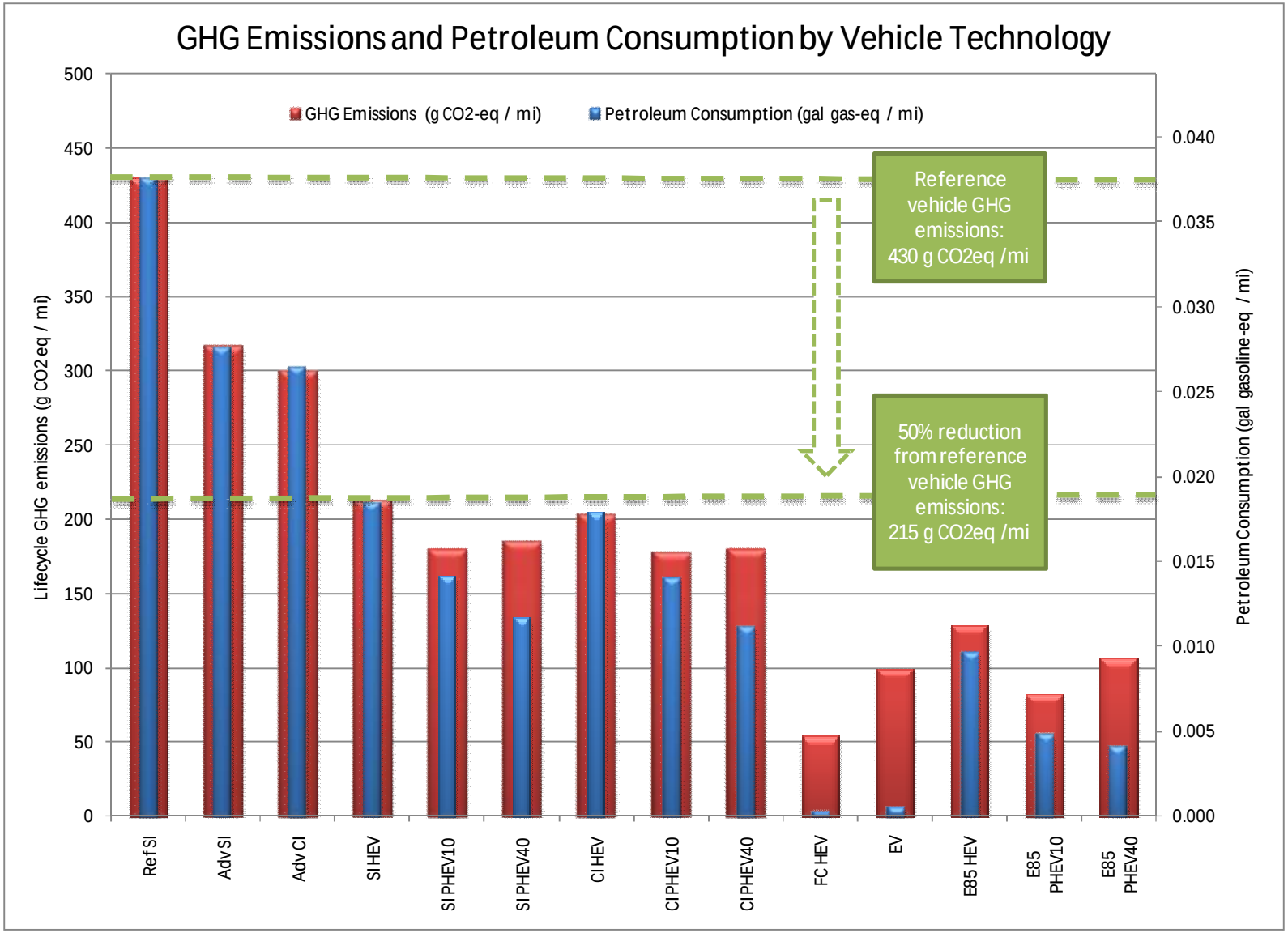
Vehicle GHG emissions fall into 3 major groups:

- Conventional
- Electric-drive
- Combination electric-drive & biofuel

Petroleum consumption loosely mirrors GHG emissions



DOE Electric Drive Activities

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Unprecedented Investment in Advanced Vehicle Technologies

- A 50% increase in Vehicle Technologies Program budget in the last 2 years
  - 1/2 of our over $311M budget directly on vehicle electrification initiatives
- $25B Advanced Technology Vehicles Mfg Loan Program,
- The launch of ARPA-e
- The Recovery Act's greater than $2.8B in grants for vehicle technology & demos

Other DOE Vehicle Activities

- **VT ARRA Activities $2.8 B**
- **ATVM Loan Program $25.0 B**
- **Other DOE**
  - **Office of Science**
  - **ARPA-E**
  - **Office of Electricity**

Open Questions About Electric Drive

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- What's Different This Time
- Grid Capacity
- Battery Cost
- Charging Infrastructure

What's Different This Time

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Answer:

- Urgency to Solve Energy and Environmental Challenges
- Battery Technology

Vehicle Electrification: Grid Impacts

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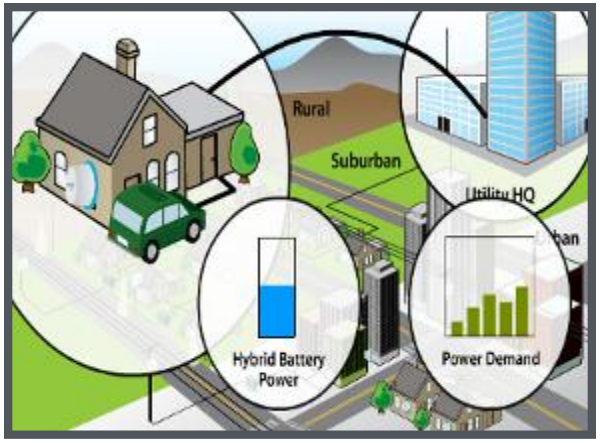
- In the U.S., current grid capacity could supply about 70% of our vehicles without adding capacity, but assumes:
  - vehicle would charge only during off-peak
  - "perfect" distribution of electricity
  - No localized affects such as overburdening neighborhood transformers
- EVs and PHEVs will not cause a grid "meltdown," but we clearly need to work fast as vehicles are rolled out to reduce impacts
- Smart Charging will be key to lowering cost and minimizing impacts
- Time of day pricing also important



Buildout of Charging Infrastructure

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- Key today: Home Charging
  - Need to get the cost and installation process right. Currently a significant barrier
- Public Charging
  - Expensive if not well utilized
  - Expansive to fully cover full driving patterns
- Ideally need market pull to determine public infrastructure build-out
  - PHEVs are key to help initiate market pull for public infrastructure

Hybrid-Electric Systems

Petroleum Displacement via Fuel Substitution & Improved Efficiency

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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

Cost reduction will occur primarily through improvements in chemistry – not manufacturing technology

Recovery Act : $2.8 Billion

Advanced Vehicle Technology Projects

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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

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.

Clean Cities: $300M for Petroleum Displacement through Alternative Fuel Vehicles and Expanded Alternative Fuel Infrastructure

Recovery Act Opportunity
Energy Storage Announcement

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Recovery Act Approach

- FOA strategy
  - Establish a complete "value chain" for lithium battery manufacturing: from material supply, to cell production, to pack assembly
- Seed money to get started
  - 500,000 PEVs/yr = <5% of market
  - Sized to support market growth
- Expect industry to grow

Electric Drive Component

Integrated Supply Chain

Material Suppliers → Cell Manufacturer → Battery Assembler → End User

Battery Market Values

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- **Lithium battery market worldwide currently:**
  - **$8 billion* (2009), largely consumer electronics applications**
- **Hybrid vehicle battery market worldwide currently:**
  - **largely nickel metal hydride**
  - **~500,000 HEVs/yr @ ~$3,000 each ==> ~$1.5 billion**
- **Market estimates for automotive lithium batteries (worldwide)**
  - **2015: ~800,000 EVs/yr** @ ~$10,000 each ==> ~$8 billion**
  - **2020: ~6,000,000 EVs/yr** @ ~$5,000 each ==> ~$30 billion**

* H. Takeshita, 26th International Battery Seminar, Ft Lauderdale, FL, March 2009

** Roland Berger, 2010; Pike Research, 2010

Recovery Act Battery Events

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President Obama at Compact Power

Secretary Chu at General Motors

President Obama at Celgard

Vice-President Biden at Dow Kokam

Governor Granholm at Toda America

Battery Manufacturing Facilities

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Company	Location	Total Investment	Cell Manu.	Pack Assembly	Description
Johnson Controls	Holland, MI Lebanon, OR	$600 M	✓	✓	Li-Ion: Nickel Metal Cobalt
A123 SYSTEMS	Romulus & Brownstown, MI	$500 M	✓	✓	Li-Ion: Iron Phosphate
cpi compact power inc.	St. Clair & Holland, MI	$390 M	✓		Li-Ion: Mixed Manganese
GM	Brownstown, MI	$236 M		✓	
saft	Jacksonville, FL	$191 M	✓	✓	Li-Ion: Nickel Metal Cobalt
DOW KOKAM	Midland, MI	$490 M	✓	✓	Manganese Spinel
EXIDE BATTERIES	Bristol, TN & Columbus, GA	$70 M	✓	✓	Spiral Wound AGM and Flat Plate Batteries
EAST PENN manufacturing co., inc.	Lyon Station, PA	$98 M	✓	✓	Advanced VRLA and the Ultra Batteries
EnerDel	Indianapolis, IN	$180 M	✓	✓	Li-Ion: Nickel Metal Cobalt

Battery Materials, Production and Recycling

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Company	Location	Funding	Material	Description
BASF	Elyria, OH	$50 M	Cathode	Production of nickel-cobalt-metal cathode material for Li-ion batteries
TODA AMERICA	Goose Creek, SC	$70 M	Cathode	Production of nickel-cobalt-metal cathode material for Li-ion batteries
Pyrotek	Sanborn, NY	$23 M	Anode	Production of carbon powder anode material for Li-ion batteries
FutureFuel Chemical Company	Batesville, AR	$25 M	Anode	Production of high-temp anode material for Li-ion batteries
Novolyte technologies	Zachary, LA	$41 M	Electrolyte	Production of electrolytes for Li-ion batteries
Honeywell	Buffalo, NY & Metropolis, IL	$55 M	Electrolyte	Production of electrolyte salt for Li-ion batteries
Celgard	Charlotte, NC & Aiken, SC	$101 M	Separator	Production of polymer separator material for lithium-ion batteries
Chemetall	Silverpeak, NV & Kings Mtn., NC	$60 M	Lithium	Production of battery-grade lithium carbonate and lithium hydroxide
enerG2	Albany, OR	$28 M	Carbon	Production of high-energy density nano-carbon for ultracapacitors
H&T Group	Holland, MI	$10 M	Cell Casing	Manufacturing of precision aluminum casings for cylindrical cells
TOXCO	Lancaster, OH	$19 M	Recycling	Hydrothermal recycling of Li-ion batteries
ENTEK	Lebanon, OR	$26 M	Separator	Production of battery separators for HEVs and EVs

Electric Drive Vehicle Components

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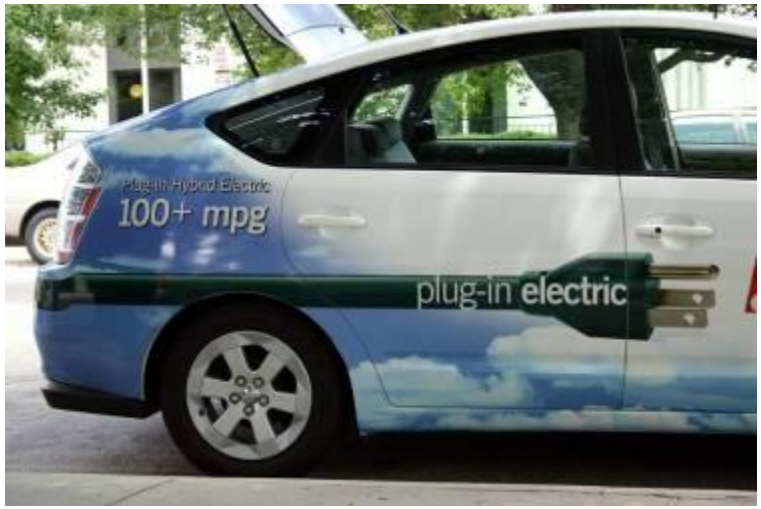
Company	Location	Funding (DOE / Total)	Description
Remy	Anderson, IN	$60 M / $120 M	Motor and Inverter Manufacturing
DELPHI	Kokomo, IN	$89 M / $179 M	Inverter, Converter, and Controller Manufacturing
Allison Transmission	Indianapolis, IN	$63 M / $126 M	Production of Commercial Truck Hybrid Systems
Ford	Sterling Heights, MI	$63 M / $125 M	Production of HEV and PHEV Transaxles
KEMET	Simpsonville, SC	$15 M / $32 M	DC Bus Capacitor Manufacturing
UQM	Frederick, CO	$45 M / $90 M	Electric Propulsion System Manufacturing
SBE	Barre, VT	$9 M / $18 M	DC Bus Capacitor Manufacturing
POWEREX	Youngwood, PA	$6 M / $9 M	Electric Drive Semiconductor Manufacturing
MAGNA	Holly, MI; Muncie, IN	$40 M / $87 M	Inverter, Converter, Controller, Charger, and Electric Drive System Manufacturing
GM	White Marsh, MD; Wixom, MI	$105 M / $246 M	Electric Drive Motor and Unit Manufacturing

Transportation Electrification Demonstration Projects

- **8 Grants representing the largest ever coordinated deployment of electric-drive vehicles and charging infrastructure in the U.S.**
  - Deployment of **7,000 electric-drive vehicles**, including light-duty, medium-duty, and heavy-duty passenger and commercial vehicles in a variety of climatic and operating environments
  - Installation of over 20,000 Level 2 (240VAC) vehicle charging sites at residential, commercial, and public locations and 350 Level 3 (500VDC) Fast Chargers
  - Collection of detailed operational data from vehicles and charging infrastructure, to evaluate and analyze vehicle usage, charging patterns, and potential grid impacts in preparation for broader, long-term deployment of vehicles and infrastructure



- **10 Grants to establish comprehensive educational and outreach programs focused on electric-drive vehicles**
  - Funding of the first programs to educate first responders and emergency personnel in how to deal with accidents involving EVs and PHEVs

American Reinvestment and Recovery Act

Smart Grid Investment Grants

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(100 projects: $3.4B Federal; $4.7B non-Federal)

Smart Grid Systems and Equipment	Numbers of Units (self-reported estimates)	Improvements
Smart Meters	18,179,912	• 13% of the 142 million customers in the U.S.
Load Control Devices	176,814	• Enables peak demand reductions
PHEVs / Charging Stations	12 / 100	• Accelerates market entry
Smart Transformers	205,983	• Enables preventative maintenance
Automated Substations	671	• 5% of 12,466 transmission and distribution substations in the U.S.




Contact Information

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ding the Electric Vehicle Industry

Moderator: Kevin Hurst, Ph.D.
Office of Science and Technology Policy
Executive Office of the President

ber 1, 2010

idential Priorities

ct our nation from the serious economic and strategic associated with our reliance on foreign oil and the bilizing effects of a changing climate.

nce energy and climate security via promoting economic ery efforts, accelerating job creation, and driving clean y manufacturing.

nitment to comprehensive energy-climate policies that will:

educe dependence on foreign oil;

mprove air & water quality;

cut back the carbon pollution that is changing the climate;

create new American jobs around the clean, domestic energy urces that will get all this done.

American Innovation Strategy

st in the building blocks of innovation

ore leadership in fundamental research

st STEM education

ngthen physical infrastructure

elop an advanced IT “ecosystem”

ote competitive markets to spur innovation

port capital markets that fund innovation

ourage innovation□based entrepreneurship

st public□sector & community innovation

mote American exports

yze breakthroughs for national priorities

eash a clean□energy revolution

)port advanced□vehicle technology

e breakthroughs in health IT

stment in advanced vehicle technologies

very Act

8B in grants for EV technology and demonstrations.

500 per-vehicle tax credit for EVs and PHEVs.

5B for Smart Grid infrastructure.

for the Advanced Technology Vehicles Manufacturing Loan Prgr

ng for the DOE Vehicle Technologies R&D Program increased by
FY2008 to FY2010.

s Vehicle Technologies R&D ($311M in FY 2010) is focused heav
le electrification initiatives.

A-E: Batteries for Electrical Energy Storage in Transportation

CAFE standards

-Generation EV Research

Vehicle Technologies Program

research at DOE Office of Science, NSF, DOD

-E

ation Hub on Energy Storage R&D (proposed)

enges

s & challenges harness the ingenuity that lurks in individuals, scho
oss society. Sponsors/organizers set an ambitious goal without p
est means to achieve it, and pay only for results.

dministration's new challenge.gov website provides 1□stop shopp
ators looking for opportunities.

ecent Progressive Insurance / DOE Automotive X□Prize illustrates
age in this approach.

M in prizes for
r□fuel□efficient passenger
cles (over 100 miles per gallon of
line equivalent) called forth
M+ in investments in innovation
ompetitors.

ning designs achieved up to 200

:y questions

- v can US-German and US-EU collaboration help enable the techni
  market success of EVs?
- v important is an energy storage “revolution” (at the device-level or
  :em-level) to the growth of the EV industry?
- ch government policy tools will be most important to building the E
  ıstry over the next five years?
- ıt should be the top priorities for electric utilities and State PUCs to
  ɔare for wide-scale deployment of EVs?
- overnment involvement needed to accelerate technical standards
  ; and EV infrastructure?