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EUROPEAN ASSESSMENT OF GLOBAL PUBLICLY FUNDED AUTOMOTIVE RESEARCH

Publicly funded automotive research in the USA

SEVENTH FRAMEWORK PROGRAMME

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1 Introduction

1.1 Background

The FP7 project EAGAR benchmarks the current public automotive research activities at international level, in particular the European Union with Brazil, Canada, China, India, Japan, Malaysia, Russia, South Korea, the United States and 13 EU Member States.
EAGAR identifies the national road transport visions and roadmaps, research priorities, supported key topics, technology pathway, as well as the level of investment. This enables a direct comparison of national automotive R&D policies relating to the environment, safety and congestion.
The EAGAR study provides a key perspective on global investments designed to improve automotive vehicle technologies for a greener, safer and smarter road transport system.

1.2 Objectives

This deliverable report summarises the situation of the RTD funding system in the United States (US) with respect to published vision statements, research targets and roadmaps, the national funding programmes of the past 4 years and the governance of automotive RTD funding in the U.S.
The report is basis for the subsequent benchmarking analysis, which delivers the key results of EAGAR addressing the following issues:

- Overview of national road transport visions, research agendas and roadmaps
- Comparison of automotive research priorities and investments focused on vehicle technologies
- Characteristics of national automotive research funding systems and approaches
- Highlight areas of strenght and weakness I European RTD compared to the analysed countries
- Potential international cooperation areas from a European perspective

This study benefits the competitiveness of Europe and enables the stakeholders to adjust its visions & plans for the future. Date of publication: September 2010. It is available from the EAGAR website
WWW.EAGAR.EU

1.3 Methodologies

This country report is mainly based on comprehensive investigations via desk research, information from the responsible programme managers and individual feedback from experienced project managers and researchers. The methodology used was developed in the first months of the project. It is consistent for all target countries. The data collection was mainly done from May to November 2009.

The four main categories are:

- General and automotive data about the country
- Published challenges, visions, targets for automotive research
- Funding organisations and hierarchies for automotive research
- National public funding programmes with dedicated calls or permanently open between in the years 2006 to 2009.

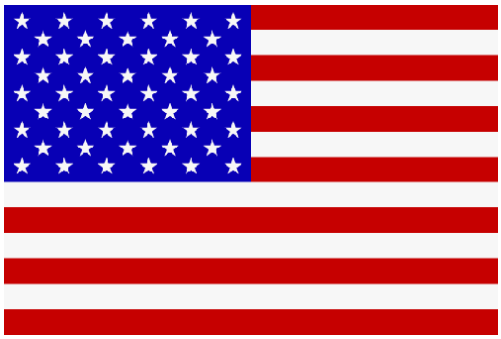
However, the data may not be complete since in 2009 and 2010 major funding resources were channeled through the Recovery Act issued by the U.S. government. Furthermore, only federal funding has been inevstigated.

Disclaimer

This document presents quantitative and qualitative data from various sources. Due to the complexity of the project and the large amount of sources of data, regularly changing during the duration of the project, it was not possible to thoroughly validate all details. The EAGAR project partners cannot guarantee that the data presented is either complete or correct. The value of some of these data is mainly explorative, as a first step in an indicators development process. In conclusion, the data provided here may be difficult to interpret, are not exhaustive and may need further development. Comments by stakeholders on the coverage, relevance and interpretation of the indicators provided, as well as observations on new indicators that could be employed to improve the analysis of publicly funded automotive research are welcomed by the EAGAR project consortium. Any quotation of the data in this document should make reference to the above disclaimer. The EAGAR project partners and EC accept no liability for any issues that arise from actions that may be taken as a result of reading this report.

2 Description of the main WP results

2.1 General Information and Automotive Data



The United States of America is the world-leading economy with a per capita GDP of $46,900. Located in North America, it has a population of 307.2 Million and covers 9,826,675 km^2 of which 93% is land. With this, the U.S. is about half the size of Russia; about three-tenths the size of Africa; about half the size of South America (or slightly larger than Brazil); slightly larger than China; more than twice the size of the European Union. Almost all climate conditions can be found ranging from dessert to permanent frost. The U.S. has a variety of natural resources such as copper, lead, bauxite, gold, iron, petroleum, and natural gas. It US has the world's largest coal reserves with 491 billion short tons accounting for 27% of the world's total.[1]

The role and importance of road transport in the United States and significance of domestic automotive industry

Road transport is a major part of the U.S. transportation system: e.g. 30% of freight is delivered by road, passenger-miles exceeding those of other mode by one order of magnitude.
Following data are for year 2007:[2]

- Transportation and warehousing accounts for 2.9% of the total GDP
    - Value Added by Truck transportation: 0.9 % of GDP
    - Value Added by Transit and ground passenger transportation: 0,1% of GDP
- Road network accounts for 4,032,126 miles (urban and rural)
- 4,958,922 million passenger-miles were travelled by road
- 1,317,061 million ton-miles of freight carried by road
- Number of passenger cars per thousand inhabitants: 789
- Passenger car sales: 5,845,000 cars
- Commercial vehicle sales: 6,200,712 vehicles
- Motorised two-wheelers: 1,124,000
- 14 car makers have factories in the U.S.
- Employment in motor vehicles and parts manufacturing in 2008: 876,900
- # of OEMs & supplier: unknown
- # of automotive R&D centers: > 70
- Industry turnover: 14,265 billion $ in 2008
- Value Added by manufacturing of motor vehicles, bodies and trailers, etc..: 0.7% of GDP

National spending and funding for research and technological development (general vs automotive sector)[3]

- Automotive R&D spending by industry (only Motor vehicles, bodies and trailers, and parts manufacturing): $ 16,625 mio in 2004 (0,15% of GDP)
- Value added by automotive industry in 2004 (only Motor vehicles, bodies and trailers, and parts manufacturing): 0.4% of GDP

[1] CIA – The World Fact Book
[2] Department of Transportation – Bureau of Transportation Statistics (BTS)
[3] NSF / Bureau of Economic Analysis

- Gross output in 2004 (only Motor vehicles, bodies and trailers, and parts manufacturing): $ 488 billion
- In 2004, 2.7% of net sale
- Total R&D investment in 2004: $ 107,557 mio (spent by government), represent about 34% of total R&D spending

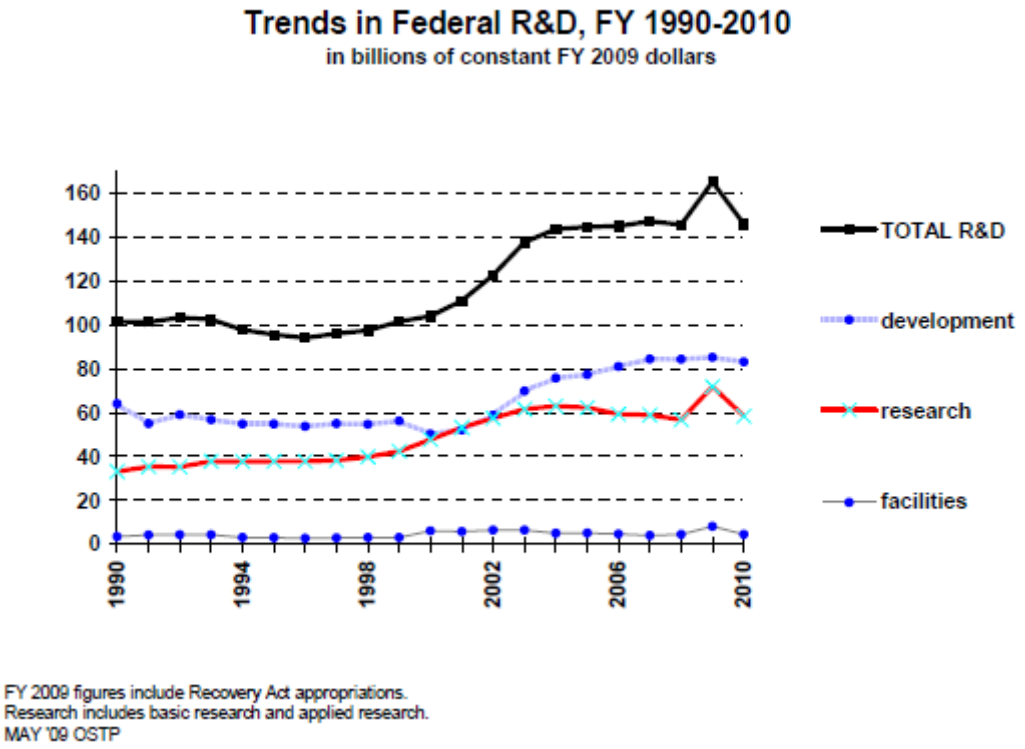


Figure 1: Trends in Federal R&D[4]

2.2 National Funding Organisations and Hierarchies for Automotive Research

The structure and governance of the national funding system

The funding structure and governance of the funding systems in the United States is rather diversified but with a trend towards a centralised approach. Altogether about 26 federal grant-making agencies and 1000 grant programs are listed. Funding and topics are administered through the federal departments which also negotiate the fiscal budget and R&D programs with the White House and the Congress. The White House itself runs the National Science and Technology Council as an executive office which defines the priorities for federal research and development. Those priorities are being implemented by the various departments running R&D programs.

Funding organisations and key players

National Science and Technology Council (NSTC)

Advisory Council for the president proposing priorities for federal research and development programs and allocated budget. The council prepares research and development strategies that are coordinated across Federal agencies to form investment packages aimed at accomplishing multiple national goals.
http://www.ostp.gov/cs/nstc

[4] Office of Science and Technology Policy

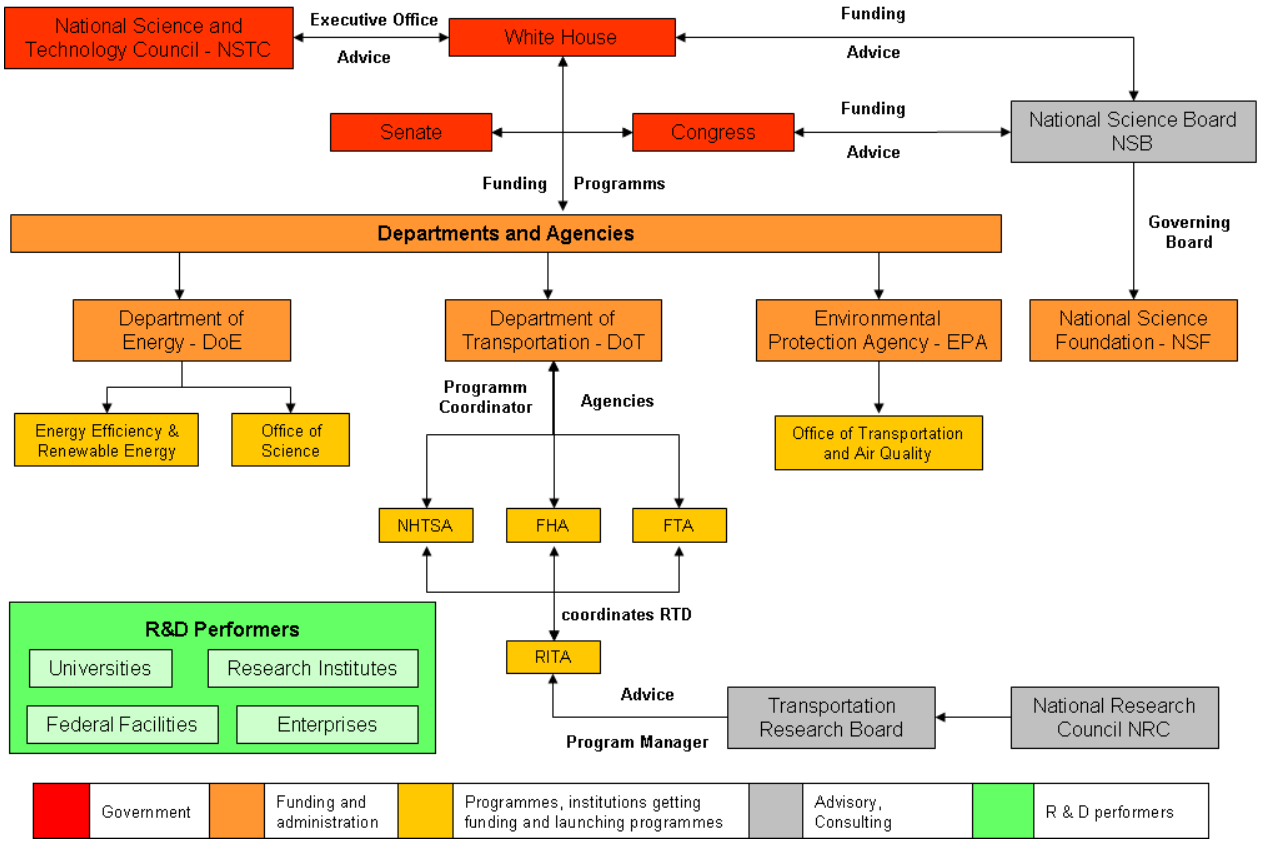


Figure 2. Funding Hierarchy of the U.S. R&D. policy

National Science Board (NSB).

The NSB establishes the policies of National Science Foundation within the framework of applicable national policies set forth by the President and the Congress. It also serves as an independent body of advisors to both the President and Congress on national policy issues related to science and engineering research and education.
http://www.nsf.gov/nsb/

National Science Foundation (NSF)

The NSF is the funding agency for approximately 20 percent of all federally supported basic research conducted by colleges and universities in the United States.

- In the Directorate for Engineering automotive-related programs are placed such as Chemical, Bioengineering, Environmental, and Transport Systems Division (CBET), Civil, Mechanical and Manufacturing Innovation (CMMI), Emerging Frontiers in Research and Innovation (EFRI) or Industrial Innovation and Partnerships (IIP).

http://www.nsf.gov/

Department of Energy (DoE)

Under the DoE, most of the energy-related research, production activities, and the transfer of technology within the U.S. is being administered. The DoE received the major budget of the Economy Recovery Act in 2009 and is coordinating most of the programs related to electrification of the transport system.

- Office of Energy Efficiency and Renewable Energy
  This office is responsible for the vehicle technologies program fostering the research on electrical vehicles.
- Office of Science
  The Office of Science is the single largest supporter of basic research in the physical sciences in the United States, providing more than 40 percent of total funding. It oversees – and is the

principal federal funding agency of – the Nation's research programs in high-energy physics, nuclear physics, and fusion energy sciences. The Office of Science manages fundamental research programs in basic energy sciences, biological and environmental sciences, and computational science. In addition, the Office of Science is the Federal Government's largest single funder of materials and chemical sciences, and it supports unique and vital parts of U.S. research in climate change, geophysics, genomics, life sciences, and science education.

http://www.energy.gov/

Department of Transportation (DoT)

The Department of Transportation is hosting the Federal Highway Administration (FHA), the Federal Transit Administration (FTA) and National Highway Traffic Safety Administration (NHTSA) under which major transport-related research is being conducted. The research and technology programs within the DoE are coordinated by the Research and Innovative Technology Administration (RITA).
http://www.dot.gov/

Environmental Protection Agency (EPA)

The EPA Office of Transportation and Air Quality's (OTAQ) mission is to reconcile the transportation sector with the environment by advancing clean fuels and technology, and working to promote more liveable communities. OTAQ is responsible for carrying out laws to control air pollution from motor vehicles, engines, and their fuels. Mobile sources include: cars and light trucks, large trucks and buses, farm and construction equipment, lawn and garden equipment, marine engines, aircraft, and locomotives. Activities include: characterizing emissions from mobile sources and related fuels; developing programs for their control, including assessment of the status of control technology and in-use vehicle emissions; carrying out a regulatory compliance program, in coordination with the Office of Enforcement and Compliance Assurance, to ensure adherence of mobile sources to standards; fostering the development of State Motor Vehicle Emissions Inspection and Maintenance Programs; and implementing programs for the integration of clean-fueled vehicles into the market.
http://www.epa.gov/

National Research Council

The National Research Council (NRC) is a private, nonprofit institution that provides science, technology and health policy. The mission of the NRC is to improve government decision making and public policy, increase public education and understanding, and promote the acquisition and dissemination of knowledge in matters involving science, engineering, technology, and health. One of the NRC units is the Transportation Research Board (TRB) which is primarily supporting transport-related research by organising conferences, workshop and task forces. The TRB administers a number of major research programs sponsored by other organizations such as some programs of the DoT.
http://sites.nationalacademies.org/NRC/index.htm

Office of Science and Technology Policy

Congress established the Office of Science and Technology Policy (OSTP) in 1976 with a broad mandate to advise the President and others within the Executive Office of the President on the effects of science and technology on domestic and international affairs. The 1976 Act also authorizes OSTP to lead interagency efforts to develop and implement sound science and technology policies and budgets, and to work with the private sector, state and local governments, the science and higher education communities, and other nations toward this end. The mission of the Office of Science and Technology Policy is threefold; first, to provide the President and his senior staff with accurate, relevant, and timely scientific and technical advice on all matters of consequence; second, to ensure that the policies of the Executive Branch are informed by sound science; and third, to ensure that the scientific and technical work of the Executive Branch is properly coordinated so as to provide the greatest benefit to society.
http://www.whitehouse.gov/administration/eop/ostp

Other organizations with influence:

United States Council for Automotive Research (USCAR)

The United States Council for Automotive Research (USCAR) was founded in 1992. Its goal is to further strengthen the technology base of the U.S. auto industry through cooperative research and development. Its main focus is to

- Create, support and direct U.S. cooperative research and development to advance automotive technologies.
- Be responsive to the needs of our environment and society and include the appropriate public and private stakeholders.

USCAR is composed of a number of specialized groups that focus on specific research areas. These research teams work to:

- accelerate technical development,
- provide a common voice to the supply base,
- increase the value of research investments,
- improve quality
- and reduce the cost for noncompetitive technologies and activities.

These goals are often accomplished through partnerships with various stakeholders including the federal government, educational institutions and suppliers.
http://www.uscar.org/

Center for Automotive Research (Cargroup)

The Center for Automotive Research, a nonprofit organization, is focused on a wide variety of important trends and changes related to the automobile industry and society at the international, federal, state and local levels. CAR conducts industry research, develops new methodologies, forecasts industry trends, advises on public policy, and sponsors multi-stakeholder communication forums.
http://www.cargroup.org/

Society of Automotive Engineers (SAE)

SAE International has more than 121,000 members - engineers, business executives, educators, and students from more than 97 countries - who share information and exchange ideas for advancing the engineering of mobility systems. SAE is a one-stop resource for standards development, events, and technical information and expertise used in designing, building, maintaining, and operating self-propelled vehicles for use on land or sea, in air or space. Every day, SAE demonstrates their commitment to society through local, national, and international public awareness programs that promote vehicle safety and maintenance and energy resource conservation. Through the SAE Foundation, they are also deeply involved in the engineering-related education of children, teachers, college students, and faculty. Industry and faculty awards provide recognition to outstanding contributors in the profession.
http://www.sae.org/

Remit for organisations & calls: overlaps or conflicts

Although the analysed R&D policy of the U.S. indicates a centralised programme management- e.g. by direct negotiation of the programme budget with the U.S. government – a degree of overlap and conflicts seems to be present. The sheer variety of different calls and involved funding agencies as well as many different funding instruments leads automatically to overlap in research projects and calls. Both departments, DoE and DoT, e.g. are addressing fuel cell technologies and electrification of vehicles, each in different agencies and departments. Only the DoT established an office (RITA) to coordinate the internal R&D programs but only to a certain degree. Not all programs are listed within RITA. Furthermore, the federal facilities and university transportation centres are conducting research without a strict centralised programme management. Consequently, several projects and pro-

grams can be found addressing similar or overlapping topics. However, the policy of publishing the basic results of each public funded project and an annual review of projects of their figure of merits (assessment of the performance of a project) is an instrument to minimise the effect of overlapping research and to improve the efficiency of the R&D policy.

2.3 Automotive Visions and Strategic Research Agendas

Significant challenges for the national road transport sector.

The automotive R&D policy in the U.S. is mostly addressing the same challenges for the national road transport sector. All analysed strategic research agendas (SRA)[5] are referring to the global changelles as identified within the European Research Area as well as defined in the EAGAR projects. The challenges are

- Fuel efficiency & GHG emissions:promotion of transportation solutions that enhance communities and protect the natural and built environment. 1. Reduction in pollution and other adverse environmental effects from transportation and transportation facilities. 2. Streamlined environmental review of transportation infrastructure projects.
- Mobility – reduce congestion: In 2003 alone, congestion in the top 85 U.S. urban areas caused 3.7 billion hours of travel delay and 2.3 billion gallons of wasted fuel, for a total cost of $63 billion. Congestion also can contribute to air pollutant emissions
- Safety & security - Reduction in transportation-related deaths & reduction in transportation-related injuries: Most transportation related fatalities and injuries occur on the Nation's roads and highways, and demographic trends make it increasingly difficult to reduce these fatalities and injuries. Within the next 25 years, the U.S. population is estimated to grow to 364 million, up from 282 million in 2000. Vehicle miles of travel (VMT) is projected to increase by approximately 60 percent from 2000 to 2030, leading to much higher numbers of highway crashes and fatalities.
- Competitiveness – Global connectivity: facilitation of an international transportation system that promotes economic growth and development and enhancing the competitiveness of U.S. transport providers and manufacturers in the global marketplace.

In the past year, a special focus was given to the electrification of the road transport with heavy investments facilitated by the Recovery Act 2009 & 2010.

Visions & focused targets for road transport

Each funding organization or major program defines up to 5 – year strategic research agendas or multi-annual implementation plans. The existing visions and targets are currently being reviewed since most of the agendas and implementations plans are defined until 2010 or 2011. On basis of these plans, the annual fiscal budget will be negotiated. For each program, a review of merit on project level will be performed and reported yearly. It was noticed that most of the SRA are still using short term goals or missing clearly defined targets.

[5] SRA's are referenced in the section below

Table 1: Visions

Vision name	Corresponding challenge	Description	Year[6]
21st Century Truck	Fuel efficiency & GHG emissions Competitiveness	trucks and buses will safely and cost-effectively move larger volumes of freight and greater numbers of passengers while emitting little or no pollution and dramatically reducing the dependency on foreign oil.	not specified
The President's goal	Fuel efficiency & GHG emissions Mobility Competitiveness	One million PHEV on road until 2015	2015
Safety (FTA MY Research Plan)	Safety & Security	Understand and address causal factors and risks; emerging research priority is human-automation interaction enhanced safety data; mitigate accidents and incidents	2013
Reduced congestion (FTA MY Research Plan)	Mobility	Reduce passenger and freight congestion in air and surface modes; emerging research priority is congestion reduction policy research and technologies; extend system life and improve durability; improve planning, operations, and management, improve services for underserved areas and populations; advance the nation's transportation research capability	2013
Global connectivity (FTA MY Research P)	Mobility Competitiveness	Harmonize standards and support leadership for U.S. transportation providers	2013
Environmental stewardship (FTA MY Research Plan)	Fuel efficiency & GHG emissions Pollution & noise	Understand and mitigate transportation impacts; emerging research priority is energy efficiency and alternative fuels; improve the environmental review process	2013
Security, preparedness, and response (FTA MY Research P)	Safety & Security	Reduce vulnerability and improve preparedness and recovery	2013
Transportation SRA	All	Enhance public health and safety by working toward the elimination of transportation-related deaths and injuries. Reduce congestion and other impediments to using the Nation's transportation system. Facilitate an international transportation system that promotes economic growth and development. Promote transportation solutions that enhance communities and protect natural and built environments.	unknown
IntelliDrive	Mobility Safety & Security	One goal is to enable active safety applications, defined as cooperative and communications-based applications designed to assist vehicle operators in avoiding imminent crashes; another goal is to enable mobility, environmental, productivity and convenience applications: The vision for Vehicle-toVehicle is that all vehicles will be able to eventually communicate with other vehicles and this communications will support a new generation of effective safety systems for motor vehicles. Active safety systems enabled by V2V technology could assist drivers avoid crashes that further reduces the number of fatalities and injuries.	2014

[6] End date of multi-year research plan

Department of Energy (DoE)

The DoE is facilitating a major part of the U.S. automotive research in two major programms.

The *Vehicle Technologies Program* (VTP) is mainly addressing efficient and environmentally friendly highway transportation technologies that will enable the U.S to use less petroleum. The program is devided in several program areas each addressing a specific technology (see also fig. 7). The vision and targets are basically described in its Multi-Year Program Plan 2006 – 2011 and the Vehicle Technologies Program Planning. No more recent documents are available publically but all relevant information can be found on the web-page of this program.[7]

The *Fuel Cell Technologies Program* (FCTP)[8] addresses the development and use of hydrogen and fuel cell technologies. These technologies are considered to have the potential to solve the major energy security and environmental challenges that face the U.S. today—dependence on petroleum imports, poor air quality, and greenhouse gas emissions. For this program a Multi-Year Research, Development and Demonstration Plan 2005 – 2015 exist which has been updated 2007 and partly 2009. Again the program is devided in several program areas as shown in Fig. 7.

An overview of visions and targest in given in table 2.

Table 2: Targets of the VTP and FCTP

Technology	Corresponding challenge	Target	By date	Year
Department of Energy – Vehicle Technologies Program[9]				
Power Electronics and Electric Motor	*oil savings and GHG reductions*	*same life and performance requirements at a cost of $12/kW*	*2015*	*2008*
		By 2010, develop an integrated electric propulsion system that costs no more than $19/kWh peak and can deliver at least 55kW of power for 18 seconds and 30kW of continuous power ($1,045 per system compared to the cost of $1,925 in 2004)	*2010*	
Energy Storage	*GHG, competitiveness*	*Reduce the production cost of a high energy and high power battery from $1,000/kWh in 2006 to $300/kWh by 2014, enabling cost competitive market entry of PHEVs*	*2014*	*2008*
	GHG, competitiveness	*Reduce the production cost of a high power 25kW battery for use in passenger vehicles from $3,000 in 1998 to $500 by 2010, enabling cost-competitive market entry of hybrid electric vehicles*	*2010*	
Vehicle and Systems Simulation and Testing	*GHG*	*Demonstrate market readiness of PHEV technologies by 2015*	*2015*	*2008*
Advanced Combustion	*GHG*	*Improve passenger vehicle engine efficiency 25%–40% and commercial vehicle engine efficiency at least 20% by 2014 while meeting emission standards by 2014*	*2014*	*2008*
	GHG	*Improve the efficiency of internal combustion engines from 30% (2002 baseline) to 45% by 2010 for passenger vehicles*	*2010*	

[7] http://www1.eere.energy.gov/vehiclesandfuels/

[8] http://www1.eere.energy.gov/hydrogenandfuelcells/

[9] VTP Planning 2008

Technology	Corresponding challenge	Target	By date	Year
Fuels	*GHG, oil savings*	*Complete testing to determine if gasoline blended with 15% and 20% ethanol can be used interchangeably with existing fuels in passenger vehicles and small, non-road engines not specifically designed to run on these blends by 2010*	*2010*	*2008*
Materials	*GHG*	*By 2010, develop material and manufacturing technologies which, could cost-effectively reduce the weight of passenger vehicle body and chassis systems by 50%*	*2010*	*2008*
Biomass[10]	*GHG, oil savings*	*Make cellulosic ethanol cost-competitive, at a modelled cost for mature technology of $1.33/gallon by 2012 and ~ $1.20/gallon by 2017*	*2012 2017*	*2009*
	GHG, oil savings	*Create an environment conducive to maximizing the production and use of biofuels by 2017 and displacing 30% of 2004 gasoline use by 2030*	*2017 2030*	
Department of Energy – Fuel Cell Technologies Program[11]				
Hydrogen Production	*GHG, oil savings*	*Reduce the cost of hydrogen to $2.00-$3.00/gge (delivered) at the pump - from natural gas to $2.00/gge - from biomass-derived renewable liquids to <$3.00/gge - central production of hydrogen from wind water electrolysis to <$3.00/gge -from biomass gasification to $2.10/gge*	*2017*	*2007*
Hydrogen Delivery	*GHG, oil savings*	*reduce the cost of compression, storage, and dispensing at refuelling stations and stationary power facilities to <$0.40/gge of hydrogen (independent of transport)*	*2015*	*2007*
	GHG, oil savings	*reduce the cost of hydrogen delivery from the point of production to the point of use in vehicles or stationary power units to <$1.00/gge of hydrogen in total*	*2017*	
Hydrogen storage	*GHG, oil savings*	*develop and verify on-board hydrogen storage systems achieving 2 kWh/kg (6 wt%), 1.5 kWh/L, and $4/kWh*	*2010*	*2007 (updated 2009)*
	GHG, oil savings	*develop and verify on-board hydrogen storage systems achieving 3 kWh/kg (9 wt%), 2.7 kWh/L, and $2/kWh*	*2015*	*2007 (updated 2009*
Fuel Cells	*GHG, oil savings*	*develop a 60% peak-efficient, durable, direct hydrogen fuel cell power system for transportation at a cost of $45/kW by 2010 $30/kW by 2015*	*2010 2015*	*2007 (updated 2009)*

[10] Biomass Multi-Year Prorgam Plan 2009

[11] Fuel Cell Roadmap & Multi-Year Research Plan

Technology	Corresponding challenge	Target	By date	Year
Manufacturing	*GHG, oil savings*	*$60 per kW for the same stack technology (2006) at high volume (500,000 units)*	*2015*	*2009*
	GHG, oil savings	*- costs for all on-board storage technologies is $2/kWh* *- reduce the cost of making high-pressure carbon composite storage tanks by a factor of 9 from 2005 costs*	*2015*	
Technology Validation	*GHG, oil savings*	*validate $1.60/gge (at the plant gate) hydrogen cost from biomass gasification and $3.10/kg for central wind based electrolysis (at the plant gate).*	*2014*	*2007*
		validate that hydrogen vehicles have greater than 300-mile range and 5,000-hours fuel cell durability, and hydrogen infrastructure that results in a hydrogen production cost of $2.50/gge (untaxed), and safe and convenient refuelling by drivers (with training)	*2015*	
Safety	*Safety*	*develop hydrogen leak detection technologies such as sensors*	*2012*	*2007*

Department of Transportation (DoT)

Besides the DoE, the Department of Transport is conducting significant automotive R&D under the various agencies and programs (see figure 8). The overall strategy is layed out in the Transportation Research, Development and Technology Strategic Plan 2006-2010[12]. However, the 5-year R&D strategy is rather old and is currently updated. Newer versions are available only for selected research programs. It is expected that within 2010 a revised 5-year R&D strategy will be published by the DoT. In the current strategy plan, no specific targets are listed. Nevertheless, a summary taken form the avaliable document is given below.

DOT Goal	RD&T Strategies	Emerging Research Priorities
Safety	Understand and Address Causal Factors and Risks	Human-Automation Interaction Enhanced Safety Data
	Mitigate Accidents and Incidents	
	Assess New Technologies, Vehicles, Concepts, Designs, and Procedures	
Reduced Congestion	Reduce Passenger and Freight Congestion in Air and Surface Modes	Congestion Reduction Policy Research and Technologies
	Extend System Life and Improve Durability	
	Advance Use of Next Generation Technologies and Combinations of Modes	System Resilience and Global Logistics Next Generation Air Transportation System
	Improve Planning, Operations, and Management	
	Improve Services for Underserved Areas and Populations	
	Advance the Nation's Transportation Research Capability	
Global Connectivity	Harmonize Standards and Support Leadership for U.S. Transportation Providers	
Environmental Stewardship	Understand and Mitigate Transportation Impacts	Energy Efficiency and Alternative Fuels
	Improve the Environmental Review Process	
Security, Preparedness and Response	Reduce Vulnerability and Improve Preparedness and Recovery	
	Secure Hazardous Materials Shipments and Assess Risks	
Organizational Excellence	Consistently Apply the R&D Investment Criteria	

Figure 3: U.S. Department of Transportation Strategic Research Goals

For the program area Intelligent Transport Systems (ITS) an updated research plan with visions and targets is available and summarised below[13]. The year when targest should be achieved are not listed.

[12] http://www.rita.dot.gov/ordt/research_planning.html

[13] http://www.its.dot.gov/strat_plan/pdf/IntelliDriveBook_Jan2010.pdf

Table 3: ITS Strategic Research Plan

Technology	Corresponding challenge	Target	By date	Year
Vehicle to Vehicle (V2V)	*Safety*	To employ advanced V2V wireless technologies to reduce, mitigate, or prevent 82 percent of crashes by unimpaired drivers.	*Not defined*	*2010*
	Safety	To establish robust DSRC standards for safety-critical applications.		
	Safety	To accelerate in-vehicle technology to ensure value to the first V2V vehicles		
Vehicle to infrastructure (V2I)	*Safety*	To employ advanced V2I wireless technologies to reduce, mitigate, or prevent an additional 12 percent of crashes.		
	Safety	To develop signal warnings that support active safety.		
Real-Time Data Capture and Management	*Mobility*	To systematically capture real-time, multi-modal data from connected vehicles, devices, and infrastructure		
	Mobility	To develop data environments that enable integration of high-quality data from multiple sources for transportation management and performance measurement.		
Dynamic Mobility Applications	*Mobility*	To identify transformative applications and innovative methods to manage and operate transportation systems based on the availability of new data sources and communications methods.		
	Mobility	To build the foundation for development of applications that can provide travelers and system operators greater access to realtime information about the transportation system to enable better decision making.		
Real-Time Information Synthesis	*GHG, Pollution, Safety, Mobility*	To capture real-time environmental data from vehicles and integrate it with other sources for use in transportation management and performance improvement.		
	GHG, Pollution	Create applications that use real-time data on environmental impact for use by transportation managers and travelers.		
Smart Roadside	*Mobility*	To enhance roadside enforcement operations through improved screening and automation of inspection/compliance checks.		
	Mobility	To identify key entities (e.g., motor carrier, commercial vehicle, commercial driver, cargo) and communicate with commercial vehicles in realtime at highway speeds.		
	Mobility	To ensure that the necessary standards and architecture are in place to support interoperable operations across the country.		
	GHG, Pollution, Safety, Mobility	To provide enhanced road condition and traffic information to support commercial vehicle route planning and improved access to intermodal ports, urban pick-up, and delivery locations.		

2.4 Funding Programmes

The link between vision & targets and funding allocation[14]

In general the vision topics and stated targets are matched with corresponding funding programmes. As mentioned above the vision & targets defined in the multi-year research plans are the basis for the budget negotiation between funding organisation and the U.S. government. However, the system allows a high degree of flexibility due to the annually review process of the programms and projects and the particular role of the Executive Office of the President (Office of Science and Technology Policy - OSTP). In 2010 the OSTP defined new priorities for federal research and development going along with changes in the budget distribution for the different funding organisation. But most important for the automotive R&D investment in 2009 and 2010 is the Recovery Act issued by the presidential office. As example, more than $2 billion will be invested to support manufacturing of advanced batteries or $187 Million to improve car and truck fuel efficiency. Theses investments are administrated through the U.S. Department of Energy (DoE) and U.S. Department of Transport (DoT). These investments and funding possibilities are not taken into account in this report. Additionally, the senate is able to define specific research programs by so-called Equity Acts of which the SAFETEA-LU program is the most important one for automotive research. In this Equity Act the federal investments (not only R&D) are defined for a safe, accountable, flexible and efficient transportation. Within this Equity Act also R&D programms and budget are listed which states the legal basis for the specific programms conducted by the DoE and DoT.

Overall, the analysed programms allocate a budget of more than $2.500 million per year although not the full budget is spent for technology categories defined within EAGAR. A significant amount of available R&D budget is used for infratsructure research and the support of federal research facilities and university transporation centers.

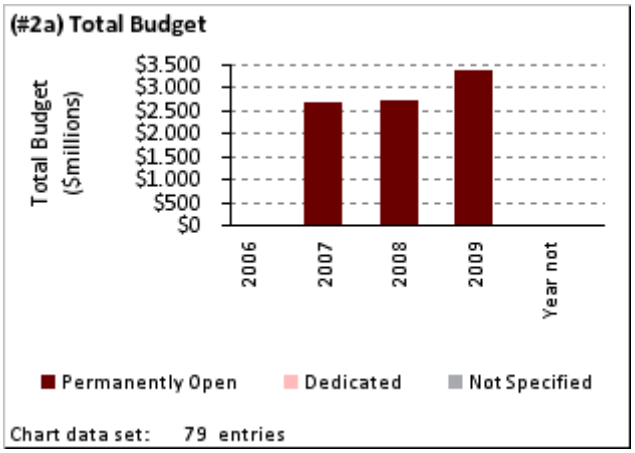


Figure 4: Total budget allocated in the analysed progamms

[14] Exchange rate: 1 € = 1,412 USD (average 2007 – 2009)

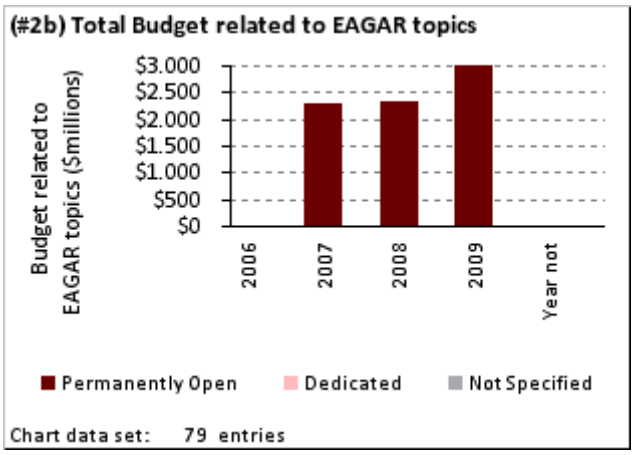


Figure 5: Total budget related to EAGAR projects

The challenges identified within EAGAR are well represented by the analysed programms and calls as shown in the Figure below. However, a tendency towards fuel efficiency and GHG emissions as well as towards competiveness can be seen from fig. 6.

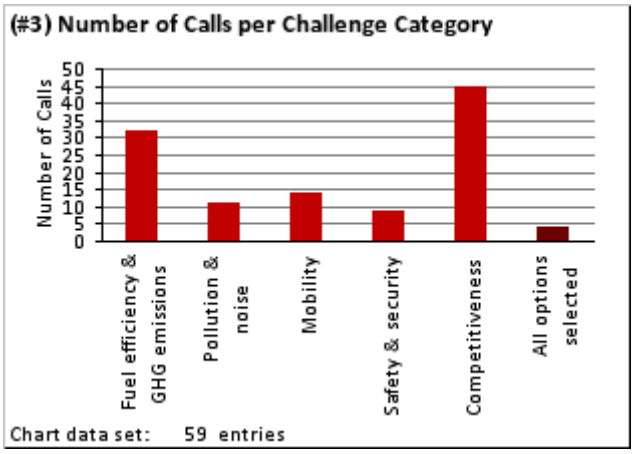


Figure 6: Number of calls per challenge category

Funding programmes and states of RTD as well as different types of instruments

The federal R&D policy of the U.S. offers a variety of funding programms and different types of instruments. In course of the performed analysis about 26 funding programms have been identified only focussing on automotive research. Within these programms 79 sub-themes are defined each issuing calls. All open calls can be found on a centralised webpage[15] over which about 1.000 grant programs are promoted.

The majority of the automotive R&D programms are coordinated - but not solely - by the U.S. Department of Energy (DoE), the U.S. Department of Transportation and the National Science Foundation NSF. In the variety of programs all types of intruments can be found from basic research over pre-competitive development to demonstration and industrialisation. The support mechanism ranges from cooperative agreements, cost-shared contratcs to financial awards and personal grants. In addition federal facilities such as the Transportation Safety Institute or Volpe National Transportation Systems Center are directly financed which are addressing R&D and testing services to the stakeholders. Another funding mechanism are University Transportation Centers which are awarded by the DoT to university addressing specific aspects of transporation systems and mobility.

[15] www.grants.gov

More than 60 of such centers are currently being funded[16]. Furthermore, programs and calls are also open for state governments, county governments, city or township governments.

Preferences toward a particular support mechanism could not be found in the analysis, however recent calls where mainly addressing collaborative research. Fundamental or basic research is mainly coordinated by the National Science foundation addressing universities and research centers and/or providers. Whereas the proagramms conducted by the DoE and DoT are basically a top-down approach the NSF is based on a bottom-up principle funding scheme only defining the broad research area. State governments, County governments, City or township governments

Due to the high number of potentials calls (= initiatives), only sub-themes and iniatives within programm areas have been considered in the analysis. Permanently open program with a yearly budget are considered as one call per year. An overview of the most important prorgamms and initiatives is given in the Figures 7 – 9.

U.S. Department of Energy (DoE)

Vehicle Technologies Programm

"*The Vehicle Technologies Program is developing more energy efficient and environmentally friendly highway transportation technologies that will enable America to use less petroleum. The long-term aim is to develop "leap frog" technologies that will provide Americans with greater freedom of mobility and energy security, while lowering costs and reducing impacts on the environment*."

Fuel Cells Technologies Programm

"*The Fuel Cell Technologies Program conducts comprehensive efforts to overcome the technological, economic, and institutional obstacles to the widespread commercialization of fuel cells and related technologies. The program works with partners in industry, academia, non-profit institutions, and the national labs, and coordinates closely with other programs in four DOE offices—Energy Efficiency and Renewable Energy, Science, Fossil Energy, and Nuclear Energy. The mission of the program is to enable the widespread commercialization of fuel cells in diverse sectors of the economy—with emphasis on applications that will most effectively strengthen our nation's energy security and improve our stewardship of the environment.*"

U.S. Department of Transportation (DoT)

Intelligent Transport Systems

"*The ITS program focuses on intelligent vehicles, intelligent infrastructure and the creation of an intelligent transportation system through integration with and between these two components. The Federal ITS program supports the overall advancement of ITS through investments in major initiatives, exploratory studies and a deployment support program. Increasingly, the Federal investments are directed at targets of opportunity – major initiatives – that have the potential for significant payoff in improving safety, mobility and productivity."*

National Cooperative Freigth Research Programm

"*The freight transportation system in the United States is a complex, decentralized, and dynamic network of private and public entities, involving all modes of transportation--trucking rail, waterways, air, and pipelines. In recent years, the demand for freight transportation service has been increasing fueled by growth in international trade, and bottlenecks or congestion points in the system are exposing the inadequacies of current infrastructure and operations to meet growing demand. US domestic freight, measured by ton mileage, is expected to grow by some 50 percent in the next 20 years. Strategic operational and investment decisions by governments at all levels will be necessary to maintain freight system performance, and will in turn require sound technical guidance based on research. The National Cooperative Freight Research Program (NCFRP) will carry out applied research on problems facing the freight industry that are not being adequately addressed by existing research programs."*

[16] http://utc.dot.gov/list_of_centers

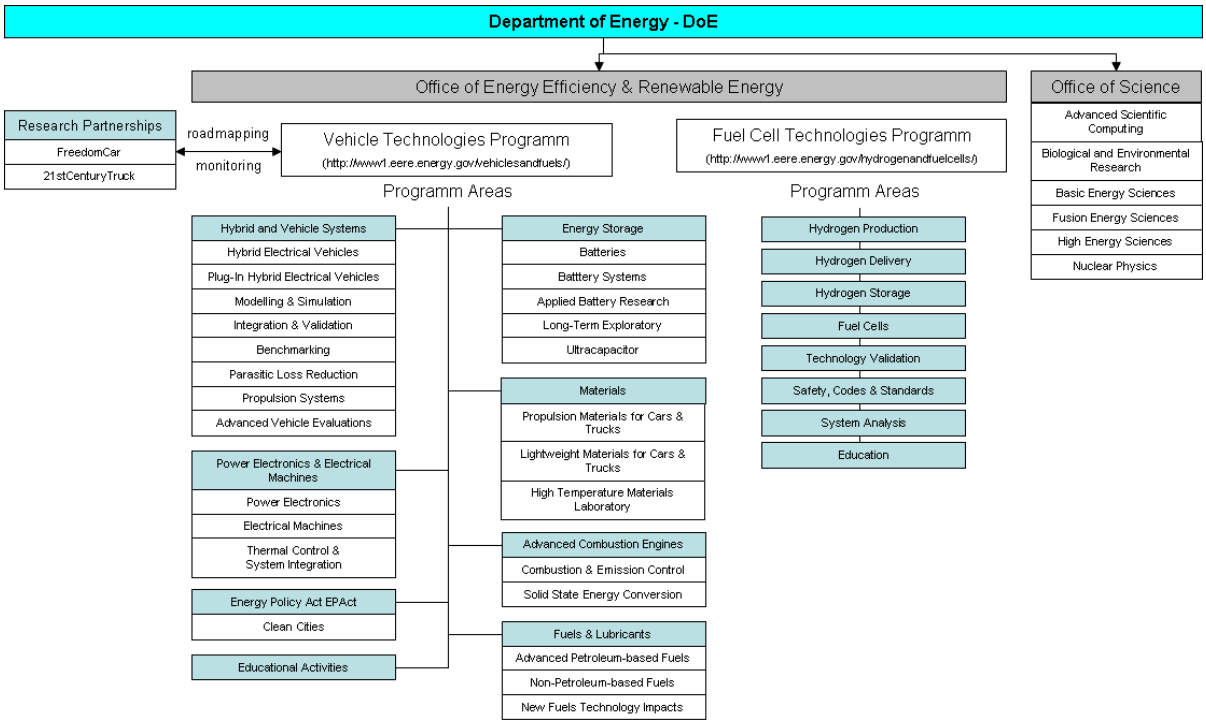


Figure 7: Overview of funding programms of the DoE

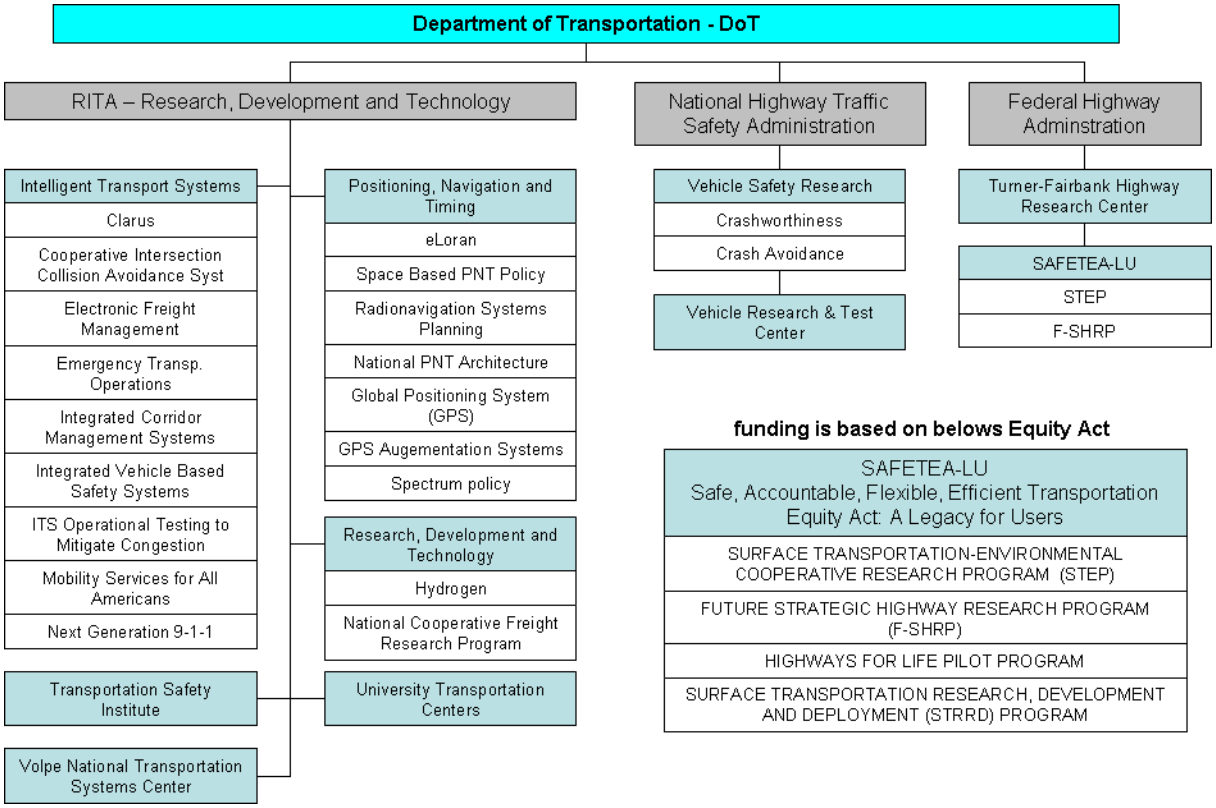


Figure 8: Overview of funding programms of the DoT

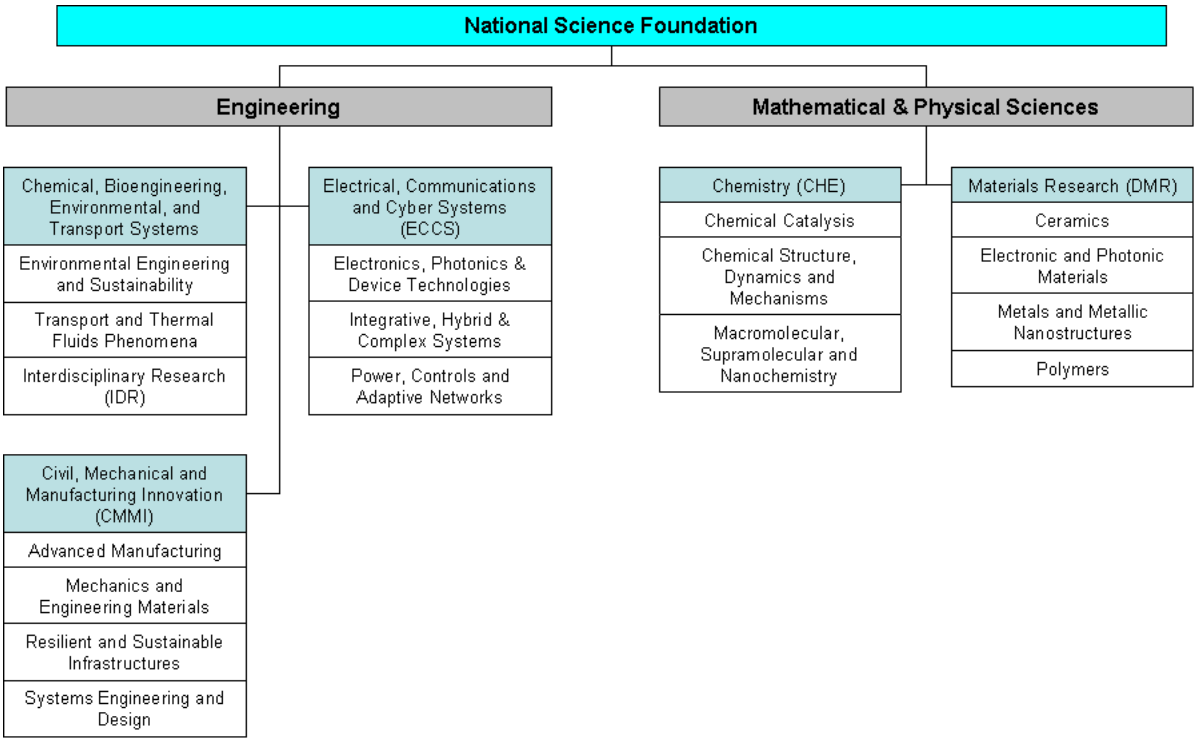


Figure 9: Overview of funding programms of the NSF, only selceted programmes are listed.

Results of the Analysis

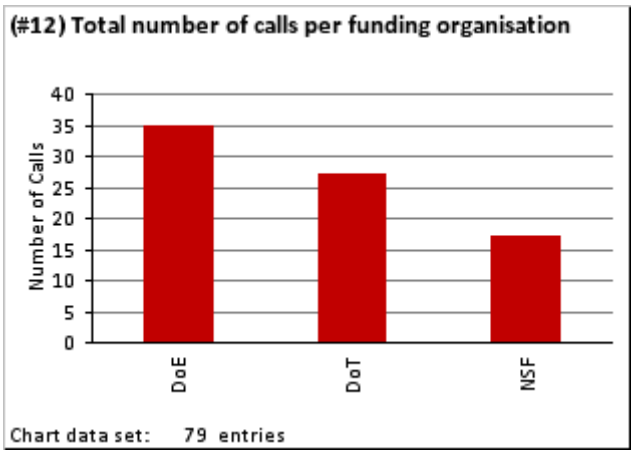


Figure 9: Total numbers of calls per funding organisation

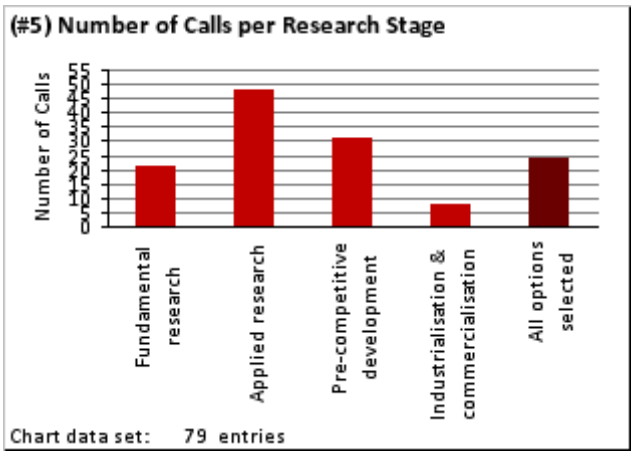


Figure 10: Number of calls per research stage

- Program call windows:

  All analysed programs are multi-year programs with an annual budget; such programs are accounted as one call per year

- Number of projects per calls:

  Information not directly available

- Number of calls per organisation type:

  This information is not explicitly available, however, the overall programs are addressing all types of organisations up to government and federal offices. For individual calls the type of organisation addressed might be specified.

Overview of technology specific programmes for automotive RTD

The 79 analysed programs within the DoE, DoT and NSF are all multi-year programs with a yearly allocated budget. Since the available budget is used in various ways, e.g. for open calls, for dedicated projects and sub-programs or as continous funding of federal facilities, a distinction between calls as performed under the European Framework Programs could not be made. Instead, each area underneath a program with an annual budget is considered as one call per year.

Within EAGAR, 17 technology categories has been identified allowing the analyse the R&D program in more detail in terms of technologies. These categories do not account for all topics related to road transport, mainly they are reflecting technologies on the vehicle side. Each program can address several of the categories or even all. Also each programm is equally weighted not taking the specific budget into account.

The analysed program shows a tendency towards alternative powering of vehicles clearly addressing the environmental challenges world-wide. This includes electrification, hydrogen but also alternative fuels and advanced internal combustion engines. Second to this group of technologies are ITS technologies (listed under telematics) and materials. Interestingly, safety issues and vehicle structure and chassis technolgies are not well represented in the analysed programs. This might be due to the fact that in the U.S. many programs exists besides the considered ones addressing cross-cutting technologies such as materials or manufacturing technologies. Furthermore, this limited analysis does not reflect the specific budget of each call. For instance, the OSTP defined a Next-Generation Manufacturing Technologies program under which also the $2 billion for manufacturing of advanced batteries are subsumed. Furthermore, broad programs run by the NSF also allow technology developments in all defined EAGAR categories. A more detailed analysis will be performed with the EAGAR benchmark report.

The analysis of the programs could also not broken down to project level just due to the huge amount of projects. Alone in the Vehicle Technologies Program of the DoE more than 304 projects are being funded.

The diagramme below provides an overview of numbers of calls per (pre-defined) technology category for the years 2007 - 2009:

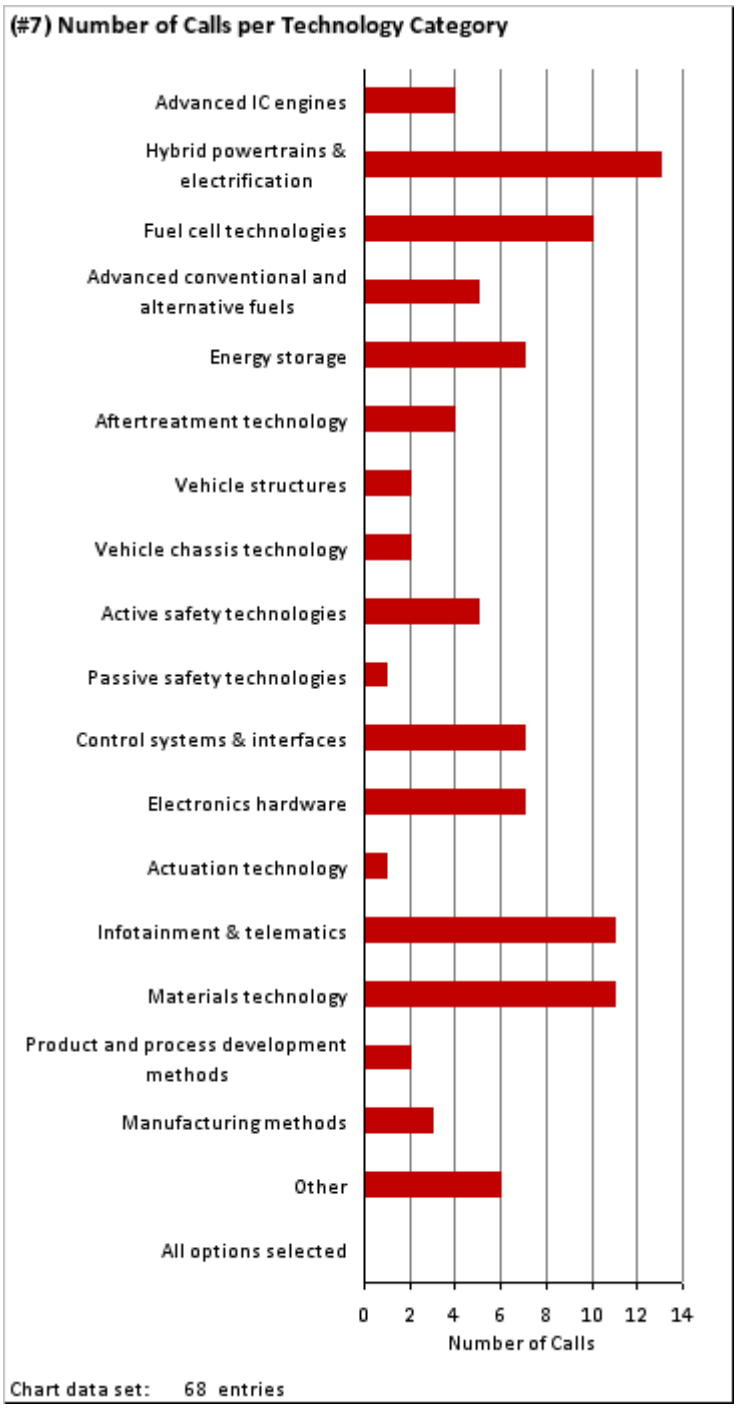


Figure 11: Number of calls per technology category

See also section 5 with the list of selected analysed calls.

2.5 The efficiency, flexibility, and experienced bureaucracy of the funding process

The flexibility to release new calls in response to changing situations

Almost all analysed programs are multi-year programs with defined strategic research agendas and implementation plans. However, the budget will be negotiated as well as the progress will be reviewed on an annual basis allowing adapting the program if needed. The programs itself are covering a wide range of topics and technologies which in itself has a degree of flexibility. Furthermore, the U.S. government has a possibility to introduce new programs or strengthen existing ones if appropriate as it has been done in 2009 and 2010 with the Recovery Act.

The application process

Most of the calls are administered through the central web-page www.grants.gov on which all open calls are listed and information on the application process can be found. The applicant has to register and has the opportunity to receive automatically information on calls as well as to track his applications. When looking at open calls the period between notification and closure date ranges from 3 to 6 months. The calls – not the program - seems to be rather dedicated ones so that no second opportunity will be available if one is missed. However, some programs are open permanently not issuing calls or have fixed applications date (one or twice a year) as it is for the NSF programs. Information on how long the proposal assessment takes and time between notification of acceptance and actual project start is not available by desk search but from experience it seems less than 12 months between proposal submission and project start. This has been confirmed by the questionnaire distributed by EAGAR.

In the call announcement the maximum number of projects as well as minimum/maximum funding per project is mentioned if applicable.

Besides submitting proposal in response of a call the direct negotiation of projects with the respective funding agency seems possible. But a direct feedback on the funding system cannot be given by the stakeholders.

Project Implementation

No information could be found by desk research on the success rate of submitted proposal. Obviously, the author itself does not have any experience with U.S. funded projects. However, based on information gained by the questionnaire distributed by EAGAR, the success rate of proposal seems to be in the order of 25% depending on the type of organisation. This is of the same order as experienced for Europe. The following negotiation phase until the actual start of the project is rather short with 3 – 6 months. Once the project is started, the process of transferring funds to the beneficiaries work is rated well by the participants of the survey. Besides the above mentioned assessment report in most cases the final report of the project is publically available, sometimes – but not always mandatory - also a dedicated “exploitation plan” is required by the funding agency defining ways how to make the results of the project publically available.

Transparency & openness

Almost all information on programs and calls can be found in the internet on the respective web-pages of the funding agencies or centralised web-pages such as grants.gov. Also information on the respective program managers is given allowing addressing questions directly to person in charge.

Furthermore, each program is publishing the major findings in an annual report. Whether individual projects are required to disseminate publicly the final results is not known. However, more and more programs are reviewing the figure of merits of each project annually by independent reviewers to

ensure a minimum level of quality. This review report is open available or can be requested from the program manager.

Foreign collaboration

Many funding agencies are running dedicated programs addressing the collaboration with foreign organisations or partners. Such programs were not analysed within this study. But in the considered programs foreign parties can participate if they are legally established in the U.S. such as the U.S. branches of all world-wide automotive OEM's or automotive supplier.

3 Discussion and Conclusion

The publicly funded automotive R&D in the U.S. as presented in this report was mainly analysed by desk research. Altogether, 26 initiatives with 79 sub-programs has been identified and analysed. Almost all information of the federal spent R&D funding is available in the internet, either on the respective web-sides of the funding agencies or centralised web-sides of the U.S. government. The analysis was strictly performed on federal level, R&D spending of the individual states were not considered. It turned out that the U.S. R&D policy related to automotive research is strictly hierarchly organised with a strong influence of the U.S. government. The budget for the various automotive R&D programs are being negotiated annually between the departments and the senat and administered mainly by the two department DoE and DoT and the National Science Foundation. Minor automotive R&D activities can also be found in the Department of Defense and Environmental Protection Agencies. Interdepartmental R&D programs can be found as well. The federal funding is being channeled down to state, regional and city level meaning that the overall availabel budget is also used for local R&D programs. Besides the multi-year federal R&D programs the U.S. government spend in the last years heavy automotive R&D investments as part of the Recovery Act such as the battery manufacturing program. The impact of the Recover Act has been not analysed in this study since it is only a short term activity.

Although budget and program information as well as the respective annual reports are publically availabe, details in terms of statistical data (e.g. number of calls and projects per year) on specific calls within the programs could not be found. Alone the shear amount of funding agencies and programs as well as funded projects would not allow a detail analysis down to call and project level. The desk research as well as the distributed questionnaires also lead to a subjective interpretation of the U.S. R$D policy and R&D programs where statistical data or specific information are missing. Nevertheless the available information on the considered programs does allow a deep analysis of the U.S. policy, identifying trends as well as benchmarking with other economies. The presented information and data just provides a global picture of the U.S. R&D policy and shoul dbe used as this. While collecting the data it was also observed that the R&D program are currently being reviewed and updates can be expected within the next two years. Even while conducting this studies additional or updated information could be found almost on a monthly basis.

The hierarchly and top-down organised multi-year funding programs of the DoE and DoT– of which some cover periods of more than 10 years – allow the U.S. to address long term challenges as the world is currntly facing with the climate change and availability of fossile fuels. Since the programs are reviewed and re-negotiated on a yearly basis recent findings and challenges can be incorporated easily. In principal these programs are addressing basic and applied research, technological development and to a high degree validation and implementation of technologies. Basic or fundamental research is additionally addressed by the National Science Foundation which allows a bottom-up approach. Each program also provide a variety of funding instruments adapted to the needs of the R&D performers. Worth to mention is the fact that beside classical project funding also federal research labs and university transportation centers are funded which are less known in the European Research Area. The above mention approaches as well as the governmental attitude that science and technology supports the U.S. economy gives the U.S. R&D policy a high leverage to support and implement innovations.

Looking at the technologies addressed by the automotive R&D programs a tendency towards clean and efficient power sources as well as towards information and communication technologies (ICT) can be identified. This include not only the vehicle side but to a high degree also the transport infrastructure. It can be observed that vehicle-side technologies - besides powertrain technologies and materials – are less addressed than anticipated. Particular advanced vehicle body concepts, chassis technologies or safety-relevant research on the vehicle-side are underrepresented. This might be owed to the differences in the road transport scenarios (speed limits, mostly highways, longer distances, etc…). Of importance seems alos the fact that particular in the DoE and DoT programs a strong emphasis is given on technology validation and implementation.

4 References

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[11] http://www.rita.dot.gov/ordt/research_planning.html
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[13] Exchange rate: 1 € = 1,412 USD (average 2007 – 2009)
[14] www.grants.gov
[15] http://utc.dot.gov/list_of_centers

Abbreviation:

BTS	Bureau of Transport Statistics
DoE	U.S. Department of Energy
DoT	U.S. Department of Transportation
EPA	Environment Protection Agency
GDP	Gross Domestic Product
FCTP	Fuel Cell Technologies Program
FHWA	Federal Highway Administration
FTA	Federal Transit Adminsitration
ITS	Intelligent Transport System
MY	Multi-Year
NHTSA	National Highway Traffic Safety Adminstration
NRC	National Research Council
NSF	National Science Foundation
NSTC	National Science and Technology Council
OSTP	Office of Science and Technology Policy
OEM	Original Equipment Manufacturer
RITA	Research & Innovation Technology Adminstration
TRB	Transport Research Board
VTP	Vehicle Technologies Program

5 Annex

Overall program initiative name	Program call name	Program call description	Funding organization	Call end date	Main point of reference
Vehicle Technologies Program (VTP)	Hybrid and Vehicle Systems	Hybrid and vehicle systems research provides an overarching vehicle systems perspective to the technology research and a development (R&D) activity of the DOE's vehicle research programs, and identifies major opportunities for improving vehicle efficiencies. The effort evaluates and validates the integration of technologies, provides component and vehicle benchmarking, develops and validates heavy hybrid propulsion technologies, and develops technologies to reduce the parasitic losses from heavy vehicle systems. Analytic and empirical tools are used to model and simulate potential vehicle systems, validate component performance in a systems context, benchmark emerging technology, and validate computer models.	DoE – Office of Energy Efficiency & Renewable Energy		http://www1.eere.energy.gov/vehiclesandfuels/
	Power Electronics and Electrical Machines	Advanced technology vehicles such as hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), fuel cell hybrid electric vehicles (FCHEVs), and electric vehicles (EVs) can help meet important DOE goals, such as petroleum reduction. However, modern day PEEM technology is not sufficient to enable market-viable PHEVs, FCHEVs, and EVs. So, the VTP aims to develop these technologies by setting strategic goals for PEEM, and undertaking research projects that are carried out through collaboration among government, national laboratories, academia, and industry partners.			
	Energy Storage	Achieving the PEEM goals will require the development of new technologies. These new technologies must be compatible with high-volume manufacturing and must ensure high reliability, efficiency, and ruggedness. These technologies must also reduce cost, weight, and volume. Of all these challenges, cost is the greatest. PEEM project partners work together to ensure that technical attributes, vehicle-scale manufacturing, and cost sensitivities are addressed in a timely fashion and that the resulting technologies can be adopted by companies willing and able to supply products to automakers.			
	Materials	Energy storage technologies, especially batteries, are critical enabling			

		technologies for the development of advanced, fuel-efficient, light- and heavy-duty vehicles, which are critical components of the DOE's Energy Strategic Goal: "to protect our national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy." The program's vision supports the development of durable and affordable advanced batteries covering the full range of vehicle applications, from start/stop to full-power hybrid electric, electric, and fuel cell vehicles. Much of this work will transfer to energy storage for heavy hybrid vehicles as well.			
	Advanced Combustion Engines	Energy storage research aims to overcome specific technical barriers that have been identified by the automotive industry together with the Vehicle Technologies Program. These include cost, performance, life, and abuse tolerance. These barriers are being addressed collaboratively by the DOE's technical research teams and battery manufacturers.			
	Fuels & Lubricants	Advanced materials, including metals, polymers, composites, and intermetallic compounds, can play an important role in improving the efficiency of transportation engines and vehicles. Weight reduction is one of the most effective ways to increase the fuel economy of vehicles while reducing exhaust emissions. The use of lightweight, high-performance materials will contribute to the development of vehicles that provide better fuel economy, yet are comparable in size, comfort, and safety to today's vehicles. The development of propulsion materials and enabling technologies will help reduce costs while improving the durability, efficiency, and performance of advanced internal combustion, diesel, hybrid, and fuel-cell-powered vehicles.			
	Clean Cities	The advanced materials research conducted under the direction of the U.S. Department of Energy and the Vehicle Technologies Program will help ensure the nation's transportation energy and environmental future by making affordable full-function cars and trucks that use less oil and produce fewer harmful emissions.			
Fuel Cells Technologies Program	Hydrogen Production	Hydrogen can be produced using diverse, domestic resources including fossil fuels, such as natural gas and coal (with carbon sequestration); nuclear; biomass; and other renewable energy technologies, such as wind, solar, geothermal, and hydro-electric power. The overall challenge to hydrogen production is cost reduction. For cost-competitive transportation, a key driver for energy independence and therefore the hydrogen	DoE – Office of Energy Efficiency & Renewable Energy		

		economy, hydrogen must be comparable to conventional fuels and technologies on a per-mile basis in order to succeed in the commercial marketplace. The DoE supports the research and development of a wide range of technologies to produce hydrogen economically and in environmentally friendly ways.			http://www1.eere.energy.gov/hydrogenandfuelcells/
	Hydrogen Delivery	A hydrogen economy requires an infrastructure to deliver hydrogen from where it's produced to the point of end-use, such as a dispenser at a refueling station or stationary power site. Infrastructure includes the pipelines, trucks, storage facilities, compressors, and dispensers involved in the process of delivering fuel.			
	Hydrogen Storage	On-board hydrogen storage for transportation applications continues to be one of the most technically challenging barriers to the widespread commercialization of hydrogen-fueled vehicles. The EERE hydrogen storage activity focuses primarily on the applied research and development (R&D) of low-pressure, materials-based technologies to allow for a driving range of more than 300 miles (500 km) while meeting packaging, cost, safety, and performance requirements to be competitive with current vehicles. Crosscutting efforts on system analysis and material chemical and environmental reactivity are also included in the National Hydrogen Storage Project. The three current materials-development CoEs have been focused on specific hydrogen storage material classes: on-board reversible metal hydrides, hydrogen adsorbents, and chemical hydrogen storage materials, which are, in general, regenerated off the vehicle.			
	Fuel Cells	Fuel cells are an important enabling technology for the hydrogen economy and have the potential to revolutionize the way we power our nation, offering cleaner, more-efficient alternatives to the combustion of gasoline and other fossil fuels. Fuel cells have the potential to replace the internal-combustion engine in vehicles and provide power in stationary and portable power applications because they are energy-efficient, clean, and fuel-flexible. Hydrogen or any hydrogen-rich fuel can be used by this emerging technology. DoE is working closely with its national laboratories, universities, and industry partners to overcome critical technical barriers to fuel cell commercialization. Current R&D focuses on the development of reliable, low-cost, high-performance fuel cell system components for transportation and buildings applications.			

	Technology Validation	addition to the technical challenges being addressed through research, design, and development, there are obstacles to successful implementation of fuel cells and the corresponding hydrogen infrastructure that can be addressed only by integrating the components into complete systems. After a technology achieves its technical targets in the laboratory, the next step is to show that it can work as designed within complete systems (i.e., fuel cell vehicles and hydrogen refueling infrastructure). Technology validation confirms that component technologies can be incorporated into a complete system solution and that system performance and operation are met under anticipated operating scenarios. DOE is developing and testing complete system solutions that address all elements of infrastructure and vehicle technology, validating integrated hydrogen and fuel cell technologies for transportation, infrastructure, and electric generation in a systems context under real-world operating conditions. Data will be collected to determine whether targets have been met under realistic operating conditions, to provide feedback on progress, and to efficiently manage the research elements of the program while providing redirection as needed.			
	Safety, Codes & Standards	DoE is working to develop and implement practices and procedures that will ensure safety in operating, handling, and using hydrogen and hydrogen systems. In addition, DoE is working with domestic and international organizations to identify the current gaps in the standards development process; facilitate the creation and adoption of model building codes and equipment standards for hydrogen systems in commercial, residential, and transportation applications; and provide technical resources to harmonize the development of international standards.			
Intelligent Transport Systems		The U.S. Department of Transportation's (USDOT) ITS program focuses on intelligent vehicles, intelligent infrastructure and the creation of an intelligent transportation system through integration with and between these two components. The Federal ITS program supports the overall advancement of ITS through investments in major initiatives, exploratory studies and a deployment support program. Increasingly, the Federal investments are directed at targets of opportunity – major initiatives – that have the potential for significant payoff in improving safety, mobility and productivity.	DoT – Research, Development and Technology (RITA)		http://www.its.dot.gov/

Positioning, Navigation and Timing			DoT – Research, Development and Technology (RITA)		http://www.rita.dot.gov/
Vehicle Safety Research		The Vehicle Safety (NVS) program serves as the foundation that supports the Agency's goal to reduce motor vehicle injuries and fatalities. Through extensive research, development, testing, crash investigation, and data collection and analysis activities, NVS provides the scientific strength needed to support the Agency's motor vehicle and traffic safety goals.	DoT – National Higway Traffic Safety Administration (NHTSA)		http://www.nhtsa.gov/Vehicle+Safety
SAFETEA-LU	Surface Transportation Environment and Planning Cooperative Research Program - STEP	The STEP is the primary source of funds for FHWA to conduct research and develop tools and technologies to advance the state of the practice regarding national surface transportation and environmental decision-making. In FY 2010, FHWA expects to seek partnerships that can leverage limited research funding in STEP with other stakeholders and partners in order to increase the total amount of resources available to meet the nation's surface transportation research needs. In FY 2010, STEP is likely to address national research priorities that include: (1) Conducting research to develop climate change mitigation and adaptation strategies; (2) Improving state of the practice regarding livability and the impact of transportation on the environment; (3) Developing and/or supporting accurate models and tools for evaluating transportation measures and developing indicators of economic, social, and environmental performance of transportation systems; (4) Developing and deploying research to address congestion reduction efforts; (5) Developing transportation safety planning strategies for surface transportation systems and improvements; (6) Improving planning, operation, and management of surface transportation systems and rights of way; (7) Enhancing knowledge of strategies to improve transportation in rural areas and small communities; (8) Strengthening and advancing State/local and tribal capabilities regarding surface transportation and the environment; (9) Improving transportation decision-making and coordination across borders; (10) Conducting research to promote environmental	DoT – Federal Highway Administration (FHWA))	> 2010	www.fhwa.dot.gov/hep/step/strategy.htm

		streamlining/stewardship; (11) Disseminating research results and advances in state of the practice through peer exchanges, workshops, conferences, etc; (12) Meeting additional priorities as determined by the Secretary; and (13) Refining the scope and research emphases through active outreach and in consultation with stakeholders.			
SAFETEA-LU	Future Strategic Highway Research Program F-SHRP	The Secretary, in consultation with AASHTO, will carry out a future strategic highway research program through the National Research Council of the National Academy of Sciences. F-SHRP will issue requests for proposals, award contracts, conduct research, and disseminate research results as defined in Special Report 260 (Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life) and NCHRP Report 510 (Interim Planning for a Future Strategic Highway Research Program) to support the priority areas of: • renewal – accelerate renewal of aging infrastructure through a consistent, systematic approach that is rapid, causes minimum disruption, and produces long-lived facilities. • safety –prevent or reduce the severity of highway crashes through more accurate knowledge of crash factors and of the cost-effectiveness of countermeasures in addressing these factors. • reliability – provide a highway system with reliable travel times by preventing and reducing the impact of nonrecurring congestion. • capacity –develop approaches and tools for systematically integrating environmental, economic, and community requirements into the analysis, planning, and design of new highway capacity.	DoT Federal Highway Administration & NRC	> 2009	www.fhwa.dot.gov/safetealu/factsheets/fshrp.htm
Engineering	Chemical, Bioengineering, Environmental, and Transport Systems (CBET)	The Chemical, Bioengineering, Environmental and Transport Systems Division (CBET) supports research and education in the rapidly evolving fields of bioengineering and environmental engineering and in areas that involve the transformation and/or transport of matter and energy by chemical, thermal, or mechanical means. CBET research and education investments contribute significantly to the knowledge base and to the development of the workforce for major components of the U.S. economy, including chemicals, pharmaceuticals, medical devices, forest products, metals, petroleum, food, textiles, utilities, and microelectronics. Support for environmental work encompasses pollution prevention and remediation as well as life cycle analysis.	National Science Foundation	> 2010	www.nsf.gov/eng/

	Civil, Mechanical and Manufacturing Innovation (CMMI)	The Civil, Mechanical and Manufacturing Innovation (CMMI) Division is one of the four research divisions in the Directorate for Engineering at the National Science Foundation. Its mission is to fund fundamental research and education in support of the Foundation's strategic goals directed at advances in the disciplines of civil, mechanical, industrial and manufacturing engineering, and materials design. In addition, the Division has a focus on the reduction of risks and damage resulting from earthquakes and other natural and technological hazards. The Division encourages cross-disciplinary research partnerships at the intersections of traditional disciplines to promote transformative advances in civil, mechanical and industrial systems and manufacturing technologies. It also encourages discovery enabled by the use of cross-cutting technologies such as adaptive systems, nanotechnology, and simulation. The integration of research and education is supported across all programs of the Division.			www.nsf.gov/eng/
	Electrical, Communications and Cyber Systems Division (ECCS)	The Division of Electrical, Communications and Cyber Systems (ECCS) addresses fundamental research issues underlying device and component technologies, power, controls, computation, networking, communications and cyber technologies. ECCS supports the integration and networking of intelligent systems principles at the nano, micro and macro scales for a variety of application domains in healthcare, homeland security, disaster mitigation, energy, telecommunications, environment, transportation, manufacturing, and other systems-related areas. ECCS envisions a research community that will address major technological challenges for the next generation of devices and systems due to convergence of technologies and increased emphasis on interdisciplinary research to achieve the goals of the American Competitiveness Initiative in leading the world in innovation.			www.nsf.gov/eng/
Mathematical & Physical Sciences	Chemistry	The mission of the Division of Chemistry of the National Science Foundation is to promote the health of academic chemistry and to enable basic research and education in the chemical sciences. Modes of support include single investigator and multi-investigator awards, as well as funding for shared instrumentation, instrumentation development, and educational projects that leverage the division's research investments to build research capacity. The Division supports research in all traditional areas of chemistry and in multidisciplinary fields that draw upon the chemical sciences. Projects that help build infrastructure and partnerships that advance the chemical sciences are also supported			www.nsf.gov/mps/

	Materials Research	The mission of the Division of Materials Research is to make new discoveries about the behavior of matter and materials; to create new materials and new knowledge about materials phenomena; to address fundamental materials questions that often transcend traditional scientific and engineering disciplines and may lead to new technologies; to prepare the next generation of materials researchers; to develop and support the instruments and facilities that are crucial to advance the field; and to share the excitement and significance of materials science with the public at large.			www.nsf.gov/mps/