USCAR

UNITED STATES COUNCIL FOR AUTOMOTIVE RESEARCH LLC

CHRYSLER

GM

Ford

Power of Automotive Collaboration

U.S. Government/ United States Council for Automotive Research

R&D Successes

Introduction

The United States Council for Automotive Research LLC (USCAR) – the collaborative research organization of Chrysler Group LLC, Ford Motor Company and General Motors Company – has collaborated with the U.S. government for many years to achieve broad societal goals in the area of personal transportation.

During the last 17 years, USCAR's core collaborative agenda has been based on striking a balance between consumer needs and wants and the changes required to ensure a sustainable transportation future.

During the last nine years, the U.S. Department of Energy (DOE) and USCAR have been leading the charge through the FreedomCAR and Fuel Partnership. Along with five energy partners and two utilities, we are working to enable affordable and sustainable transportation solutions that enhance our nation's economic and energy security and maintain a progressive path of environmental stewardship.

The *Power of Automotive Collaboration* highlights many of the successes achieved through USCAR's work with the U.S. government, predominantly through the FreedomCAR and Fuel Partnership.

What's remarkable about these achievements is that they often represent the sum of hundreds of smaller achievements – by individuals and teams in national and federal research labs, suppliers, colleges and universities and the U.S. automakers – through USCAR. Together, we are able to do more…better…and quicker…than any one of us could possibly do alone.

For more information, visit the USCAR Web site at www.uscar.org

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What is USCAR?

The United States Council for Automotive Research LLC (USCAR) is the collaborative automotive technology organization for Chrysler Group LLC, Ford Motor Company and General Motors Company.

Founded in 1992, the goal of USCAR is to further strengthen the technology base of the domestic auto industry through cooperative research and development.

UNITED STATES COUNCIL FOR AUTOMOTIVE RESEARCH LLC

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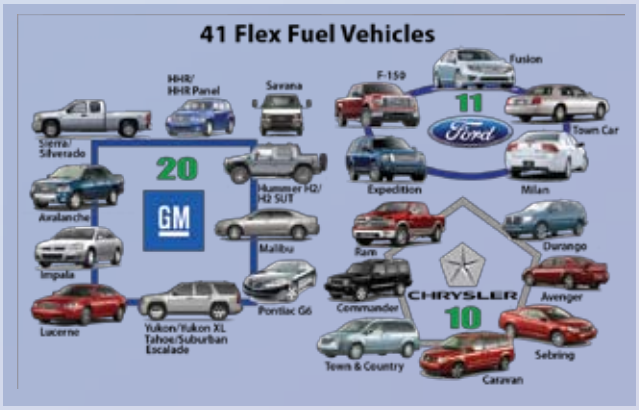
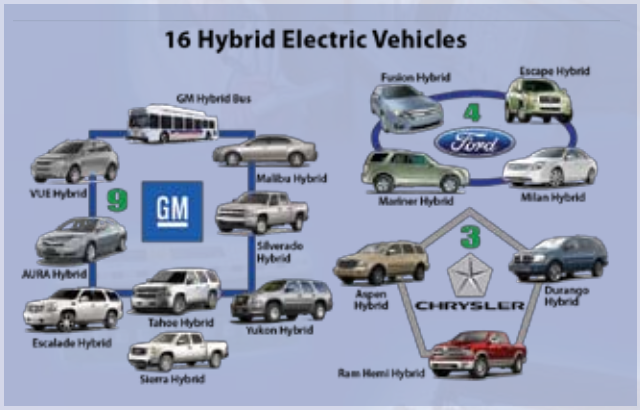
Collaboration Drives Technology for America

Individually and collectively, Chrysler Group, Ford and General Motors have distinguished themselves as quality vehicle manufacturers and innovative technological leaders.

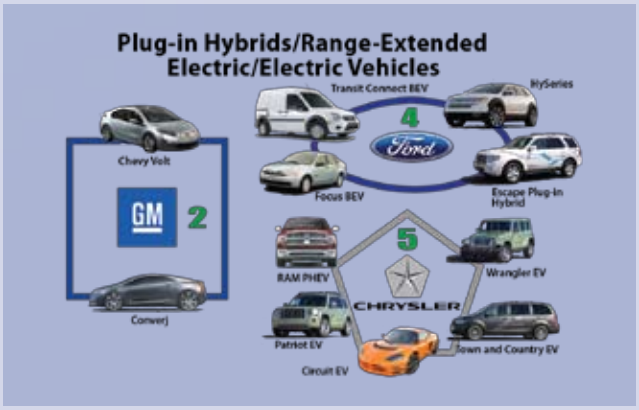
In addition to their conventional gasoline-engine vehicle fleets that long have provided reliable transportation for consumers worldwide, their product lines collectively include: 16 hybrid electric vehicle models; 41 flexible fuel vehicle models that run on gasoline and E-85 ethanol; and six hydrogen fuel cell and hydrogen internal combustion engine vehicle models now on the road in demonstration and test fleets. They also are planning the production of 11 plug-in hybrid electric and electric vehicles, which soon will be on the road, including the 2010 Chevrolet Volt range-extended electric vehicle.

These innovative vehicles are the products of each company's individual genius and engineering know-how. Yet most include technologies researched and developed collaboratively through USCAR.



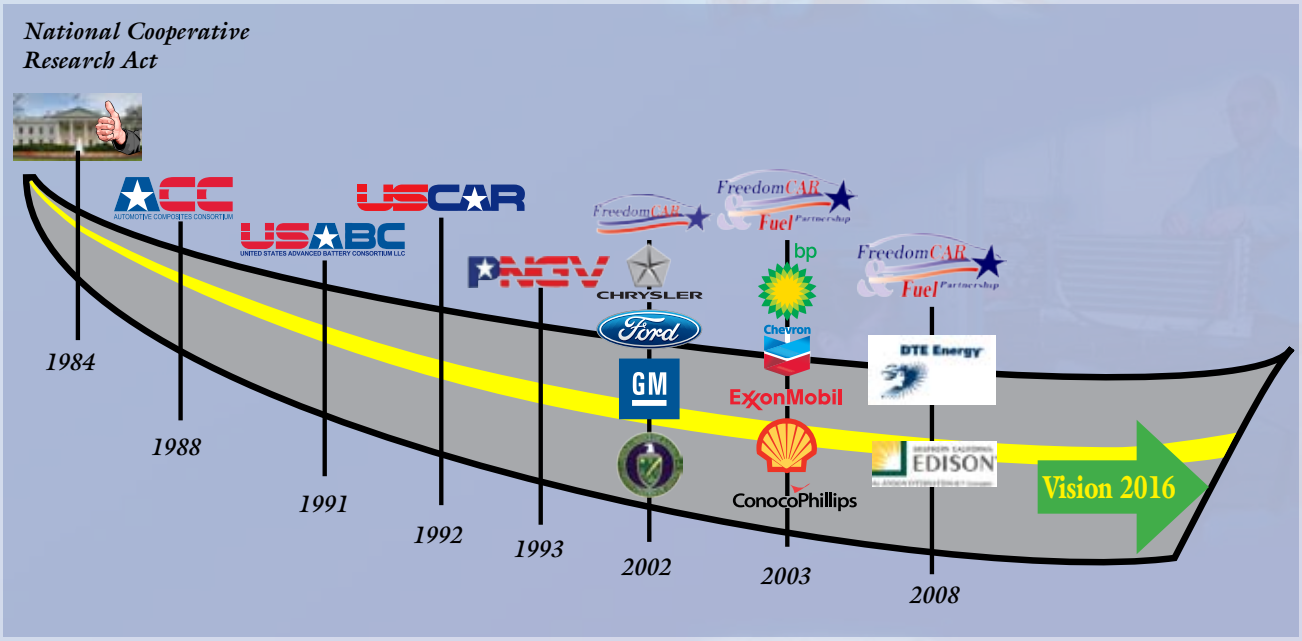


Pictured above are some of the Chrysler Group, Ford and GM vehicles that comprise their alternative fuel and HEV product lines. More flex-fuel and HEV models are planned through 2010 from the Detroit Three.



Chrysler Group, Ford and GM also are developing a wide range of battery-electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and range-extended electric vehicles (REEVs), along with hydrogen-powered internal combustion engine and fuel cell vehicles. Many are on the road in demonstration and test fleets throughout the United States and are being evaluated for possible production.

U.S. Government and USCAR Collaboration – *The Road to Progress*



Passage of the 1984 National Cooperative Research Act opened the door for government-industry collaboration to address societal needs. Pictured on the Road to Progress are key consortia and partnerships that were formed since 1988.

Since its inception in 1992, USCAR has been the focal point for collaborative R&D among Chrysler Group LLC, Ford Motor Company and General Motors Company. It is considered one of the most effective models of R&D collaboration in the world.

USCAR also has been the primary portal for collaborative research between the Detroit Three and the U.S. Government, as both work to address broad societal issues and goals related to sustainable automotive transportation.

USCAR and the consortia that preceded it represent two decades of R&D partnerships between the U.S. automakers and U.S. government. When the National Cooperative Research Act was passed in 1984, the U.S. government opened the door of opportunity for government/industry collaboration to address societal needs.

> "The Partnership plays an important role in the planning, pursuit and assessment of high-risk R&D for many of the needed vehicle and fuel technologies, and federal funds allow much of this work to move forward."
>
> *National Research Council of the National Academies, "Letter Report on Review of the Research Program of the FreedomCAR and Fuel Partnership, Phase 3"*

Beginning with the Automotive Composites Consortium (ACC) in 1988 and the United States Advanced Battery Consortium's (USABC) creation in 1991, through USCAR's creation and broad partnerships like the Partnership for a New Generation of Vehicles (PNGV) and the FreedomCAR and Fuel Partnership, each has produced new enabling technologies and a multitude of successes.

The Success Formula
Collaboration (U.S. Government + USCAR) = Accelerated Technology + Societal Benefits

Clearly, the road to progress has required two powerful entities – the U.S. automakers and U.S. government – to work together to address some of society's toughest challenges. These include: improving fuel efficiency, reducing regulated emissions, reducing the U.S. dependency on oil, improving safety, reducing landfill use and strengthening the U.S. economy.

Each of these challenge areas has seen measurable improvements during the last 20 years. And while the U.S. economy has

Through collaboration, the U.S. government and U.S. automakers have advanced innovative and important automotive technologies.

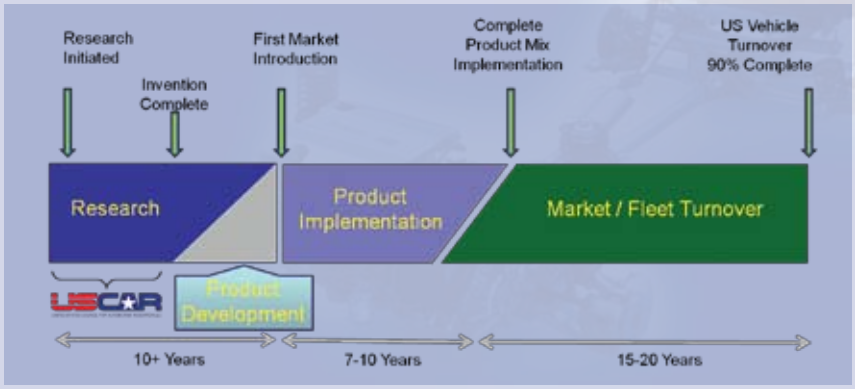
experienced some broad pendulum swings, the automakers have continued in their joint efforts with the government to advance important technologies to help transform automotive transportation.

Technology developments contributed to efforts involving: direct injection gasoline and diesel engines; hybrid-electric drivetrains; power electronic controllers; hydrogen fuel cells; lightweight structural components and joining; nickel-metal hydride and lithium-ion batteries; and vehicle recycling.

Advanced Technology Time-To-Market
Need to focus on short, mid <u>and</u> long-term

Although we measure progress toward our goals, success doesn't happen overnight. Often, there are hundreds of smaller successes that lead to enabling technologies. Then it's up to the individual automakers to put those technologies into production.

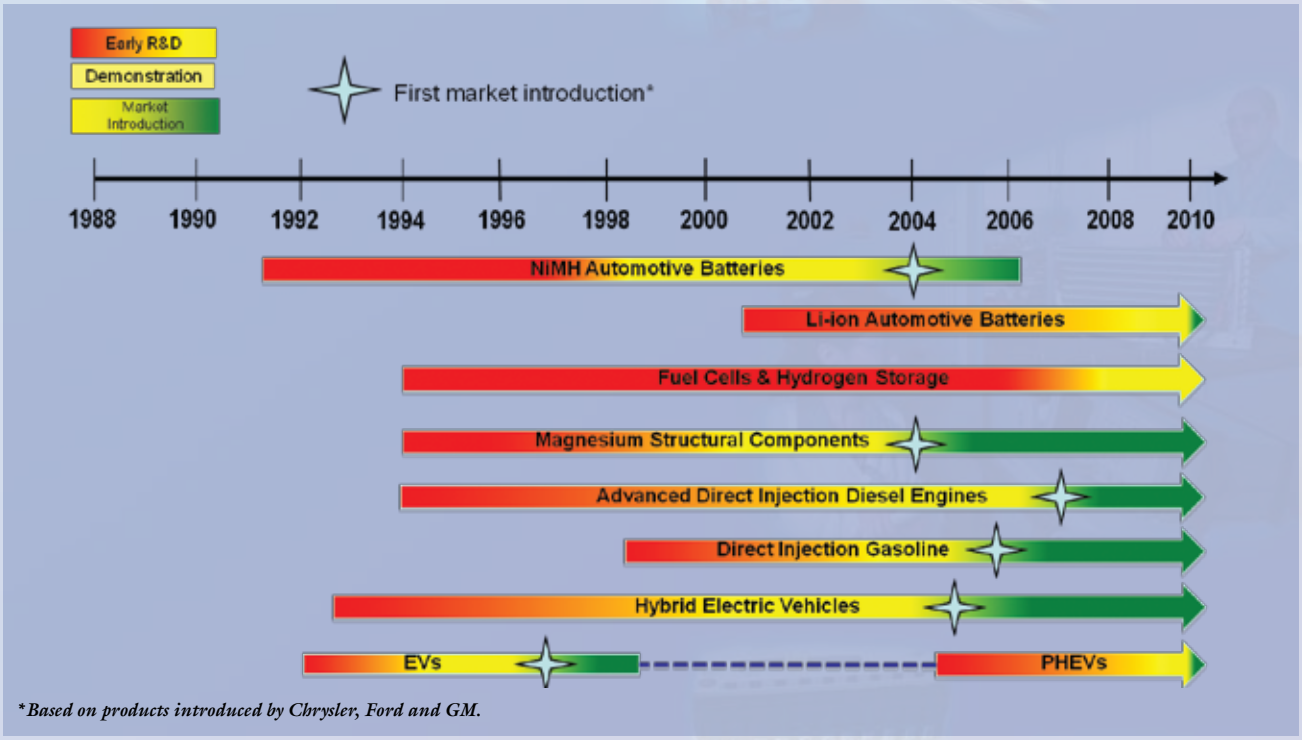
USCAR realizes its impact early in the Time-to-Market process. USCAR's work occurs before the automakers develop their products and introduce vehicles that incorporate the resulting technologies. Even when introduced in vehicles, however, it often takes an additional 15 to 20 years for the entire market fleet



USCAR R&D occurs early in the Time-to-Market process. New technologies are researched, developed, tested, demonstrated and validated before they are considered for use in production vehicles.

to turnover. In other words, even if every new vehicle in the U.S. was powered by alternative fuels, it would take nearly two decades for 90 percent of conventionally powered gasoline vehicles to disappear from American roads.

Progress and Implementation from U.S. Government and USCAR Collaboration



This chart shows the progress of U.S. Government/USCAR collaborative R&D to advance key automotive technologies. The stars indicate when those technologies were first introduced in U.S. production vehicles. The chart also shows new technologies that continue to be developed, including some for which market introduction is imminent.

Government investment is not just rewarded with scientific progress. The real payoff is in the implementation of new technologies in vehicles purchased by consumers.

U.S. Government/USCAR collaboration contributed to the market introduction of many 'firsts.' Electric vehicle R&D contributed to the introduction of GM's EV1. Hybrid-electric vehicle and NiMH battery R&D contributed to the first hybrid SUV – the Ford Escape Hybrid – as well as every hybrid on the road today, including those built by foreign OEMs. Magnesium structural components R&D led to GM's implementation of technology that placed a magnesium engine cradle in the 2006 Chevrolet Corvette Z06. And Li-ion battery R&D will play a role in the introduction of PHEVs by Chrysler Group, Ford and GM.

The FreedomCAR and Fuel Partnership's mission is to develop and advance high-risk research needed to create component and infrastructure technologies that will:

- ***enable a full range of affordable cars, light trucks and the fueling infrastructure for them.***
- ***reduce the dependence of the nation's personal transportation system on imported oil.***
- ***minimize harmful vehicle emissions, without sacrificing freedom of mobility and freedom of vehicle choice.***
- ***enable transition to a hydrogen transportation economy.***

New technologies in consumer-purchased vehicles build success in achieving broader societal goals. Advanced batteries enable hybrid electric vehicles that reduce petroleum consumption and gasoline costs. Advanced gas and diesel engines use less gas, perform better and emit less regulated emissions. Advanced lightweighting of vehicles reduces fuel consumption and yet maintains passenger safety.

Advanced Combustion and Emissions Control Successes

Near-term fuel efficiency and cleaner air

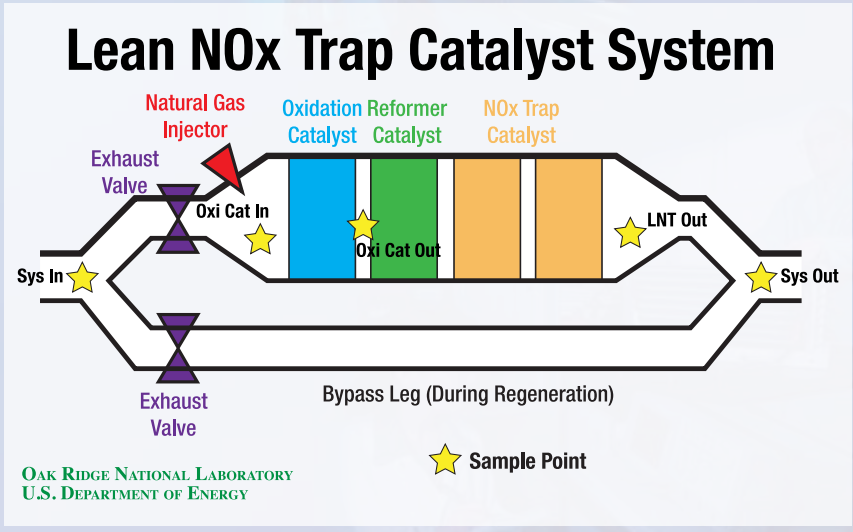
Advances in combustion and emissions control are leading to near-term fuel efficiency and cleaner air.

Internal combustion engine improvements, advances in aftertreatment modeling and engine R&D for alternative fuels are areas where U.S. Government/USCAR collaboration has produced solid successes and helped the OEMs meet new, more stringent emissions standards, while still meeting consumer demands and improving fuel efficiency.

Work in internal combustion engine R&D has increased the technical competence of the industry, with improved combustion and aftertreatment modeling tools now being used by the automakers. In addition, advances in homogeneous charge compression ignition (HCCI) and premix charge compression ignition show potential for engine development with very low emissions and higher fuel efficiency.

GM HCCI Concept Engine

Dodge Cummins Turbo Diesel



Diesel engine improvements have led to new light-duty diesel vehicles entering the U.S. market with higher efficiencies than gasoline-powered vehicles, and low regulated emissions.

Aftertreatment advances include new diesel aftertreatment alternatives that enable compliance to stringent Tier 2 regulations entering production. Lean NOx aftertreatment is included in the HD Dodge Ram Pickup Truck with Cummins Diesel engine, and urea selective catalytic reduction (SCR) has been demonstrated in light-duty vehicles.

Diesel particulate filters (DPFs) are part of the aftertreatment in GM 2500/3500 and Ford F-250 trucks.

Because diesels run lean, using minimal fuel, it is difficult to destroy the nitrous oxides using typical catalytic converter technology. Collaborative work has led to methods that greatly reduce both particulates and nitrous oxides.

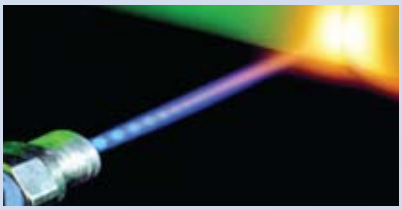
Dodge Ram Pickup with Cummins Diesel

Advanced combustion projects have laid the groundwork for next generation ethanol-optimized engines. More than 8 million flex-fuel vehicles produced by the U.S. automakers are on the road today.

Hydrogen internal combustion engines, like those in commercially used Ford shuttle buses, deliver zero emissions and show peak H_2 efficiency of 45 percent, which is better than advanced gasoline engines.

Lightweight Materials Successes
Mass Reduction and Fuel Efficiency

Through U.S. DOE/USCAR collaboration, new processes and applications for automotive lightweighting were implemented.



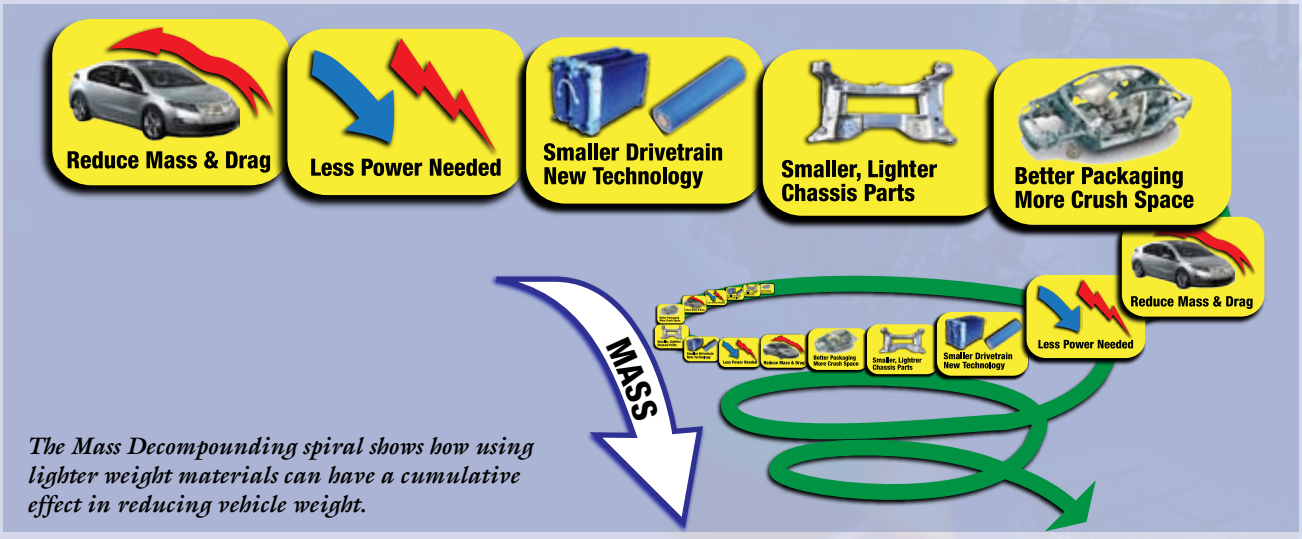
Laser welding (above) friction stir welding (below).

Using more lightweight materials in cars and trucks means less mass and greater fuel efficiencies.

To successfully incorporate new, more lightweight materials in vehicles, improved joining and forming technologies were required. These included laser welding, friction stir welding, thermal drilling, adhesive bonding and hydroforming. Stamping techniques and product features have been designed into advanced high-strength steel production parts to control springback. Rapid preforming processes, like advanced composites P4 – Programmable Powdered Preform Process, have been developed.

Automated P4 Process (top), hydroformed steel (below).

Mass Decompounding:
A Design Approach that Reduces Overall Vehicle Weight



The Mass Decompounding spiral shows how using lighter weight materials can have a cumulative effect in reducing vehicle weight.

Mass decompounding also is applied as a way to make vehicles lighter. It represents a systems design approach that yields a 'spiral' of power and mass reduction actions that lead to increased use of lightweight materials. It starts by reducing vehicle weight and drag, allowing for smaller and lighter engines and drivetrains. Smaller engines mean smaller and lighter supporting systems, content and mass. Less engine component mass enables even more body and chassis weight reductions.

Lightweight Materials Successes
Mass Reduction and Fuel Efficiency

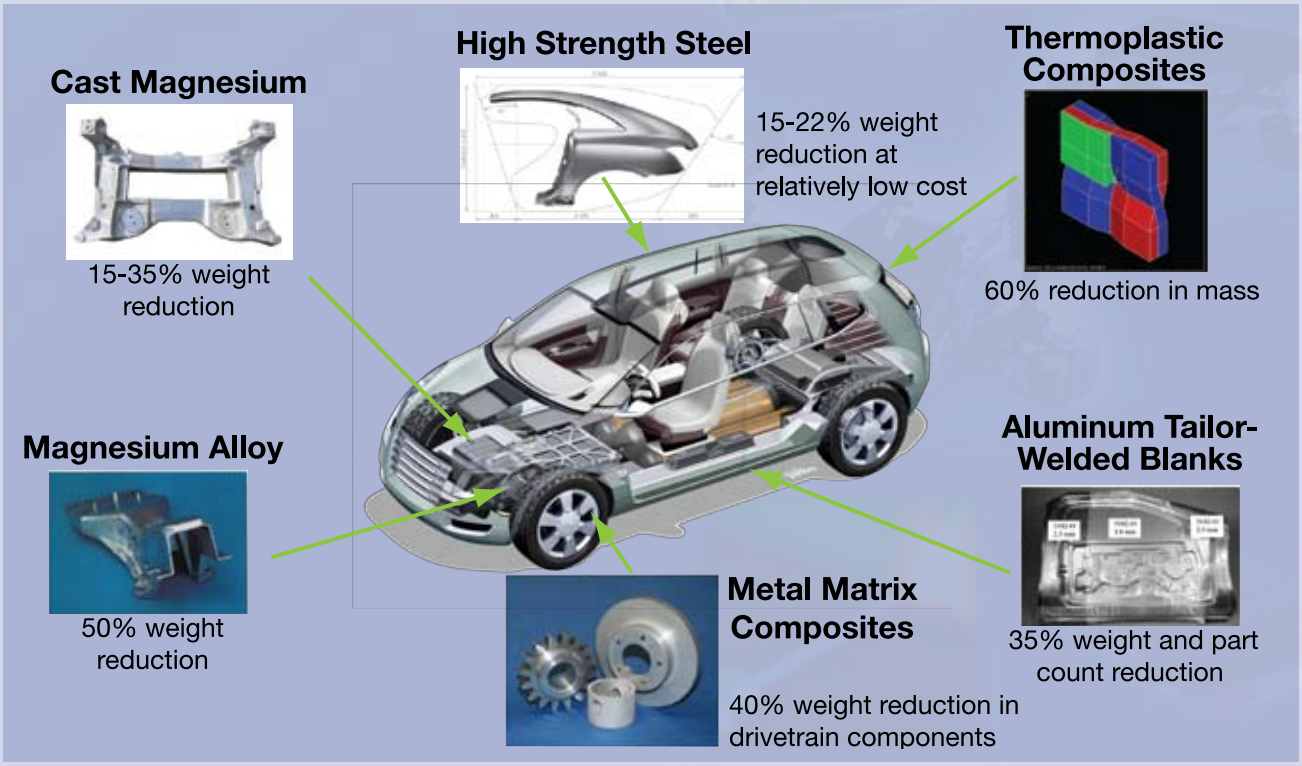
U.S. DOE and USCAR R&D moved lightweight materials into component and, subsequently, vehicle production. This includes: advanced high-strength steels, cast magnesium, magnesium alloys, metal matrix components, aluminum tailor-welded blanks and thermoplastic composites.

Lightweight components moved into vehicle production included the magnesium engine cradle in the 2006 Chevrolet Corvette; the composite 2009 Ford Sport Trac Limited tonneau cover; and optional glass-fiber-reinforced polymer matrix composite truckbed and tailgate on the 2001 Chevrolet Silverado.

Approximately 50 percent more aluminum is being used in vehicles, and high-strength steels continue to reduce weight and mass.

The Corvette Mg engine cradle has a weight savings of 34% when compared to aluminum.

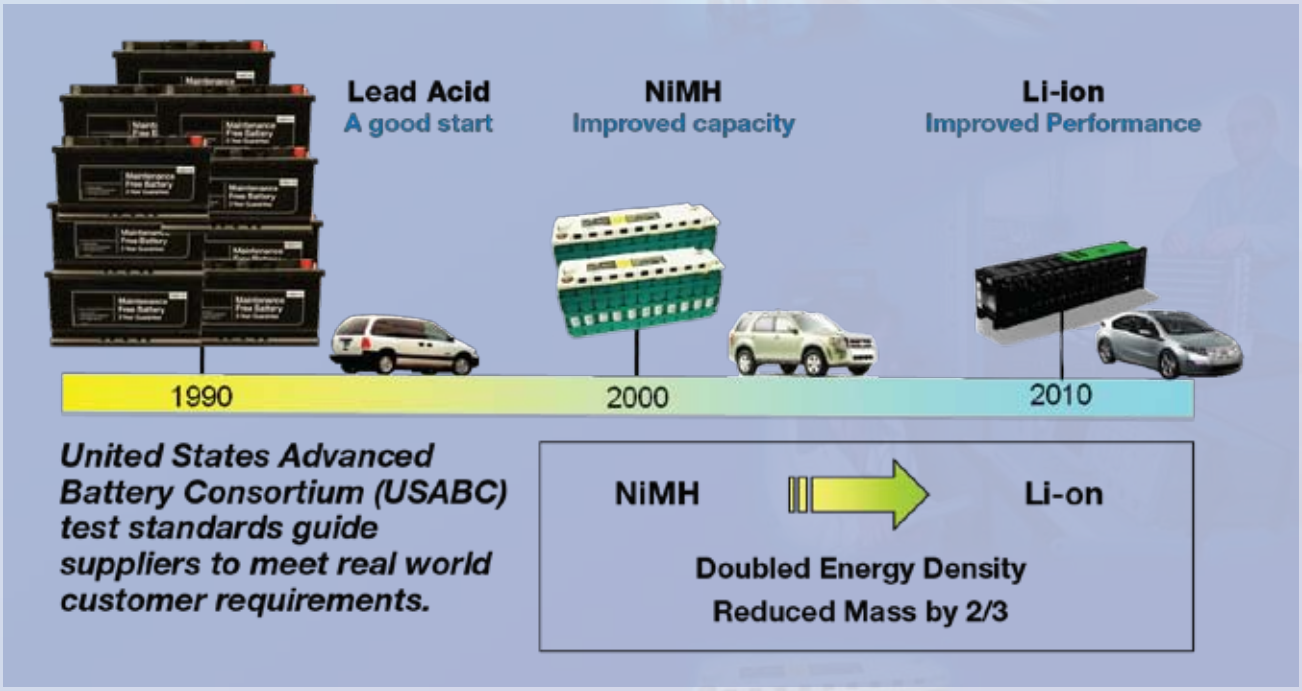
The 2010 Dodge RAM 1500 utilizes an aluminum hood and components to reduce vehicle weight.



The U.S. DOE and USCAR moved lightweight materials into component production.

Advanced Batteries & Energy Storage Successes

Vehicle electrification



The U.S. DOE and USCAR continue to advance battery technology.

In collaboration with the U.S. Government, USCAR has made significant strides in advanced batteries, which have enabled vehicle electrification.

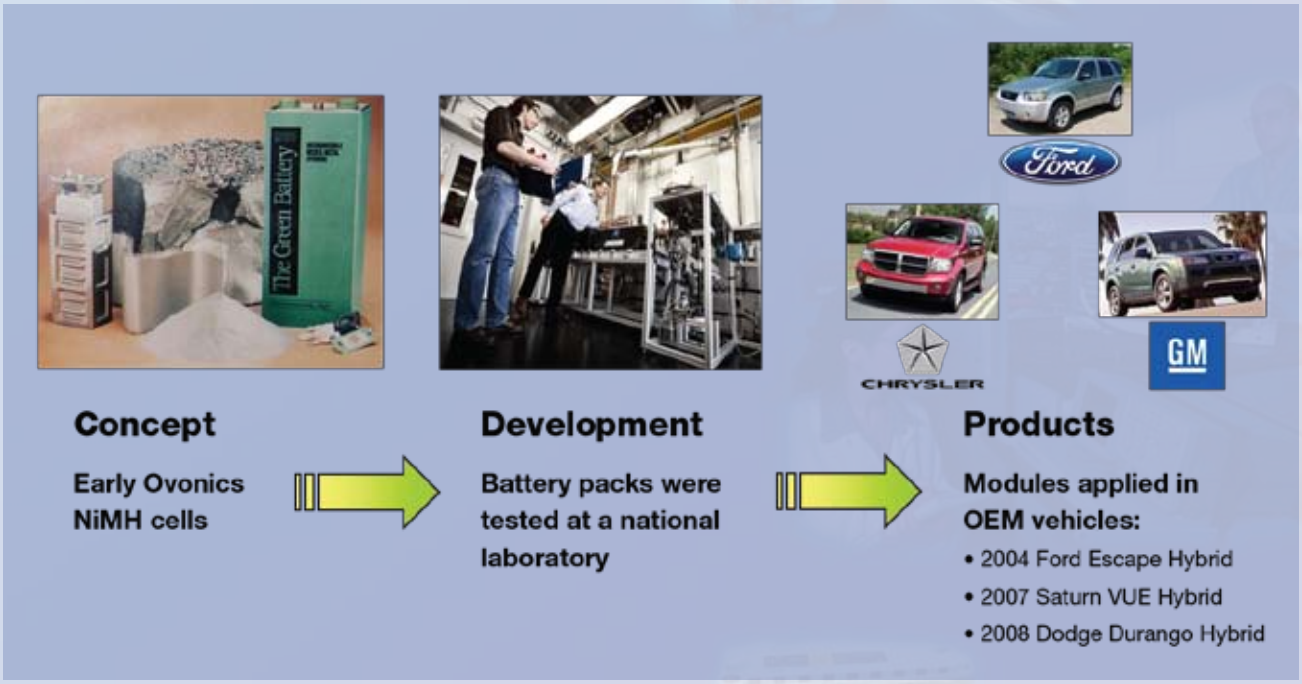
This includes the development of nickel-metal hydride (NiMH) batteries that are in almost all hybrid-electric vehicles (HEVs) today and lithium-ion (Li-ion) batteries that will power future electric vehicles and plug-in hybrid electric vehicles (PHEVs).

The United States Advanced Battery Consortium LLC (USABC), which operates under the USCAR umbrella, has been at the forefront of many of the technology achievements in energy storage. USABC test standards guide suppliers to meet real-world customer requirements.

USABC sponsored supplier technology development that helped NiMH batteries move from concept to commercial applications, where they were applied in the 2004 Ford Escape Hybrid and later, in the 2007 Saturn VUE Hybrid and 2008 Dodge Durango Hybrid.

While the industry continues to refine and enhance NiMH batteries, the development of Li-ion batteries that double the energy density of NiMH and are 1/3 of the mass, represent the next generation in advanced battery R&D.

Advanced Batteries & Energy Storage Successes
Vehicle electrification



The U.S. DOE and USCAR helped move NIMH Batteries from concept to commercialization.

All three automakers are moving from concept to preproduction applications of Li-ion batteries for battery-electric vehicles (BEVs), range-extended electric vehicles (REEVs), hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs). GM's 2010 Chevrolet Volt plans to feature Li-ion batteries. The 2007 Ford HySeries Edge demonstration vehicles feature Li-ion battery packs. And Chrysler Group has announced five ENVI electric-drive vehicles using Li-ion batteries, one targeted for production in 2010.

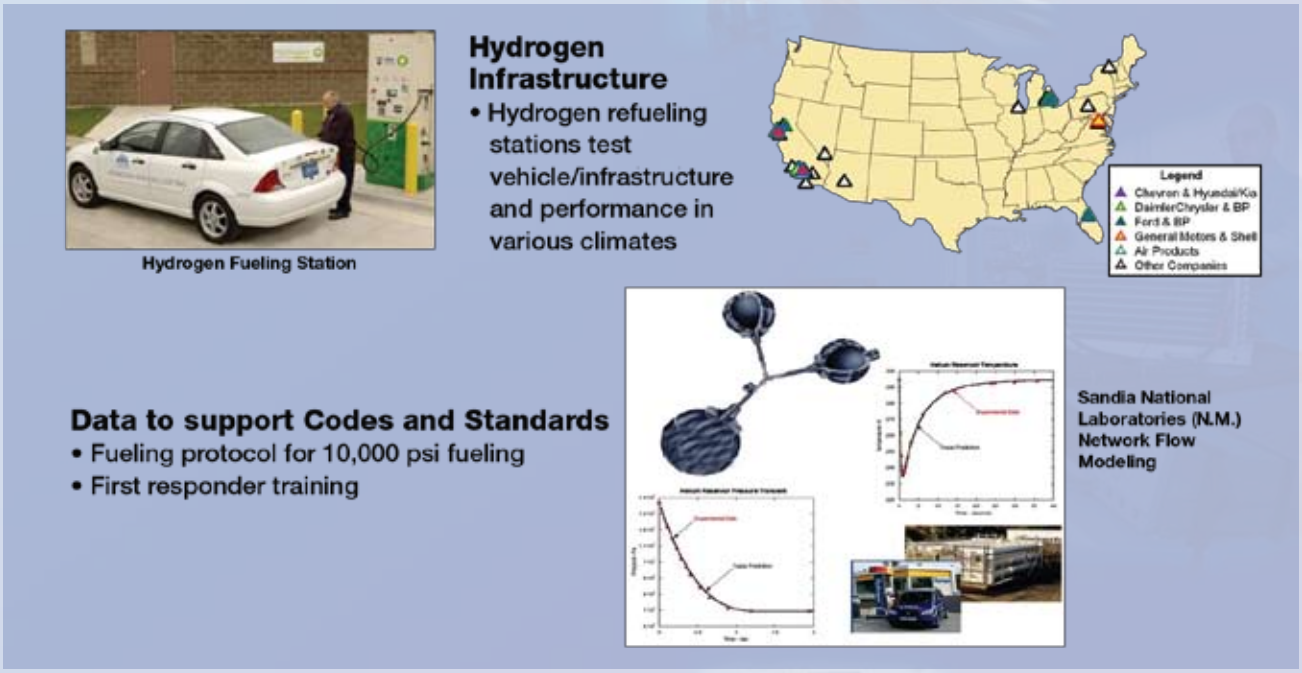
These vehicles will enable their drivers to travel up to 40 miles on inexpensive electricity.

2010 Chevrolet Volt

2007 Ford HySeries Edge

Dodge Circuit EV

Fuel Cell and Hydrogen Successes
Potential for 100% non-carbon fuel



The FreedomCAR and Fuel Partnership advanced hydrogen fuel cell technology and infrastructure.

Hydrogen (H_2) fuel cells represent the potential for 100 percent non-carbon fuel. Through the FreedomCAR and Fuel Partnership, the U.S. Department of Energy, USCAR and five energy partners are advancing H_2 fuel cell technologies and the infrastructure to support them.

The U.S. Government and USCAR have advanced the state-of-the-art for H_2 fuel cells and H_2 storage technologies, fuel stacks and higher pressure storage tanks. H_2 fuel cell vehicles offer zero on-road emissions and high efficiency. H_2 fuel cells represent a totally new approach to powering vehicles, yet still require a significant amount of science and engineering to speed commercial viability for transportation.

The FreedomCAR and Fuel Partnership has helped to lower costs, mass and volume of fuel cells and storage systems.

Fuel cell stack R&D achievements include cost reductions, improved durability, and since 2002, a 10-fold increase in specific power and power density, with corresponding volume and efficiency improvements.

Higher pressure H_2 storage achievements include three-times faster filling and smaller 10,000 psi tanks. And advanced H_2 storage technologies have shown a two-fold increase in the storage capacity of materials-based systems.

Gen-2 Hydrogen Fuel Cell

Prototype H_2 Fuel Tanks.

Fuel Cell and Hydrogen Successes
Potential for 100% non-carbon fuel

USCAR is a major participant in the FreedomCAR and Fuel Partnership hydrogen learning demonstration program. Overall results include:

- 140 vehicles/20 hydrogen fuel stations
- 2.3 million miles traveled w/zero emissions
- 346,000 individual vehicle trips analyzed
- Fuel cell durability and vehicle range targets met with Gen 2 vehicles

The project continues in 2010.

U.S. Automakers are gaining real-world experience and knowledge of consumer expectations.


HySeries Edge


Equinox

The FreedomCAR and Fuel Partnership technical demonstration program brought hydrogen powered test vehicles into the 'real world.'

A limited number of H_2 fueling stations are in place to support H_2 fuel cell test demonstration vehicles. These test-bed programs are providing the data and real-world experiences needed to develop appropriate codes and standards for hydrogen manufacture, distribution and use.

Through their collaboration in the FreedomCAR and Fuel Partnership (FC&FP), the U.S. Department of Energy and USCAR have brought H_2-powered test vehicles into the real world.

To date, overall results of the FC&FP hydrogen learning demonstration program include the development and production of 140 H_2-powered vehicles and 20 H_2 fuel stations. These vehicles have traveled 2.3 million miles with zero emissions, and 346,000 individual vehicle trips have been analyzed. In addition, fuel cell durability and vehicle range targets were met by second generation vehicles. The program, which includes commercial and consumer vehicles, is meeting a $3/gallon fuel cost equivalent and the cars are achieving 250+ mile ranges.

The project continues in 2010.

The fuel cell learning demonstration program is "an essential way for the Partnership to learn about the real-world performance of the technologies it is developing."

National Research Council of the National Academies, "Review of the Research Program of the FreedomCAR and Fuel Partnership: Second Report"

Hybrid Vehicle Components & Systems Successes

Sustainable transportation/reduced fuel consumption

2005 Ford Escape Hybrid Drivetrain

Hybrid Components and Systems

U.S. Government/USCAR collaboration is helping to develop the supply base for hybrid vehicle systems.

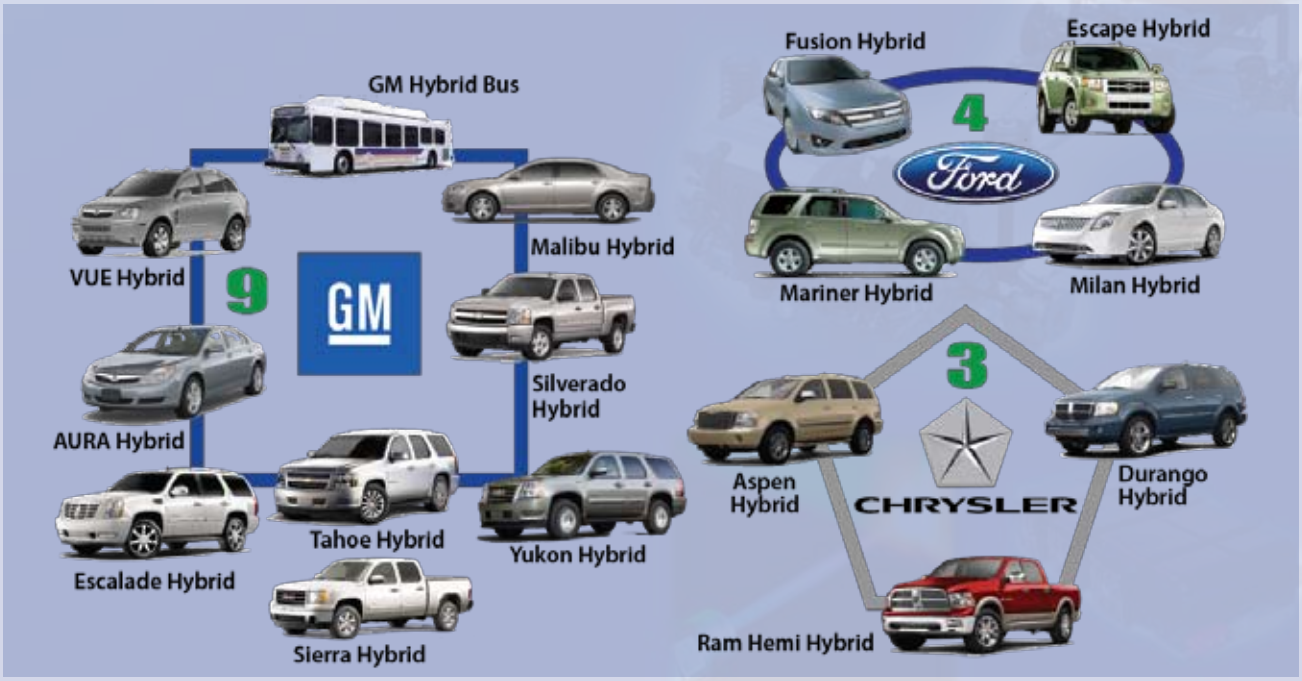
In the area of power electronics, suppliers, working under DOE-sponsored projects, are meeting the challenges. New materials and improved packaging have increased power density by 45 percent. Reliability improved and cost was reduced by 40 percent. Specifications guiding thin-film capacitor R&D were developed.

Suppliers also are pursuing 'leapfrog' technologies such as silicon carbide and gallium nitride power modules to withstand higher temperatures.

U.S. Government/USCAR collaboration is developing technology for hybrid systems, including the development of interior permanent magnet motors that provide higher power density. R&D successes include advanced motor design and magnet materials. Bonded magnet material research has increased operating temperature capability. New designs enable the reduction of magnet materials to provide the same torque density.

The U.S. automakers have 16 HEVs in production and on the road today – nine GM hybrids, four Ford hybrids and three Chrysler Group hybrids.

The 2010 Ford Fusion Hybrid Electric Motor Cutaway



Pictured above are the U.S. automakers' HEV product lines, with even more planned through 2010.

Other U.S. Government/USCAR Successes
More than fuel efficiency

The U.S. Government and USCAR collaborate in many areas, in addition to the FreedomCAR and Fuel Partnership, including:

Safety – USCAR's Occupant Safety Research Partnership (OSRP) is central to the development of a side impact dummy – WorldSID – that will serve as the global standard for measuring side-impact crash safety in vehicles worldwide.

Recycling – USCAR's Vehicle Recycling Partnership LLC (VRP) is recognized as a worldwide leader in vehicle recycling. In North America, 95 percent of all end-of-life vehicles go through a market-driven infrastructure in which approximately 84 percent of each vehicle, by weight, is recycled. This happens without any additional cost or tax to consumers. As part of its work, the VRP also is focused on continually improving the percentage of each vehicle recycled as well as planning for the recycling of new materials and eliminating all substances of concern from shredder residue.

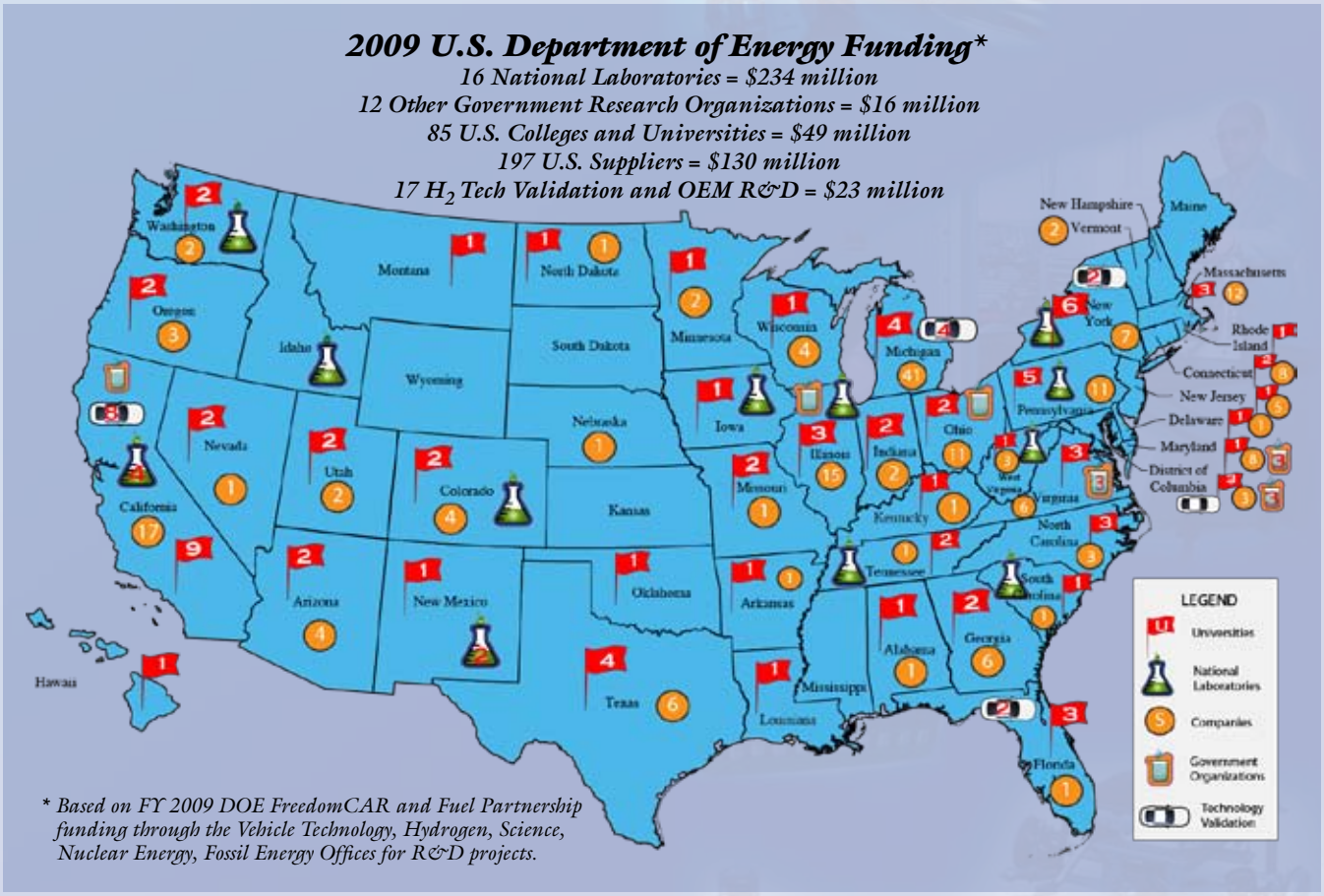
Manufacturing – Continuously improving sustainable manufacturing processes, promoting ergonomic efficiencies and enabling new electronic environments are areas of collaborative interest and action for USCAR. Plant floor controllers, digital virtual tools and ergonomics are areas in which significant progress has resulted.

Safety
WorldSID

Recycling
Plastics recovery
Elimination of substances of concern

Manufacturing
Plant floor controllers
Ergonomics
Digital virtual tools

Partners: Leveraging Academia, National Labs and Private Industry

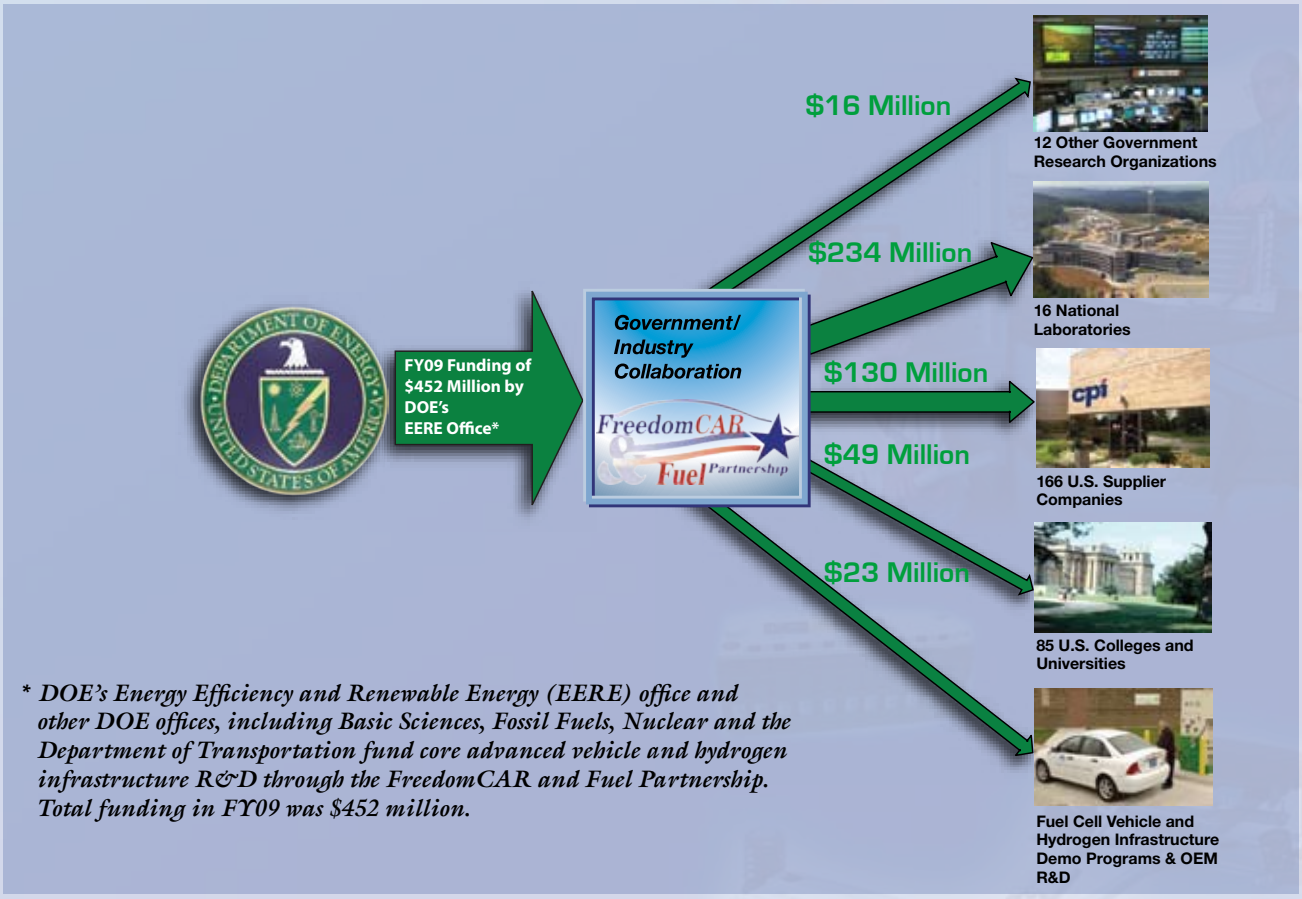


FreedomCAR and Fuel Partnership dollars benefit research facilities and suppliers in nearly every state. This map shows how FY 2009 DOE funds were distributed.

In 2009, through the FreedomCAR and Fuel Partnership, the U.S. Department of Energy provided $452 million in funding for automotive R&D at research institutions, national laboratories, suppliers and OEMs throughout the United States. Eighty-five U.S. colleges and universities received $49 million in R&D funding, 197 U.S. suppliers received $130 million, 16 national laboratories received $234 million and 12 other governmental organizations received $16 million.

In addition, the DOE provided funding for cost-shared demonstration & validation programs for hydrogen fuel cell vehicles and infrastructure. Combined with DOE funding for other R&D projects through contract awards from competitively-bid solicitations, the automakers received approximately $23 million.

U.S. Government Funding Flows Primarily to National Labs, Suppliers, Colleges and Universities, not the Automakers



** DOE's Energy Efficiency and Renewable Energy (EERE) office and other DOE offices, including Basic Sciences, Fossil Fuels, Nuclear and the Department of Transportation fund core advanced vehicle and hydrogen infrastructure R&D through the FreedomCAR and Fuel Partnership. Total funding in FY09 was $452 million.*

It is important to know that government funding for U.S. automotive collaboration flows primarily to national laboratories, suppliers, colleges and universities – not to the automakers. There is a critical role for a limited amount of government funding to provide demonstration programs that allow testing and validation of prototype vehicles under real world conditions, but this is far exceeded by the automakers' own research budgets.

The automakers collectively devote billions of dollars in cash and human resources to the research and development of advanced vehicle technologies, including fuel cells, hydrogen storage, power electronics, batteries, lightweight materials, high efficiency combustion, emission controls and advanced manufacturing processes.

National and Federal Laboratory Partners
Developing & Leveraging the Government's High Tech Tools

In its work with national and federal laboratory partners, USCAR leverages and often helps develop the government's high-tech tools, working with labs coast-to coast.

Following are some of the USCAR laboratory partners and some of the areas in which they collaborate with USCAR.

Suppliers also play a major role in USCAR's collaborative research efforts with the federal government.

The government funds major research efforts, often with a supplier cost share, to develop new technologies and bring them to the brink of commercialization.

- **Sandia National Laboratories**
  - Optical engines and combustion modeling*
  - Battery abuse testing facility*
- **Argonne National Laboratory**
  - Powertrain Systems Analysis Toolkit (PSAT) Hardware in the Loop testing
  - Advanced Photon Source (APS)
  - Shredder residue recycling facility
- **Idaho National Laboratory**
  - Battery accelerated life cycle testing facility*
- **Oak Ridge National Laboratory**
  - High Temperature Materials Lab (HTML)
  - Neutron Sciences and Nanophase Materials Facility
  - National Transportation Research Center (NTRC)
- **National Renewable Energy Laboratory**
  - Battery imaging facility*
- **National Institute of Standards and Technology**
  - Neutron imaging
  - Water flow in fuel cells*
- **Pacific Northwest National Laboratory**
  - Hazardous Materials Management Emergency Response (HAMMER) training facility*
  - Environmental Molecular Sciences Lab
- **Lawrence Berkeley National Laboratory** – Advanced Light Source (ALS)
- **Lawrence Livermore National Laboratory** – Combustion modeling (KIVA, etc.)

* Developed as part of the partnership activity with industry technical input
** Private facility funded through the U.S. Department of Energy

Optical engine at Sandia National Laboratories (Calif) Combustion Research Facility

Mobile Advanced Technology Testbed (MATT) at Argonne National Laboratory

Oak Ridge National Laboratory neutron imaging lab

Supplier Partners
Leveraging Private Industry Expertise

The U.S. Government and USCAR jointly contract with hundreds of U.S. supplier partners.

Hydrogen and Fuel Cells

UTC Power · Quantum · Millennium Cell · Proton Energy Systems · plug power · Air Products · Nuvera · GE Global Research · Praxair

Energy Storage

Johnson Controls · Ener1 · cpi · A123 Systems

Combustion and Aftertreatment

TIAX · Envera · Cummins · BSST

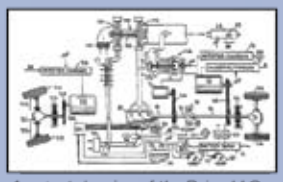
Power Electronics and Motors

Delphi Automotive Systems · UQM · Electron Energy Corporation · Semikron

Materials

Alotech, Inc. · Geometric · Altair · Multimatic · SP

Government/Industry Collaboration Brings Technology to the Road

Then... 1992		And Now... 2010	
	Gasoline vehicles dominate. Efficient diesel limited to heavy duty trucks and large pickups.	 Dodge Ram Pickup	Clean, quiet diesel-powered vehicles; enabled by government/industry combustion and emissions research
 *A patent drawing of the Paice LLC hybrid invention submitted to the U.S. Patent and Trademark Office in the early 1990s.*	Hybrid electric vehicles were not available in the U.S., and their broad commercial feasibility was questioned.	 Ford Fusion Hybrid	Hybrid electric vehicles, accelerated by PNGV and FreedomCAR technologies, are on the road. PHEVs and extended-range EVs are in development.
 Phase II Ballard hydrogen fuel cell bus	H_2-powered fuel cell vehicles were not in the market. Early experimental automotive fuel cells cost millions of dollars, lacked durability, and were extremely large.	 Chevrolet Fuel Cell Equinox	Light duty fuel cell vehicles are in demonstration fleets. With a hydrogen fueling infrastructure, fuel cell vehicles appear feasible before the end of the next decade.

Without successful collaboration between the U.S. government and U.S. automakers, major advances in automotive technologies might still be on the drawing board. Pictured are just a few examples of where we were 17 years ago – right before the formation of USCAR – and where we are today.

In Summary

The U.S. Government and USCAR have a proven record of collaborative success. Our many accomplishments benefit the United States and global society.

It is important to continue our work to reduce petroleum consumption and emissions by:

- Enabling the deployment of more efficient and advanced propulsion systems
- Increasing the availability and use of alternative fuels
- Improving transportation system efficiency.

It also is important to continue our work in developing and supporting a robust and efficient domestic manufacturing base by:

- Reducing manufacturing energy intensity
- Retooling for manufacturing of more energy efficient products
- Developing innovative manufacturing processes for advanced materials
- Developing environmentally sustainable manufacturing technology.

We are committed to providing sustainable and affordable transportation solutions for consumers. And we will continue to seek and develop creative approaches to meet the significant technology and commercialization challenges that remain.

Increased U.S. Government/ USCAR collaboration is essential.

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