DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST
ENERGY EFFICIENCY AND RENEWABLE ENERGY
ENERGY CONSERVATION
(Tabular Dollars in Thousands, Narrative in Whole Dollars)

TRANSPORTATION SECTOR

PROGRAM MISSION

Mission

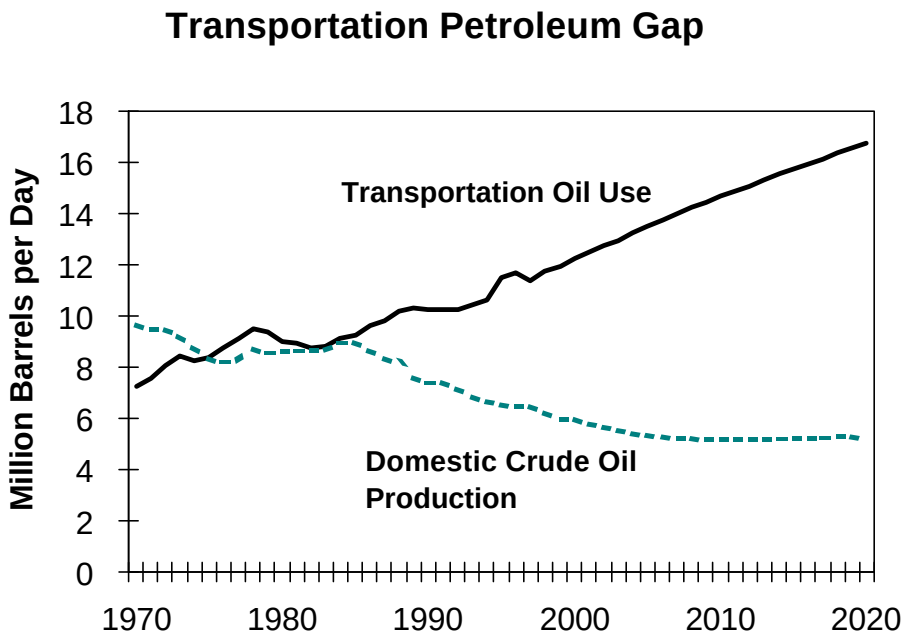
The Office of Transportation Technologies (OTT) partners with industry, research organizations, State governments, and other Federal agencies to support development and use of advanced vehicle technologies and fuels which reduce demand for petroleum, decrease emissions of criteria air pollutants and greenhouse gases, and enable the U.S. transportation industry to sustain a strong, competitive position in domestic and world markets.

Strategic Context

Moving people and goods accounts for 67 percent of the Nation's oil use, and our vehicles remain 95 percent dependent on a single fuel -- petroleum. Transportation's thirst for oil has gotten our country to the point where we need to import 10 million barrels of oil per day (the difference between the amount of petroleum we consume and the amount we produce). Oil imports, about 52 percent of our petroleum consumption, are at an all-time high, currently adding an estimated $109 billion this year to our balance of payments deficit. Further, EIA projects a 1.8 percent per year growth in the transportation sector's energy use through 2020. This growth will increase the gap between domestic consumption and production (as shown below), increase imports, and increase the pressure on global oil prices. Improving the efficiency of the cars and trucks we drive, combined with the introduction of alternative fuels (e.g., biomass, natural gas) provide the most significant opportunity to improve our energy security. In fact, if the fuel economy of every car and light truck in the U.S. could be increased by 3 miles per gallon, the "gap" between oil supply and demand would be reduced by 1 million barrels per day. The world production of conventional oil is expected to peak within the next several decades. Sound programs and policies implemented now can assure that the upcoming world oil gap can be filled by a combination of improved fuel economy and domestic fuels that are clean, reliable, and affordable.

Strategic Approach

The Office of Transportation Technologies programs provide support for research, development, and deployment programs which will reduce oil consumption by achieving: 1) significant improvements in vehicle fuel economy; and 2) displacement of oil by other fuels which are domestic, clean, and cost-competitive. This investment focuses on areas that would not be pursued by industry alone due to high risk and uncertain outcomes. OTT's work is primarily focused on research and development of advanced technologies, with priorities established in conjunction with cost-sharing partners, primarily industry. The work is accomplished by numerous organizations, including industry, government and university laboratories and supports such initiatives as the Partnership for a New Generation of Vehicles (PNGV) and the 21st Century Truck Program. Initiatives in such areas as incentives, information, and education will also be necessary if advanced transportation technologies are to achieve market share sufficient to provide significant benefits.



Goals and Benefits

Goals and Performance Measures:

- By 2010, reduce oil used by highway vehicles by 0.5 million barrels per day (mbpd) due to efficiency and substitution improvements. Longer-term goals for oil reduction are 1.5 mbpd in 2020 and 3.0 mbpd in 2030.
- By 2010, increase the average fuel efficiency of new cars and light trucks by 16 percent relative to the EIA's reference fuel efficiency level for that year.
- By 2010, increase the average fuel efficiency of large trucks by 7 percent relative to the 1998 efficiency level.
- By 2010, increase the fuel efficiency of new light vehicles by 4.2 mpg, compared to 2001.
- By 2010, increase the number of vehicles on the road with light weight materials to 7 million.
- By 2010, increase cellulosic ethanol production to 2 billion gallons per year.

Benefits:

By sharing costs and risks, the program is successfully stimulating both evolutionary and break-through technologies and processes. The transportation program assists industry throughout the spectrum of high risk research and development activities, and provides a neutral, third-party platform to help competitors, suppliers, and other government organizations reach consensus on program directions and plans. The projected annual benefits of OTT programs are summarized in the table below:

	2005	**2010**	**2020**
Petroleum Displaced (Million Barrels per Day)	0.17	0.58	1.90
Total Primary Energy Displaced (Trillion Btu)	168	973	3,595
Energy Costs or Savings (Millions of $)	1,931	9,386	34,773
Carbon Equivalent Emissions Displaced (MMTCe)	3.8	18.9	70.1

Source: GPRA 2001 EERE Database. Numbers in the above table represent the projected annual benefits in 2005, 2010, and 2020 based on the FY2002 funding request, assuming all program goals are met.

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TRANSPORTATION SECTOR

PROGRAM FUNDING PROFILE

Program Activity	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	Program Change Request vs. FY 2001 Dollar	Program Change Request vs. FY 2001 Percent
Vehicle Technologies R&D	$ 138,365	$ 159,610	$ 154,116	$ -5,494	-3.4%
Fuels Utilization R&D	$ 21,196	$ 23,509	$ 23,529	$ 20	0.1%
Materials Technologies	$ 41,580	$ 42,223	$ 41,293	$ -930	-2.2%
Technology Deployment	$ 12,826	$ 15,017	$ 10,200	$ -4,817	-32.1%
Cooperative Programs with States	$ 1,964	$ 1,996	$ 0	$ -1,996	-100.0%
Energy Efficiency Science Initiative	$ 3,830	$ 3,891	$ 0	$ -3,891	-100.0%
Management and Planning	$ 8,995	$ 9,152	$ 10,232	$ 1,080	11.8%
TOTAL	$ 228,756	$ 255,398	$ 239,370	$ -16,028	-6.3%

Program Activity	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	Program Change Request vs. FY 2001 Dollar	Program Change Request vs. FY 2001 Percent
Summary					
Operating Expenses	$ 225,256	$ 255,398	$ 239,370	$ -16,028	-6.3%
Capital Equipment	$ 3,500	$ 0	$ 0	$ 0	0.0%
Total Program	$228,756[a]	$255,398[b]	$ 239,370	$ -16,028	-6.3%
Staffing (FTE's)					
HQ FTEs	56	62	62		
Field FTEs	1	1	1		
Total FTEs	57	63	63		

Authorizations:
P.L. 93-275, "Federal Energy Administration Act of 1974"
P.L. 93-577, "Federal Nonnuclear Energy Research and Development Act of 1974"
P.L. 94-163, "Energy Policy and Conservation Act" (EPCA) (1975)
P.L. 94-413, "Electric and Hybrid Vehicle Research, Development and Demonstration Act of 1976"
P.L. 95-91, "Department of Energy Organization Act" (1977)
P.L. 95-238, Title III - "Automotive Propulsion Research and Development Act of 1978"
P.L. 96-512, "Methane Transportation Research, Development and Demonstration Act of 1980"
P.L. 100-494, "Alternative Motor Fuels Act of 1988"
P.L. 102-486, "Energy Policy Act of 1992"

[a/] Reflects adjustment for approved reprogramming 00-R-3 of $-3,778,000 for the Small Business Innovative Research (SBIR) program and $-226,000 for the Small Business Technology Transfer Pilot Program (STTR).
[b/] Reflects adjustments of $-562,000 for Omnibus Rescission, P.L. 106-554.

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TRANSPORTATION SECTOR

SUMMARY OF CHANGES

	FY 2002 Request
FY 2001 Comparable	$ 255,398
Non-Discretionary	
- Increase for Federal Pay Raise and Locality Pay	381
- Increase for Federal Personnel Transit Subsidy	18
FY 2002 Base	$ 255,797
Vehicle Technologies R&D:	
- Hybrid Systems R&D - Reduce funding for R&D of vehicle propulsion and ancillary loads (-2,131); continue level of effort for R&D of high power batteries (-7); increase funding for high-performance electric motors, transfer technology to AIPM developers (+553); continue level of effort funding for Heavy Vehicle propulsion systems (+3); fund technical support services (+5).	-1,577
- Fuel Cell R&D - Increase funding for R&D on electrode structure and cell design for high termperature membranes	+594
- Advanced Combustion Engine R&D - Reduce funding for hybrid direct injection engine R&D (-459); increase funding for combustion emission control systems validation (+1,391); decrease funding for R&D of Light Truck Engine (-1,015); continue level of effort for Heavy Truck Engine Technology (-18); decrease Engine Boosting Technology, (-500); begin Off-Highway Engine R&D program for agriculture, construction locomotive, mining and marine engines (+500); continue level of effort for Health Impacts (+3); fund technical support services (+25)	-73
- Electric Vehicles R&D - Funding reduced as phase out of USABC Phase III program begins.	-5,444

- Heavy Vehicle Systems R&D - Increase funding for Vehicle Systems Optimization to include modification of projects to reflect demands of government/industry truck partnerships and increased R&D tests (+1,139); decrease funding for truck safety systems (-100); initiate funding for STICK (+100); decrease funding for technical support services (-133).	+1,006
Fuels Utilization R&D:	
- Increase Advanced Petroleum Based Fuels (+601); decrease alternative fuels (-581)).	+20
Materials Technologies:	
- Propulsion Materials Technology - Continue funding at current level of effort .	-31
- Lightweight Materials Technology - Continue funding at current level of effort.	+89
- High Temperature Materials Laboratory - Decrease by 3 the staffing level for HTML .	-988
Technology Deployment:	
- Clean Cities Program - FY 2002 will retain emphasis on key niche markets while decreasing funding for State grants, national parks, and rebates.	-3,367
- Testing and Evaluation - Decrease number of hybrid and electric vehicle models tested but continue to provide data to key industry and fleet stakeholders.	-1,150
- EPACT Replacement Fuels - Funding request will maintain key enforcement and analytical activities while decreasing funding for regulatory programs.	-300
Cooperative Program With States:	
- No funding requested for this program.	-1,996
Energy Efficiency Science Initiative:	
- No funding requested for this program.	-3,891
Management and Planning:	
- Program Direction - Reflects an increase for discretionary payroll adjustments and travel.	+681
FY 2002 Congressional Budget Request .	$ 239,370

TRANSPORTATION TECHNOLOGIES
TRANSPORTATION SECTOR
(Dollars in Thousands)

VEHICLE TECHNOLOGIES R&D

I. Mission, Supporting Goals and Objectives

Mission

The Vehicle Technologies research and development (R&D) program supports work on advanced vehicle technologies that will produce dramatic improvements in fuel economy for automobiles, sport utility vehicles (SUVs), and light and heavy trucks, without sacrificing safety, environmental performance, and affordability.

Goals and Benefits

Vehicle Technologies R&D includes five vehicle technology development topics: Hybrid Systems R&D, Fuel Cell R&D, Advanced Combustion Engine R&D, Electric Vehicle R&D, and Heavy Vehicle Systems R&D. In addition, the Cooperative Automotive Research for Advanced Technology (CARAT) and the Graduate Automotive Technology Education (GATE) support these topics.

Hybrid Systems R&D

The Hybrid Systems R&D program develops advanced propulsion and ancillary system components and tests and validates them in a vehicle context. The program includes development of advanced power electronics, high power energy storage devices, and hybrid propulsion system components for light duty as well as heavy duty vehicles. Through a combination of component and vehicle testing and computer simulation, the program also sets performance targets for component development programs and validates the achievement of the vehicle-level OTT objectives. All activities are system driven and barrier focused to ensure maximum benefit from the R&D investment and development of hybrid systems technologies that are practical for automobile and heavy vehicle applications. All technological targets for hybrid system technologies are derived from a common vehicle-level perspective, and the resultant technologies are validated in the context of a vehicle operating environment. Additionally, resources are focused on those technological barriers that are of high priority and on high-risk R&D that would not be conducted independently by industry.

Goals and Performance Measures:

- By 2004, develop and validate propulsion subsystem technologies that will contribute to 80 mile per gallon six-passenger sedans that retain all the attributes of competitive conventional vehicles, including emissions control.
- By 2006, develop technologies that enable commercialization of high-efficiency urban heavy vehicles.
- By 2010, reduce hybrid electric high power battery cost to $500 per kWh and increase battery life to 12 years.
- By 2010, increase the number of light duty hybrid electric vehicles on the road to 6.8 million.
- By 2015, develop and validate production-feasible propulsion subsystem technologies that allow a quadrupling of fuel economy in six-passenger sedans, emphasizing non-petroleum-based fuels and zero emissions, and which retain all the attributes and features of competitive vehicles.

Benefits:

The projected benefits of the Hybrid Systems R&D Program are shown in the table below.

	2005	2010	2020
Petroleum Displaced (Millions Barrels per Day)	0.02	0.09	0.51
Total Primary Energy Displaced (Trillion Btu)	41	184	1,073
Energy Costs or Savings (Millions of $)	427	1,905	11,049
Carbon Equivalent Emissions Displaced (MMTCe)	0.80	3.60	20.80

Source: GPRA 2001 EERE Database. Numbers in the above table represent the projected annual benefits in 2005, 2010, and 2020 based on the FY2002 funding request, assuming all program goals are met.

Fuel Cell R&D

The Fuel Cell R&D Program develops highly-efficient, low- or zero-emission, cost-competitive automotive fuel cell power system technologies that operate on conventional and alternative fuels. The program integrates efforts of the automotive industry, fuel cell and fuel processor developers, national laboratories, universities, and fuel suppliers in a customer-focused national program to develop more fuel-efficient, cleaner, and cost-effective vehicle power systems that meet the most stringent emission standards while retaining the same performance as today's vehicles.

Goals and Performance Measures:

- By 2004, reduce the cost of a 50kW fuel cell system to $125/kW.
- By 2004, reduce fuel cell stack platinum loading to 0.6g/peak kW.

- By 2008, reduce the cost of a 50kW fuel cell system to $45/kW.
- By 2008, develop and validate fuel cell power system technologies that meet vehicle requirements in terms of: (1) cost competitiveness with internal combustion engines; and (2) performance, range, safety, and reliability.

Benefits:

Fuel cell vehicles have the potential to reduce harmful emissions and consumption of non-renewable energy sources because they are clean and efficient. Fuel cells are a technology that will change our future. They can power automobiles with little or no tailpipe emissions, provide energy to homes and factories with virtually no smokestack pollution, and use renewable, domestic energy at high efficiency while creating thousands of jobs. The projected benefits of the Transportation Fuel Cell Power Systems Program are shown in the table below.

	2005	2010	2020
Petroleum Displaced (Millions Barrels per Day)	0.00	0.003	0.102
Total Primary Energy Displaced (Trillion Btu)	0	6	201
Energy Costs or Savings (Millions of $)	0	64	1,655
Carbon Equivalent Emissions Displaced (MMTCe)	0.00	0.12	3.90

Source: GPRA 2001 EERE Database. Numbers in the above table represent the projected annual benefits in 2005, 2010, and 2020 based on the FY2002 funding request, assuming all program goals are met.

Advanced Combustion Engine R&D

The Advanced Combustion Engine R&D program develops technologies that will significantly improve the fuel efficiency of conventional piston engines while cost-effectively meeting projected emissions regulations. The primary focus is on developing and validating compression-ignition, direct-injection (CIDI) engine technologies that will produce dramatic improvements in fuel economy for automobiles and SUVs, as well as light and heavy trucks, without sacrificing safety, environmental performance, or affordability. Because of the stringent emissions regulations proposed for particulates and nitrogen oxides, a secondary focus will be to enhance the performance of spark-ignition, direct-injection (SIDI) technology as a power system alternative that will contribute to achievement of the aggressive fuel economy goals.

The program collaborates with industry to develop technical roadmaps and establish research priorities. Projects aimed at overcoming the technical barriers to the commercialization of high-payoff technologies are then initiated. Most R&D is performed through co-funded government/industry partnerships that ensure that results are practical for vehicle applications and that a maximum benefit is achieved from the R&D investment.

Goals and Performance Measures:

- By 2003, demonstrate SIDI engine technology which achieves 37 percent thermal efficiency while meeting Tier 2 emission standards.
- By 2004, complete development of advanced clean diesel engine technologies that enable commercial production of pickup trucks, vans, and SUVs that achieve at least a 35 percent fuel efficiency improvement relative to current gasoline-fueled trucks while meeting Tier 2 emission standards.
- By 2004, reduce the cost of light-duty emissions controls to $4/kW and reduce particulate emissions to 0.01 grams/mile and oxides of nitrogen emissions to 0.07 grams/mile.
- By 2006, increase the efficiency of heavy duty diesel engines from 45 percent to 50 percent, while reducing emissions to EPA 2007 levels.
- Provide the engine technology community with toxicological assessments of health impacts for various technologies.
- By 2010, increase the thermal efficiency of heavy truck engines to 55 percent.

Benefits:

The projected benefits of the Advanced Combustion Engine R&D Program are shown in the table below.

	2005	2010	2020
Petroleum Displaced (Millions Barrels per Day)	0.04	0.25	0.68
Total Primary Energy Displaced (Trillion Btu)	84	520	1,444
Energy Costs or Savings (Millions of $)	1,100	6,547	17,878
Carbon Equivalent Emissions Displaced (MMTCe)	1.50	9.60	26.80

Source: GPRA 2001 EERE Database. Numbers in the above table represent the projected annual benefits in 2005, 2010, and 2020 based on the FY2002 funding request, assuming all program goals are met.

Electric Vehicles R&D

The Electric Vehicles R&D program develops and validates advanced electric vehicle battery technologies that will enable full-range electric vehicles and facilitate their commercial viability. Advanced lithium batteries are being developed under a cooperative agreement with United States Advanced Battery Consortium (USABC). This work is supported by national laboratories and universities funded directly by DOE. Exploratory work on new electrode and electrolyte materials is conducted by the national laboratories and selected university researchers under Exploratory Technology Research.

Goals and Performance Measures:

- In 2010, reduce electric vehicle battery cost to $150/kilowatt-hour, as compared to $350/kilowatt-hour in 1998.

Benefits:

Advanced electric vehicles can provide the same level of comfort, performance, and affordability as today's internal combustion engines without their associated air and noise pollution. The Electric Vehicles R&D program also helps support the automobile industry's response to the California Air Resources Board's Zero Emissions Vehicle Program, as reaffirmed in January 2001. The projected benefits of the Electric Vehicle Battery R&D Program are shown in the table below.

	2005	2010	2020
Petroleum Displaced (Millions Barrels per Day)	0.01	0.02	0.08
Total Primary Energy Displaced (Trillion Btu)	8	27	103
Energy Costs or Savings (Millions of $)	0	0	657
Carbon Equivalent Emissions Displaced (MMTCe)	0.01	0.05	1.40

Source: GPRA 2001 EERE Database. Numbers in the above table represent the projected annual benefits in 2005, 2010, and 2020 based on the FY2002 funding request, assuming all program goals are met.

Heavy Vehicle Systems R&D

The Heavy Vehicle Systems R&D Program sets performance targets for components and subsystems in the context of the heavy vehicle as an integrated system, and validates achievements of vehicle-level OTT objectives. The program focuses on reducing parasitic energy losses, such as aerodynamic drag, rolling resistance, friction/wear and lubrication, and underhood thermal management, that are common in heavy vehicles. By collaborating with industry to develop technical roadmaps and a set research priorities, the program identifies R&D which will overcome barriers to the commercialization of high-payoff technologies.

Goals and Performance Measures:

- By 2004, complete advanced diesel and vehicle systems technologies for Class 7 and 8 trucks that, when integrated in a truck, increase the average fuel economy to 10 mpg from the current 7 mpg.
- By 2010, reduce the aerodynamic drag coefficient of heavy trucks to 0.4 from 0.6 today.

Benefits:

Utilizing emerging technologies to reduce parasitic energy losses could double heavy vehicle truck economy from 7 to 14 miles per gallon and save surface transportation $21 billion in fuel costs per year. This program supports other programs for which GPRA benefits are estimated.

Vehicle Technologies R&D Accomplishments

FY 2000 Accomplishments:

- Completed testing of baseline prototype, 50-volt high power lithium-ion modules for use in hybrid vehicles. Worked with three domestic automakers to incorporate the most promising Partnership for a New Generation of Vehicles (PNGV) technologies in concept vehicles with up to three times average fuel economy of 1993 Taurus, Lumina and Concorde models.

FY 2001 Ongoing Accomplishments:

- Complete test and evaluation of a fuel-flexible 50 KW integrated fuel cell power system.
- Complete development of the 200-volt battery aimed at satisfying the PNGV high power energy storage requirements of hybrid vehicles.

FY 2002 Planned Accomplishments:

- Light Truck Engine: Complete initial testing of light trucks with prototype diesel engines to demonstrate a 35 percent increase in fuel efficiency and Tier 2 emissions when integrated into a vehicle using low sulfur fuel.
- Heavy Truck Engine: Demonstrate 45 percent thermal efficiency while meeting EPA standards.
- Fuel Cell R&D: Demonstration and delivery of an advanced 50kW fuel processor for automotive fuel cell systems.
- Hybrid Systems R&D: Complete low-cost nickel-metal hydride nominal 50-volt module performance validation against the Partnership for a New Generation of Vehicles technical targets.
- Electric Vehicle R&D: Complete United States Advanced Battery Consortium (USABC) Phase III lithium-ion development program, and orderly phase out of DOE's commitment to the United States Advanced Battery Consortium (USABC) Phase III Cooperative Agreement.
- Advanced Combustion Engine R&D: Demonstration of optimized emission control system that achieves 0.07 g/mile NOx and 0.01 g/mile PM short-term performance over the Federal driving cycle (FTP-75). System will be installed and tested on a PNGV diesel-electric hybrid passenger car.

II. A. Funding Table: VEHICLE TECHNOLOGIES R&D

Program Activity	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
Hybrid Systems R&D	$ 41,829	$ 49,783	$ 48,206	$ -1,577	-3.2%
Fuel Cell R&D	$ 36,585	$ 41,331	$ 41,925	$ 594	1.4%
Advanced Combustion Engine R&D	$ 46,750	$ 53,059	$ 52,986	$ -73	-0.1%
Cooperative Automotive Research for Advanced Technologies	$ 1,554	$ 1,500	$ 1,500	$ 0	0.0%
Electric Vehicles R&D	$ 8,732	$ 8,963	$ 3,519	$ -5,444	-60.7%
Heavy Vehicle Systems R&D	$ 2,915	$ 4,974	$ 5,980	$ 1,006	20.2%
Total, Vehicle Technologies R&D	$ 138,365	$ 159,610	$ 154,116	$ -5,494	-3.4%

II. B. Laboratory and Facility Funding Table: VEHICLE TECHNOLOGIES R&D

	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
Argonne National Lab (East)	$ 22,871	$ 23,348	$ 21,848	$ -1,500	-6.4%
Brookhaven National Lab	$ 405	$ 463	$ 280	$ -183	-39.5%
Idaho National Engineering and Environmental Lab	$ 1,675	$ 1,830	$ 1,720	$ -110	-6.0%
Lawrence Berkeley National Lab	$ 4,636	$ 4,008	$ 3,008	$ -1,000	-25.0%
Lawrence Livermore National Lab	$ 2,307	$ 1,700	$ 826	$ -874	-51.4%
Los Alamos National Laboratory	$ 5,920	$ 7,960	$ 7,500	$ -460	-5.8%
National Renewable Energy Lab	$ 5,693	$ 6,600	$ 6,575	$ -25	-0.4%
Oak Ridge National Lab	$ 11,127	$ 12,458	$ 10,958	$ -1,500	-12.0%
Pacific Northwest National Lab	$ 3,020	$ 3,100	$ 3,000	$ -100	-3.2%
Sandia National Laboratories	$ 7,749	$ 7,512	$ 6,977	$ -535	-7.1%
All Other	$ 72,962	$ 90,631	$ 91,424	$ 793	0.9%
Total, Vehicle Technologies R&D	$ 138,365	$ 159,610	$ 154,116	$ -5,494	-3.4%

III. Performance Summary: VEHICLE TECHNOLOGIES R&D

Program Activity	FY 2000	FY 2001	FY 2002
Hybrid Systems R&D	**Light Vehicles Propulsion & Ancillary Subsystems** The propulsion systems development activities required to achieve the 50 mpg goal were completed in FY 1999. The light vehicles key activities below were re-focused on R&D directed at achieving the overall goals for the light vehicles program: (1) Develop component technologies enabling 80 mpg mid-size automobiles; and (2) 50 percent improvement in fuel efficiency of light trucks. Optimization tools were added to vehicle system models. A cost estimating model was initiated for making component trade-offs for 80 mpg vehicle concepts. A process which enables examination of component concepts and designs, without the cost of building and testing components, was initiated. This process is called Digital Functional Vehicle. Tested newly-developed components and component combinations from small companies	**Light Vehicles Propulsion & Ancillary Subsystems** The light vehicles key activities for 2001 continue to focus on R&D directed at achieving the overall goal for the light vehicles program by developing propulsion and ancillary technologies to enable 80 mpg mid-size automobiles. In addition, studies have begun to determine technology shortfalls and performance targets for improving the fuel efficiency of sport utility vehicles. Performance models are being developed for aftertreatment devices and for predicting emissions from advanced engines. The government and industry performance models (ADVISOR and PSAT) are being combined and improved into one efficient model which can be used to evaluate vehicle control strategies as well as perform design trade-off studies. Component data for the cost model is being gathered to enable cost/benefit trade-offs.	**Light Vehicles Propulsion & Ancillary Subsystems** Examine, through analysis and trade-off studies, the potential for fuel efficiency improvements of several propulsion system candidates that achieve the performance and target goals for SUVs and light trucks. Evaluate emission control models under steady state and transient conditions. Continue benchmarking commercial technologies worldwide, to compare state-of-the-art performance with DOE performance targets. Assemble a parallel hybrid vehicle system in the laboratory, and use government/industry-developed models to demonstrate advanced control techniques to improve fuel efficiency and reduce emissions. Continue to develop models which will enable improved cost estimation of advanced vehicles and systems. Demonstrate fuel efficiency benefits

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Hybrid Systems R&D (Cont'd)	and from automotive suppliers. Evaluated components developed in other vehicle technology programs. Used the test data collected to validate analytical models, feedback technical requirements to technology development programs, and assess progress toward the 80 mpg program goal. Work began on selecting partners to develop better sun reflecting glazing materials and developing measuring techniques for evaluating new concepts that reduce climate comfort loads without reducing perceived passenger comfort. Evaluated thermal characteristics of nickel metal hydride and lithium ion battery packs and began development of battery pack thermal models. Continued to develop a modular battery management system that will offer higher accuracy, higher efficiency, lower cost, smaller size (by 75 percent) and weight (by 50 percent), and more convenient installation. Participants included: ANL, NREL,	The Digital Functional Vehicle process is being developed with industry partners to show energy savings benefits from optimizing related subsystems in a vehicle. Several projects have been initiated. This process will aid in rapid evaluations of propulsion systems and analysis of thermal, mechanical and electrical subsystems using engineering simulations as well as providing first order packaging estimates. Validation procedures for OTT-supported technologies in the hybrid test facility using hardware-in-the-loop testing methods are being developed. This method simulates the performance of a complete vehicle in the laboratory using component hardware in the simulation loop. Benchmarking of the latest commercially available hybrid vehicles and advanced components continues. Work continues on R&D to demonstrate 50 percent reductions in vehicle ancillary loads such as heating and air-conditioning.	that can result from using the Digital Functional Vehicle process. With industry partners, show how this process can improve fuel efficiency through subsystem optimization. Award contract for the next generation Automotive Climate Control System (ACCS) and begin evaluation of thermal manikin response to cold & hot temperatures. Complete an integrated systems model for automotive interior climate control. Validate vehicle system performance models using data from testing an advanced lithium-ion battery pack and an advanced electric drive subsystem in a vehicle systems environment. Investigate new concepts such as efficient battery self heating and hybrid energy storage systems and begin testing thermal management system in a test vehicle. Participants include: ANL, NREL, ORNL, USCAR, other contractors. (PNGV: $11,718) ($11,718)

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Hybrid Systems R&D (Cont'd)	INEEL, ORNL, USCAR, other contractors. (PNGV: $14,436) ($14,436)	Advanced batteries are being tested to develop thermal management techniques to improve subsystem life and operating efficiency. Participants include: ANL, NREL, ORNL, USCAR, other contractors. (PNGV: $13,849) ($13,849)	
	High Power Energy Storage Supported R&D on high power batteries with the U.S. Advanced Battery Consortium (USABC), with an industry cost share of 50 percent in FY 2000. Completed performance characterization of baseline prototype 50-volt lithium-ion modules with life cycle testing at DOE laboratories; compared results to PNGV technical targets. Based on the lithium-ion test results, select one lithium-based technology for scale-up development to a 200-volt subsystem battery pack for application in the PNGV concept vehicle(s). Identified manufacturing processes with potential for high-volume production, and estimated	**High Power Energy Storage** Support R&D on high power batteries with the U.S. Advanced Battery Consortium (USABC), with an industry cost share of 50 percent in FY 2001. Continue benchmarking nickel-metal hydride technologies to verify performance and life capabilities of production-feasible designs. Continue development of lithium-ion battery subsystems for use in PNGV concept vehicles, including cells and modules with acceptable life and abuse-tolerance, subsystem controls and software, and all subsystem/vehicle interfaces. Initiate testing to validate performance, life, and abuse-tolerance against PNGV	**High Power Energy Storage** Support R&D on high power batteries with the U.S. Advanced Battery Consortium (USABC), with an industry cost share of 50 percent in FY 2002. Complete life verification testing of four 50-volt nickel metal hydride modules at a DOE laboratory, to validate the performance against PNGV energy storage requirements. Transfer data base and nickel metal hydride technology to DaimlerChrysler, Ford, and General Motors for use in their hybrid-electric vehicle (HEV) development efforts. Validate nickel-metal hydride technologies to verify performance and life capabilities of production-feasible designs.

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Hybrid Systems R&D (Cont'd)	subsystem lithium-ion production costs at two specified rates of production.	requirements. Deliver two complete, validated subsystems for bench testing at a national laboratory. Assess subsystem manufacturing processes; and identify components and processes needed to achieve the PNGV energy storage cost goals for the candidate lithium-ion technologies. Develop a plan for verification of candidate cost reduction measures.	
	Completed development of baseline lithium-ion cell technology. Used results in developing diagnostic techniques leading to better understanding of performance and safety as a function of changes in cell chemistry and design. Assessed diagnostic techniques for ability to identify lithium-ion degradation/failure mechanisms as a function of cycle life and thermal cycling; developed a plan to address technical deficiencies. Selected one low cost lithium-ion packaging technology. Selected one low cost conventional electrolyte for incorporation into full-size cells, to evaluate performance against PNGV technical targets and to assess abuse tolerance.	Incorporate lithium-ion electrochemistry and packaging improvements from the Advanced Technology Development program into laboratory test cells for validation of performance, life, and abuse-tolerance capabilities. Transfer validated technology improvements to candidate industrial suppliers for incorporation into full subsystem demonstration packs. Validate improved diagnostic tools and techniques to identify lithium-ion degradation/failure mechanisms that limit life and abuse-tolerance capabilities. Participants include: USABC, ANL, BNL, LBNL, INEEL, SNL.	Continue development of lithium-ion battery subsystems for use in PNGV vehicles. Incorporate second generation lithium-ion electrochemistry and packaging improvements from the Advanced Technology Development program in full-size cells. Continue transfer of technology improvements to industrial suppliers for validation in small cells prior to incorporation into full size, prototype, lithium-based cells. Assess diagnostic tools and techniques and select those that have the potential to identify lithium-ion degradation/failure mechanisms that limit life and

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Hybrid Systems R&D (Cont'd)	Participants included: USABC, ANL, BNL, LBNL, INEEL, SNL. (PNGV: $13,425) ($13,425)	(PNGV: $17,801) ($17,801)	abuse-tolerance capabilities. Initiate an accelerated calendar life study to predict the life of lithium-ion batteries. Participants include: USABC, ANL, BNL, LBNL, INEEL, SNL. (PNGV: $17,794) ($17,794)
	Advanced Power Electronics Under 50 percent cost-shared agreements and contracts, fabricated Automotive Integrated Power Modules (AIPMs) and advanced motors. Validate performance of intermediate AIPM hardware against PNGV technical targets. Defined motor system requirements to enable selection of final motor designs and components. Developed and validated models for switched reluctance, permanent magnet, and induction motor technology. Validated motor technology developments against PNGV technical targets. Initiated a project with IEEE P1461 working group to address international automotive standards and recommended practices promoting competition and	**Advanced Power Electronics** Under 50 percent cost-shared agreements, fabricate Generation 2 AIPM prototypes. Validate performance of prototypes against PNGV technical targets. Fabricate the first generation high-performance electric motors and deliver prototype motors to the national laboratories for validation against the PNGV technical targets. With the developers initiate integration of the AIPM and advanced motor technologies.	**Advanced Power Electronics** Evaluate second generation Automotive Integrated Power Module (AIPM) and Automotive Electric Motor Drive (AEMD) production prototypes developed under 50 percent cost-shared agreements. At the national laboratories, validate performance of the second generation AIPM and AEMD production prototypes against PNGV performance targets. Validate AIPM and AEMD propulsion systems' performance in an integrated systems configuration.

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Hybrid Systems R&D (Cont'd)	scalable architecture for automotive integrated power modules. Incorporated materials technology improvements into limited quantities of prototype AIPM devices; assessed performance against technical targets for increased power density and lower production costs. Initiated transfer of advanced capacitor technology to AIPM developer. Participants included: General Motors, Ford, Chrysler, ORNL, SNL, Navy, DoD. (PNGV: $9,515) ($9,515)	Incorporate advanced component technology improvements into prototype motors; assess performance against technical targets for increased specific power and lower production cost. Scale-up advanced capacitor developments to the component level. Validate improvements and performance, and transfer technology to the AIPM developer(s). Participants include: Con, SPCO, Semikron, ORNL, SNL, LLNL. (PNGV: $13,850) ($13,850)	Develop/explore improved materials and architectures for advanced automotive propulsion systems and flexible manufacturing. Evaluate prototype high temperature polymer capacitors and continue materials development to increase capacitor energy storage at high temperature. Participants include: SatCon, SPCO, Semikron, ORNL, SNL, LLNL. (PNGV: $14,403) ($14,403)
	Heavy Vehicle Propulsion Systems Supported a four-year, heavily cost shared (greater than 50 percent) program to accelerate the time-to-market for heavy vehicle hybrid technology by 5 to 10 years. Using the urban service truck and transit bus as platforms, develop	**Heavy Vehicle Propulsion Systems** With natural gas as the fuel of choice, complete component selection and system design definitions for candidate hybrid technologies and target the development of regenerative braking technologies to improve	**Heavy Vehicle Propulsion Systems** Integrate the latest technologies for heavy hybrid vehicles. Finalize design and establish preliminary manufacturing techniques for cost-effective mass production of components/subassemblies. Perform analytical modeling to

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Hybrid Systems R&D (Cont'd)	hybrid/electric propulsion systems as a replacement for transmissions (new production and retrofit). Supported competitive industry teams focusing on cost reductions of the critical components specific to their systems, and taking full advantage of the pre-competitive technology programs in advanced power electronics and high power energy storage. Activities funded in this area were coordinated with the Advanced Vehicle Program activities funded by the Department of Transportation. ($3,848)	efficiency and braking system durability of heavy hybrid vehicle designs. Conduct systems integration efforts focused on development of vehicle prototype architectures to achieve efficiency and emission goals consistent with the needs of the urban truck and bus industry/users. The industrial partners funding participation in this competitively solicited activity is 50 percent. Maintain coordination with the U.S. Department of Transportation Advanced Vehicle Program and appropriate DoD technology development activities. ($3,938) Participants include: DOT, DoD, ORNL, ANL.	confirm industry predictions of fuel economy improvement and emission reduction. Participants include: DOT, DoD, ORNL, ANL. ($3,941)
	Provide critical technical and program management support services. (CSMI, Antares). (PNGV: $572) ($605)	Provide critical technical and program management support services. (CSMI, Antares). (PNGV: $300) ($345)	Provide critical technical and program management support services. (Sentech, Antares). (PNGV: $300) ($350)
Total, Hybrid Systems R&D	**$41,829**	**$49,783**	**$48,206**

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Fuel Cell R&D	**Systems**	**Systems**	**Systems**
	Completed development and began testing of an advanced integrated 50-kW fuel cell power system, capable of operation on conventional and alternative fuels, to achieve year 2000 targets for system power density, specific power, emissions, efficiency, cost, durability. System demonstrated for the first time a proton-exchange-membrane (PEM) fuel cell stack, fuel processor, sensors, controls, and thermal and air management systems integrated at the automotive scale using conventional fuels. System demonstrated steady state operation and limited transient response capability (the ability to rapidly respond to changes in demand for power).	Complete test and evaluation of integrated 50-kW fuel cell power system to verify achievement of year 2000 performance targets for system power density, specific power, emissions, efficiency, cost, durability. Test and evaluate 10-kW system that addresses resolution of fuel processing and system control issues such as start-up and transient response. Update the rigorous systems cost analysis to include advanced materials and low cost fabrication processes.	Complete test and evaluation of 10-kW system, addressing system control issues such as start-up and transient response. Update and validate integrated power system model to include data from 50-kW integrated systems testing and update cost and system trade-off analyses. Benchmark progress of available technology relative to achieving revised year 2004 PNGV performance targets of 250 W/l system power density, 250 W/kg system specific power, near-zero emissions, 40 percent efficiency at 25 percent power, $125/kW cost and more than 4,000 hours durability in a fuel-flexible fuel cell system.
	Built 10-kW integrated fuel cell system for system model validation. Characterized unresolved fuel processing and systems control issues affecting start-up and transient response, operation at temperature extremes and freeze-thaw cycles.	Initiate development of fuel cell system sensors and actuators suitable for automotive use. Initiate benchmarking of integrated fuel-flexible fuel cell power system that meets year 2004 PNGV performance targets of 300 W/l system power density, 300 W/kg	Continue development of fuel cell system sensors (CO, H_2, NH_3, H_2S, etc.) and actuators suitable for automobile use. Initiate development of compact humidifiers/heat exchangers. Participants include: TBD, A.D.

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Fuel Cell R&D (Cont'd)	Initiated a rigorous systems cost analysis for high volume manufacturing of fuel cell systems. Integrated cost analysis findings into existing system model for determination of lowest cost system configuration. Participants included: International Fuel Cells, Plug Power, Energy Partners, Honeywell, Nuvera, ANL, Arthur D. Little, Directed Technologies. (PNGV: $5,940) ($5,940)	system specific power, near-zero emissions, 48 percent efficiency at 25 percent power, $125/kW cost, and more than 4,000 hours durability. Update and validate existing system model using data from 10-kW integrated system tests. Leverage cost analyses and system modeling activities through international cooperation. Participants include: International Fuel Cells, Plug Power, Energy Partners, Honeywell, Nuvera, IIT, Arthur D. Little, ANL, Directed Technologies. (PNGV: $7,527) ($7,527)	Little, ANL, International Fuel Cells, IIT, Directed Technologies, Nuvera, (PNGV: $7,600). ($7,600)
	Stack Subsystems Components Emphasized development of low cost, high performance components needed to meet the PEM fuel cell system year 2000 cost target. Completed development of 50-kW reformate-capable fuel cell stack subsystem meeting year 2000 performance and cost targets. It included controls, sensors, thermal and air management systems. Long-	**Stack Subsystems Components** Conduct research on low-cost, high performance components which are needed to meet the PEM fuel cell stack system year 2004 cost target of $100/kW. Continue long-term tests to provide data on durability of stack components and small stack subsystems. Demonstrate advanced O_2-reduction electrodes and membrane electrode assemblies	**Stack Subsystems Components** Continue research on low-cost, high performance components, increasing power density from 250 to 500 mW/cm^2 at 0.8V, to meet PEM fuel cell stack system 2004 cost target of $100/kW and durability target of 4,000 hours. Continue long-term tests to provide data on durability of stack components and small stack

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Fuel Cell R&D (Cont'd)	term tests were initiated to demonstrate durability of stack components and small stack subsystems. Developed advanced CO-tolerant (100 ppm) electrodes and membrane electrode assemblies (MEAs) operating at higher voltage (0.7-0.8 V) to enable high efficiency. Demonstrated durability of advanced electrodes tolerant to more than 100 ppm CO in stacks, to maintain high performance during transient operation. Tested polymer membranes at higher fuel cell operating temperatures (120-150°C), in order to increase CO tolerance and facilitate heat rejection. Initiated development of high volume pilot plant manufacturing processes for MEAs to meet MEA cost target of $10/kW. Completed development of lightweight, low cost composite bipolar plate; initiated demonstration of high volume manufacturing processes in pilot plant operation to meet plate cost target of $10/kW. In collaboration with DARPA, initiated development of small direct	(MEAs) operating at higher voltage (0.7-0.8 V) to enable high efficiency. Develop advanced CO-tolerant (>200 ppm) membrane electrode assemblies enabling lower platinum loading, higher efficiency, and quicker system start-up. Demonstrate polymer membranes at higher fuel cell operating temperatures (120-150°C), in order to increase CO tolerance and facilitate heat rejection. Demonstrate feasibility of low-cost fabrication processes for MEAs to meet MEA cost target of $10/kW. Initiate development of reformate-capable fuel cell stack subsystem to meet more challenging targets associated with the 2004 PNGV goal. Demonstrate low-cost fabrication processes for lightweight, low-cost composite bipolar plate in pilot plant operation to meet plate cost target of $10/kW. Develop and test low-crossover membrane, high activity methanol oxidation catalyst, and direct	subsystems to fuel impurities and cycling. Develop advanced O_2-reduction electrodes and membrane electrode assemblies (MEAs) into short stacks to enable high efficiency. Develop polymer membranes and MEAs for higher fuel cell operating temperatures (120-150°C), in order to increase CO tolerance and facilitate heat rejection. Investigate electrode structure and cell design for higher operating temperatures. Demonstrate feasibility of low-cost fabrication processes for MEAs in pilot plant operation to meet MEA cost target of $10/kW, and initiate development of advanced catalyst deposition techniques to meet the 2004 precious metal loading target of 0.6g/kW. Build and test 1-kW direct methanol fuel cell stack incorporating low platinum MEA. Demonstrate advanced, mixed-flow turbocompressor which meets established pressure-ratio turndown requirements. Initiate development of oxygen enhancement technology to improve cathode performance

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Fuel Cell R&D (Cont'd)	methanol fuel cell stack with improved power density. Based on testing of current compressor/expander technologies and peer review, selected most promising; initiated development of advanced, high efficiency compressor/expander to meet 2004 system level targets. Participants included: Honeywell, Plug Power, International Fuel Cells, Energy Partners, IGT, 3M, Southwest Research Institute, W.L. Gore, Foster Miller, LANL, ANL, LBNL, NREL, TBD. (PNGV: $13,608) ($13,608)	methanol fuel cell with improved power density. Some direct methanol activities will be leveraged through international cooperation. Based on outcome of peer review, continue development of advanced, high efficiency compressor/expander to meet 2004 system level targets. Continue evaluation of ambient pressure fuel cell stack subsystem to minimize the risk of potentially unsuccessful air compressor system. Participants include: Honeywell, Plug Power, International Fuel Cells, Energy Partners, IGT, 3M, Southwest Research Institute, W.L. Gore, Foster Miller, LANL, ANL, LBNL, NREL, TBD. (PNGV: $12,255) ($12,255)	and meet efficiency target. Participants include: Honeywell, Plug Power, International Fuel Cells, Energy Partners, IGT, 3M, Southwest Research Institute, W.L. Gore, Foster Miller, LANL, ANL, LBNL, NREL, TBD. (PNGV: $12,825) ($12,825)
	Fuel Processor/Storage Assessed innovative concepts for hydrogen storage in collaboration with DOE Hydrogen program. Completed development and	**Fuel Processor/Storage** Research innovative concepts for hydrogen storage in collaboration with DOE Hydrogen program. Proceed with development of	**Fuel Processor/Storage** Develop advanced on-board hydrogen storage technologies, in collaboration with DOE Hydrogen Program, to meet goals of 1500 Wh/l and 2000 Wh/kg.

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Fuel Cell R&D (Cont'd)	evaluation of the 50-kW fuel-flexible fuel processor capable of processing methanol, ethanol, natural gas and gasoline. Integrated it with advanced shift reactor, fuel vaporizer and CO clean-up systems, and tested against year 2000 PNGV technical targets for efficiency, power density, specific power, cost, start-up, durability, and emissions. Initiated advanced fuel-flexible fuel processor development designed to achieve year 2004 PNGV technical targets of 78 percent efficiency, 700 W/l, 700 W/kg, less than $25/kW, less than 1 minute start-up, 4,000 hours durability and less than Tier 2 emissions. Transferred successful laboratory CO cleanup technology to industry for development of production designs and processes to enable the integrated fuel-flexible fuel processor to achieve less than 10 ppm CO under steady state operation and less than 500 ppm during transients. Continued development of novel microchannel fuel processor components to meet stringent size	advanced fuel processor to meet revised PNGV 2004 technical targets of 78 percent efficiency, 700 W/1, 700 W/kg, less than $25/kW, 4,000 hours durability, less than 1 minute start-up, and less than Tier 2 emissions. Fuel processor will be capable of processing methanol, ethanol, natural gas and gasoline, and will be completely integrated with required shift reactors and CO cleanup system. Evaluate low pressure fuel processor operation to reduce air management requirements, start-up, and transient response. Fabricate a prototype CO clean-up device based on low-cost design, eliminating the need for precise measurement of input gas composition and metering of air injection, and achieving less than 10 ppm CO under steady state operation and less than 500 ppm during transients. Preliminary results indicate that microchannel technology can reduce the size and weight of conventional fuel processing technology by a factor of 10. Using this approach,	Demonstrate components of an advanced fuel-flexible fuel processor meeting PNGV 2004 technical targets of 80 percent efficiency, 750 W/1, 750 W/kg, less than 1 minute start-up, and less than Tier 2 emissions. Demonstrate low pressure fuel processor operation to reduce air management requirements. Investigate innovative fuel processing techniques to allow rapid start-up (<30sec.). Demonstrate a highly compact (>1500W/l) prototype 50 kW microchannel steam reformer capable of reforming methanol, ethanol, natural gas and gasoline. Demonstrate microchannel technology in conjunction with other fuel processing components such as heat exchangers and steam generators. Develop high activity, sulfur tolerant shift catalysts for fuel processor system, needed to reduce reactor size and precious metal content, to meet 4,000 hour durability requirement, and to

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Fuel Cell R&D (Cont'd)	requirements. Developed advanced catalysts for fuel-flexible fuel processing to achieve reductions in operating temperature and pressure, thereby decreasing cost, start-up time and transient response. Initiated development of fuel processing catalysts and processing methods, to enable transition from pellets to monolithic structures which are required for low cost, high volume manufacturing. Initiated development of low-concentration, fast response carbon-monoxide detector, for detecting CO concentrations as low as 10 ppm and as high as 200 ppm in the gas mixture entering the fuel cell stack. Participants included: Hydrogen Burner Technology, Epyx (Arthur D. Little), Plug Power/UOP, Catalytica, Corning, United Catalysts, McDermott, ANL, LANL, PNNL, TBD. (PNGV: $16,663) ($16,663)	demonstrate and test a highly compact (>1500W/l) prototype 50 kW microchannel steam reformer capable of reforming methanol, ethanol, natural gas and gasoline. Develop and test high activity, sulfur tolerant reforming and shift catalysts for fuel processor system. Initiate low-cost fabrication processes for applying catalysts to monolithic support structures. Participants include: Epyx, Hydrogen Burner Technology, Plug Power/UOP, Catalytica, Corning, United Catalysts, McDermott, ANL, LANL, PNNL. (PNGV: $21,149) ($21,149)	reduce a 200,000 ppm CO input to <2,000 ppm. Initiate development of hydrogen and oxygen enhancement technologies to improve system performance. Participants include: Nuvera, Plug Power, Catalytica, Corning, United Catalysts, McDermott, ANL, LANL, PNNL. (PNGV: $21,100) ($21,100)

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Fuel Cell R&D (Cont'd)	Provided critical technical and program management support services. (CSMI). (PNGV: $374) ($374)	Provide critical technical and program management support services. (Sentech). (PNGV: $400) ($400)	Provide critical technical and program management support services. (Sentech). (PNGV: $400) ($400)
Total, Fuel Cell R&D	**$36,585**	**$41,331**	**$41,925**
Advanced Combustion Engine R&D	**Hybrid Direct Injection Engine** Conducted research supporting the development of spark ignition direct injection (SIDI) engine technology . Research focused on technologies that will enable SIDI engines to meet future emission standards while achieving at least 35 percent thermal efficiency. Developed two improved exhaust gas sensors and transferred the sensors to industrial partners for evaluation. Developed improved carbon coatings for reduced wear in emission-critical components and coated sample injectors supplied by industry. Used optical engines and computer modeling tools to study mixture preparation and combustion dynamics in operating engines. In parallel, used simulation vessels and	**Hybrid Direct Injection Engine** Completing the development of sensors by four national labs participating in a cooperative research and development (CRADA) agreement with the auto industry. Continue testing of advanced catalyst formulations to measure their effectiveness in reducing NOx emissions from simulated SIDI exhaust. Continue development of improved nitrogen oxide and oxygen sensors for SIDI engines. Continue exploratory evaluation of the variable compression ratio (VCR) engine concept. A conventional engine is being modified to evaluate the VCR mechanism, measure engine efficiency improvements, and develop engine control algorithms.	**Hybrid Direct Injection Engine** Conduct engine research directed at developing technology that can enable the introduction of competitive spark ignition, direct injection (SIDI) gasoline engines. Research is focused on combustion and exhaust treatment technology that can help to accelerate the introduction of SIDI engines that meet Tier 2 emission standards, while offering high efficiency in either conventional or hybrid power vehicles. Research will include exhaust sensor development, combustion modeling, fuel injection system development, and SIDI engine testing. Laboratory tests will combine an SIDI engine with a hybrid drivetrain to characterize the synergies of the two technologies.

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Combustion Engine R&D (Cont'd)	conventional engines to perform a parametric study of emission-influencing variables. Collected particulate matter from a sample of cars and characterized particulate size, mass and distribution. Particulate samples were forwarded to partner laboratories for toxicity studies. Focused university research on computer modeling of fundamental combustion processes and quantifying the effects of controllable variables. Participants included: SNL, ORNL, ANL, LANL, LLNL, USCAR, suppliers, universities. (PNGV: $6,802). ($6,802)	Continue fundamental combustion research to improve understanding and control of in-cylinder variables. Support research at universities on key SIDI issues, including fuel-wall interactions, fuel spray development, and fluid modeling. Continue laboratory work on advanced concepts, including near frictionless coatings and nitrogen oxide reducing devices. Participants include: SNL, ORNL, ANL, LANL, LLNL, Delphi, universities. (PNGV: $5,869). ($5,869)	Explore the variable compression ratio (VCR) engine concept as an alternative method for improving gasoline engine efficiency. An optimized cylinder head for the variable compression ratio engine will be designed, built and tested. Optimize the VCR mechanism and combustion critical components to determine the best engine configuration and components for the second generation VCR engine. Conduct tests on the engine to characterize its fuel saving and emission reduction potential. Participants include: SNL, ORNL, ANL, LANL, LLNL, Delphi, universities. (PNGV: $5,410). ($5,410)
	Combustion and Emission Control R&D Conducted R&D which will enable passenger cars and light trucks to utilize fuel efficient compression-ignition, direct-injection (CIDI) engines while meeting projected Federal Tier 2 and State emissions requirements.	**Combustion and Emission Control R&D** Conduct R&D which will enable passenger cars and light trucks to utilize fuel efficient compression-ignition, direct-injection (CIDI) engines while meeting Federal Tier 2 and State emissions requirements.	**Combustion and Emission Control R&D** Conduct R&D which will enable passenger cars and light trucks to utilize fuel efficient compression-ignition, direct-injection (CIDI) engines while meeting Federal Tier 2 and State emissions requirements.

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Combustion Engine R&D (Cont'd)	Combustion: Enhanced the understanding of the diesel combustion process by using laser diagnostics and high-speed photography to visualize the formation of oxides of nitrogen (NOx) and particulate matter (PM) in optically accessible light- and heavy-duty diesel engines, and in an ultra-high-pressure combustion vessel. Used the experimental data in the development of computer models which simulate fuel injection spray, combustion, and emissions formation. Investigated efficiency and emissions characteristics of advanced combustion concepts such as Homogeneous Charge Compression Ignition and other methods to reduce in-cylinder emissions formation. The Office of Science collaborated on this research effort primarily by providing research facilities..	Combustion: Apply the understanding of the diesel combustion process to optimize fuel injection and combustion chamber design. Using laser diagnostics and high-speed photography, visualize the formation of oxides of nitrogen (NOx) and particulate matter (PM) in optically accessible light- and heavy-duty diesel engines, and in an ultra-high-pressure combustion vessel. Use the experimental data in the validation of computer models which simulate fuel injection spray, combustion, and emissions formation. Evaluate efficiency and emissions characteristics of advanced combustion concepts such as Homogeneous Charge Compression Ignition and other methods to reduce in-cylinder emissions formation. The Office of Science collaborates on this research effort, primarily by providing research facilities and data exchange.	Combustion: Utilize Advanced Photon Source (APS) to optimize industry fuel injection system operation and improve combustion chamber design. Using laser diagnostics and high speed imaging techniques, visualize the formation and oxidation of in-cylinder soot and evaluate different fuel injection strategies to minimize emission formation. Use experimental results to validate computational models to simulate the fuel injection spray, combustion process, and emissions formation. Develop late cycle injection and other strategies to generate reductants for lean NO_X catalysts and adsorbers. Develop control strategies to demonstrate feasibility of homogeneous charge compression ignition technologies to reduce engine out emissions.
	Emission Controls: Focused exhaust aftertreatment research on the reduction of NOx and particulates that remain in the exhaust stream after in-cylinder combustion.	Emission Controls: Develop exhaust emission control technologies to meet EPA Tier 2 NOx and particulate emissions standards for light-duty vehicles, through 35	Emission Controls: Demonstrate emission control systems that meet interim targets of 0.2g/mi NO_X and 0.02 g/mi PM for PNGV and light truck applications. Complete down-

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Combustion Engine R&D (Cont'd)	Explored several technologies, including lean NOx catalyst, non-thermal plasma, particulate filter, and NOx and particulate traps. Initiated development of advanced exhaust gas recirculating (EGR) components for improved cylinder-to-cylinder distribution and control under transient operating conditions. Completed component-level testing required to achieve intermediate emissions targets for PNGV passenger vehicle application. Initiated collaborative exploratory R&D effort with emission control manufacturers to develop more advanced catalysts and components. Developed emission control components which can meet the higher horsepower and more demanding duty cycle required for light truck applications.	percent cost shared cooperative agreements. Evaluate feasibility of selective catalytic reduction (SCR) technologies for PNGV-sized engines. [Conduct full-scale device testing of non-thermal plasma and lean NOx catalysts.] Perform testing of advanced exhaust gas recirculating (EGR) components for improved cylinder-to-cylinder distribution and control under transient operation conditions. Begin integration and initial testing of advanced emission control devices with engines to measure NOx and particulate reduction conversion efficiencies under real operating conditions. Conduct system level testing and begin engineering simulation and model validation of selected emission control components for PNGV passenger vehicle and light truck applications. Conduct collaborative exploratory R&D projects with emission control manufacturers to develop more advanced catalysts and components. Test emission control components which can meet the higher horsepower and more demanding	select of emission control system technologies to meet Tier 2 standards of 0.07g/mi NO_X and 0.01g/mi PM for light-duty vehicles. Develop urea-based Selective Catalytic Reduction (SCR) catalysts and NO_X adsorbers that give improved activity at the relatively low light duty diesel exhaust temperatures. Test durability of these catalysts. Complete development and evaluate performance of prototype NO_X catalysts utilizing hydrocarbon reductants. Develop sulfur tolerant catalysts and sulfur traps. Conduct full-scale device testing to determine feasibility of non-thermal plasma. Using a systems approach, work with engine manufacturers to determine how engine parameters, such as EGR level, can be adjusted to meet NO_X and particulate goals with a plasma/catalyst aftertreatment device. Develop continuously regenerated PM traps using both catalyst and microwave energy sources. Conduct system level testing and begin engineering simulation and

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Combustion Engine R&D (Cont'd)		duty cycle required for light truck applications.	model validation of emission control systems for PNGV passenger vehicle and light truck applications to evaluate fuel economy, emissions, and cost trade-offs.
	Engine/Emission Control Integration: Demonstrated low cost CIDI fuel injection system with improvements in rate control, opening and closing events, and reduced leakage at higher pressures. Continued projects in partnership with DOE laboratories, universities, and industry. Participants included: SNL, LANL, LLNL, ORNL, PNNL, ANL, Ford, GM, Daimler-Chrysler, Delphi, Caterpillar, Detroit Diesel/Johnson Matthey, Cummins/Engelhard, catalyst manufacturers, Tier 1 suppliers, and universities, TBD/RFP. (PNGV: $14,447) ($17,502)	Engine/Emission Control Integration: Optimize control system for combustion and emission control efficiency utilizing sensors (NOx/PM) and feedback loops. Continue projects in partnership with DOE laboratories, universities, and industry. Participants include: SNL, LANL, ORNL, PNNL, ANL, Ford, GM, Daimler-Chrysler, Delphi, Detroit Diesel/Johnson Matthey, Cummins/Engelhard, Diesel and catalyst manufacturers, Tier 1 suppliers, and universities. TBD/RFP. (PNGV: $16,692) ($20,360)	Engine/Emission Control Integration: Optimize control systems for combustion and emission control efficiency, utilizing PM, NO_X and wide range O_2 sensors in feedback loops. Continue ongoing projects in partnership with DOE laboratories, universities, and diesel engine and catalyst manufacturers. Participants include: SNL, LANL, ORNL, PNNL, LBNL, LLNL, ANL, Ford, GM, Daimler-Chrysler, Detroit Diesel, Cummins, Engelhard, ExxonMobil, Diesel Engine and catalyst manufacturers, Tier 1 suppliers, and universities. (PNGV: $18,075) ($21,751)

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Combustion Engine R&D (Cont'd)	**Light Truck Engine** Optimized a laboratory test engine for emissions, performance, cost, and noise; integrated the optimized system (200-250 horsepower) into a light truck (pickup, van, or sport utility vehicle). Selected exhaust aftertreatment, fuel injection, air handling, and exhaust energy recovery systems that will enable the high efficiency diesel engine to meet market and regulatory demands. Two of the three teams have demonstrated success in meeting the efficiency goal. Continued focus of third team, which is also expected to meet the efficiency goal, to develop emissions and advanced combustion technologies that will set new low levels for oxides of nitrogen (NO_X) and particulate emissions. Automotive and truck combustion and aftertreatment activities and funding were combined, and described in, the Combustion and Emission Control R&D program. Participants included: SNL, LANL, LLNL, ORNL, PNNL, ANL,	**Light Truck Engine** Interactively test, evaluate, and redesign production prototype diesel engine (200-275 hp), integrated with vehicle chassis, for the light truck (pickup, van, or sport utility vehicle). Optimize the exhaust aftertreatment, fuel injection system, boost air, exhaust gas recirculating (EGR) and associated cooling with microprocessor control to comply with emissions standards. Evaluate exhaust energy recovery systems to further improve the efficiency with respect to commercial viability. Reduced emissions by an order of magnitude since program inception. The current goal is to demonstrate feasibility of meeting EPA Tier 2 standards by 2003. Two of the three teams are on schedule and have exceeded the efficiency goal. The 3rd team is developing more advanced technology which promises even greater efficiency. Participants include: Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp., and Tier 1 suppliers. ($17,783)	**Light Truck Engine** Optimize production-ready prototype clean diesel engines for light trucks (pickups, vans, and sport utility vehicles). Incorporate emission reduction technology to achieve compliance with EPA emission standards. Initiate reliability testing of engine and emissions reduction technology. Continue development of promising NOx reducing homogeneous charge compression ignition (HCCI) combustion and fuel injection systems. Develop non-thermal plasma for 80 hp diesel engine. Scale-up non-thermal plasma devices for both light and heavy trucks, utilizing solid state power systems compatible with vehicle installation. Design, fabricate, and test the first quantum well thermoelectric device to convert waste exhaust energy directly to electricity, which will increase the fuel economy by up to 7 percent.

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Combustion Engine R&D (Cont'd)	Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp., NOxTech. ($17,357)		Participants include: Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp., Hi-Z, NoxTech). ($16,768)
	Heavy Truck Engine Awarded three cost shared competitive contracts to develop engine technologies for heavy duty trucks, with emissions reduced to EPA 2002 standards while maintaining or improving their high thermal efficiency. The DOJ/EPA Consent Decree with the diesel manufacturers accelerated the enactment of the EPA Heavy-Duty emissions regulations from 2004 to 2002. Efficiency will be sacrificed unless new emission control strategies are developed to meet these regulations. Utilizing emission reduction technologies developed in the Combustion and Emission Control R&D program, evaluated in-cylinder and aftertreatment systems for controlling emissions from Class 7 and 8 trucks. Participants included: Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp. ($4,777)	**Heavy Truck Engine** Once emission standards are demonstrated while maintaining or improving efficiency, shift focus to developing technologies that will improve engine thermal efficiency to 55 percent from the current 45 percent, while reducing emissions to near-zero levels. Conduct 50 percent cost-shared R&D with industry to develop and test laboratory diesel engines which will reduce emissions while maintaining or improving the thermal efficiency. Investigate technologies to reduce friction with improved lubricants containing no sulfur or phosphates which poison emission control catalysts; optimize fuel injection, emissions control, and waste heat recovery systems. Evaluate technologies developed in the Combustion and Emission Control R&D and Light Truck Engine R&D programs to determine	**Heavy Truck Engine** Develop and test laboratory diesel engines, through a competitively awarded 50 percent cost-shared R&D with industry, that will meet EPA emissions standards while improving the thermal efficiency to 50 percent from the current 45 percent. Investigate technologies to optimize fuel injection, emissions control, and waste heat recovery systems, and reduce friction and pumping losses. Evaluate technologies developed in the Combustion and Emission Control R&D and Light Truck Engine R&D programs to determine their applicability to the higher pressures and temperatures experienced in heavy duty engines. Develop a Multi-Year Program Plan for the Heavy Duty Diesel Engine Emissions Control Technology Program to address the

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Combustion Engine R&D (Cont'd)		their applicability to heavy duty engines. Explore engine and emission control strategies (e.g., fuel/air injection timing) that have the potential to increase thermal efficiency to 55 percent and approach near-zero emission levels. Participants include: Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp., suppliers, National Labs. ($5,914)	recommendations from the National Research Council (NRC) peer review of the Office of Heavy Vehicle Technologies (OHVT) Program. Participants include: Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp., suppliers, National Labs. ($5,896)
	Engine Boosting Technology	**Engine Boosting Technology**	**Engine Boosting Technology**
	No Activities ($0)	Initiate cooperative agreements to develop electrically driven turbocharger to increase response and reduce particulate emissions. Develop electric turbocompounding combined with starter motor-alternator and damper technology, to eliminate turbo-lag and improve thermal efficiency by up to 10 percent. Participants include: Honeywell, Caterpillar, suppliers. ($1,000)	Continue work under cooperative agreements to develop electric turbocompounding to combined starter motor-alternator and damper technology to eliminate turbo-lag, reduce particulate emissions and improve thermal efficiency by up to 10 percent. Participants include: Honeywell, Caterpillar, suppliers. ($500)

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Combustion Engine R&D (Cont'd)		TRANSFERRED FROM: Fuels Utilization R&D/Alternative Fuels **Health Impacts** Extend health impacts investigations to interspecies comparisons of the toxicity of emissions from gasoline and diesel samples. Perform short-term health impacts testing on samples representing newly-developed candidate fuel, engine, and exhaust aftertreatment technologies. Include in the health impacts studies selected inhalation experiments to help determine short and intermediate-term health risks from engine emissions. Participants include: Lovelace Respiratory Research Institute, NIOSH. ($1,497)	**Health Impacts** Continue comparison of toxicity of diesel and gasoline emissions by sub-chronic inhalation exposures. Complete exposures to diesel emissions and begin exposures to gasoline emissions. Perform short-term biological assays of new technology diesel emissions, including organic and solid nanoparticles without emissions passing through trap and catalyst aftertreatments. Participants include: Lovelace Respiratory Research Institute, NIOSH. ($1,500)
	Off-Highway Engine R&D No Activities. ($0)	**Off-Highway Engine R&D** No Activities. ($0)	**Off-Highway Engine R&D** Off-highway (agriculture, construction, locomotive, mining and in-land marine) engines operate at higher temperatures due to limited air flow and harsher

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Combustion Engine R&D (Cont'd)			operating conditions (higher load, severe vibration and mechanical shock) than on-highway diesel engines. These engines consume approximately 10 percent of the total diesel fuel while emitting more than 30 percent of the total NOx and particulate matter. Award cost shared competitive cooperative agreements to develop technologies that will improve the efficiency of diesel engines used in these unique applications and reduce their emissions to meet more stringent EPA regulations. Evaluate technologies developed in the Heavy Truck Engine program and determine their applicability to off-highway engines. (TBD-Competitive solicitation) ($500)
	Provide critical technical and program management and support services (Antares, CSMI). (PNGV: $60) ($312)	Provide critical technical and program management and support services (Antares, CSMI). (PNGV: $400) ($636)	Provide critical technical and program management and support services (Sentech, Antares). (PNGV: $400) ($661)

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Total, Advanced Combustion Engine R&D	**$46,750**	**$53,059**	**$52,986**
Cooperative Automotive Research for Advanced Technologies (CARAT)	**CARAT** Supported innovative Phase 1 and 2 projects by small businesses and universities, to accelerate potential technology breakthroughs needed to make advanced automobiles commercially viable. Awarded seven competitive, Phase 2 engineering prototype development contracts. Phase 2 includes complete hardware development, test and evaluation of components, and a preliminary economic analysis to determine high volume, low-cost fabrication targets. Awarded five additional Phase 1 projects on new topics. Participants included: ANL, Penn State Univ., Univ. of Michigan, Univ. of Miami, Illinois Institute of Technology, NexTech Materials, BST Systems, Superior Graphite, Virginia Power Technologies, Energy Conversion Devices, Makel Engineering, Univ. of Michigan-Dearborn, North Carolina State Univ. (PNGV: $777) ($777)	**CARAT** Continue development efforts of the seven Phase 2 contracts which were competitively selected from the original 26 Phase 1 projects. Complete the Phase 1 projects that were initiated in FY 2000 and hold a CARAT Forum to facilitate partnering of CARAT researchers with companies having the financial and technical resources to bring the technologies to market. Initiate solicitation of new Phase 1 projects for FY 2002. Participants include: ANL, Penn State Univ., Univ. of Michigan, Univ. of Miami, Illinois Institute of Technology, NexTech Materials, BST Systems, Superior Graphite, Virginia Power Technologies, Energy Conversion Devices, Makel Engineering, Univ. of Michigan-Dearborn, North Carolina State University, small businesses, universities. (PNGV: $1,000) ($1,000)	**CARAT** Initiate six new CARAT Phase 1 projects to tap the innovation and expertise that small businesses and universities offer for developing advanced automotive technologies. Participants include: ANL, small businesses and universities. (PNGV: $1000) ($1000)

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Cooperative Automotive Research for Advanced Technologies (CARAT) (Cont'd)	**GATE** Complete curriculum development and provide first academic year fellowship funding. Participants included: ANL, universities. (PNGV: $777) ($777)	**GATE** Continue curriculum development and provide second academic year fellowship funding. Conduct GATE Forum with industry and universities to encourage industry-university collaborations. Participants include: ANL, universities. (PNGV: $500) ($500)	**GATE** Provide third academic year fellowship funding. Conduct an evaluation of GATE to determine costs and benefits. Participants include: ANL, universities. (PNGV: $500) ($500)
Total, Cooperative Automotive Research for Advanced Technologies	**$1,554**	**$1,500**	**$1,500**
Electric Vehicles R&D	**Advanced Battery Development** Completed support for R&D on long-term advanced batteries for electric vehicles under Phase 2 of the Department of Energy's Cooperative Agreement with the USABC, with an average industry cost share of 55 percent. Initiated support for R&D on long-term, lithium-based advanced batteries for electric vehicles under Phase 3 of the USABC program, with an average industry cost share of 65 percent in FY 2000.	**Advanced Battery Development** Support R&D on long-term advanced batteries for electric vehicles with USABC under Phase 3 cooperative agreement, with an average industry cost share of 65 percent in FY 2001.	**Advanced Battery Development** Start an orderly phase out of DOE's commitment to the United States Advanced Battery Consortium (USABC) Phase III Cooperative Agreement with an industry average cost-share of 65 percent. No activities concerning the Advanced Battery Readiness Working Group. After FY2002, industry will develop electric vehicle advanced batteries without further Federal government support. (USABC) ($1,079)

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Electric Vehicles R&D (Cont'd)	Mid-term Battery R&D: No additional nickel metal hydride development program planned. Completed performance and life testing and evaluation of lithium-based battery modules and mini-packs. Worked with the Society of Automotive Engineers, as well as European and Japanese entities, in codifying recommended practices for testing and evaluation of advanced batteries.	Mid-term Battery R&D: No Activities.	Mid-term Battery R&D: No Activities.
	Assessed recycling issues, abuse tolerance, and shipping requirements for lithium-based advanced EV battery technology, through the Advanced Battery Readiness Working Groups. Coordinated these activities with the Department of Transportation's, National Highway Traffic Safety Administration, and the Environmental Protection Agency.	Environmental, health, and safety: Continue assessment of recycling issues and abuse tolerance requirements for lithium-based battery technology for electric and hybrid vehicles through the Advanced Battery Readiness Working Groups. Coordinate these activities with the National Highway Traffic Safety Administration and the Environmental Protection Agency.	
	Long-term Battery R&D: Completed extended testing of USABC long-term, lithium-polymer batteries to determine life	Long-term Battery R&D: Investigate alternative materials and fabrication processes for advanced lithium battery technology,	Long-term Battery R&D: No Activities.

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Electric Vehicles R&D (Cont'd)	and safety under accident conditions. Initiated development of ambient-temperature, lithium-based, long-term battery technologies. Focused technology development on enhanced manufacturing processes which control fabrication variables to improve battery performance, life, and abuse tolerance, and to reduce costs. Participants include: ANL, INEEL, LBNL, NREL, SNL, USABC, 3M/Hydro-Quebec. ($5,511)	incorporating knowledge from other Federally funded research and development battery programs. Focus technology development on enhanced manufacturing processes which control fabrication variables to improve battery performance, life, and abuse tolerance, and to reduce battery costs. Continue development of ambient temperature, lithium-based advanced battery technologies. Validate successive generations (sixth and seventh) of lithium polymer battery modules and packs in laboratory and automotive industry prototype vehicles. This includes extended testing of prototype cells and modules of lithium-based batteries to determine life and assure benign response to abusive test conditions. Continue international cooperation on advanced batteries through the International Energy Agency. Cooperate with Japanese Lithium Ion Battery Energy Storage program. Participants include: ANL, INEEL, LBNL, NREL, SNL, USABC, 3M/Hydro-Quebec. ($5,683)	

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Electric Vehicles R&D (Cont'd)	**Exploratory Technology Research** Refocused research and development efforts to emphasize application-oriented measurement and diagnostic techniques. More closely link activities and interests of industrial developers with program activities, to achieve more rapid progression of technology into competitive products for the marketplace. Developed and characterized new anode materials with high capacities, and cathodes with thermal stability at temperatures greater than 125°C. Developed improved non-flammable lithium-ion electrolytes for abuse tolerant EV batteries. Focused on developing diagnostic methods to identify the fundamental causes of the lithium battery's decrease in performance as a function of cycle life, calendar life, and thermal cycling. Refined existing models and data bases to support development of improved lithium rechargeable batteries by the EV battery developers. Investigated new battery electrochemistries capable of major improvements in	**Exploratory Technology Research** Focused research and development efforts continue to address the key barriers impeding the successful development of lithium ion and lithium polymer battery technologies. Focus on understanding and improving the performance of advanced solid polymer electrolytes by studies of the transport properties and interactions at the electrode and polymer interfaces. Develop and characterize novel anode and cathode materials that have higher capacity and are lower in cost and inherently safer. Develop non-flammable or fire retardant electrolytes that are abuse tolerant for lithium ion batteries. Continue research and development of advanced diagnostic methods to investigate life limiting and performance limiting processes in lithium batteries. Refine improved electrochemical models to understand the failure mechanisms and the mechanisms for thermal runaway of lithium-ion and lithium polymer systems. Continue to	**Exploratory Technology Research** Reduce focused research and development efforts addressing the key barriers impeding the successful development of lithium-ion and lithium polymer battery technologies. Develop and characterize novel anode, electrolytes and cathode materials that have higher capacity and are lower in cost. Continue research and development of advanced diagnostic methods to investigate life limiting and performance limiting processes in lithium batteries. Refine improved electrochemical models to understand the failure mechanisms and the mechanisms for thermal runaway of lithium-ion and lithium polymer systems. Conduct evaluations of specific integrated electrochemical systems at the cell level to demonstrate that these innovative technologies address advanced automotive program goals for performance, life, abuse tolerance, and cost. ($2,375)

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Electric Vehicles R&D (Cont'd)	performance, life, cost, and abuse tolerance. Participants included: ANL, LANL, LBNL. ($2,997)	investigate novel electrode couples for the next generation of batteries which could meet or exceed the USABC long term requirements. Participants include: ANL, LANL, LBNL. ($3,155)	Participants include: ANL, BNL, LANL, LBNL, SNL.
	Provide critical technical and program management support services. (CSMI). ($224)	Provide critical technical and program management support services. (CSMI). ($125)	Provide critical technical and program management support services (Sentech). ($65)
Total, Electric Vehicles R&D	**$8,732**	**$8,963**	**$3,519**
Heavy Vehicle Systems R&D	**Vehicle Systems Optimization** Implemented a program based on prior year planning that will reduce aerodynamic drag of heavy trucks, to reduce fuel use by about 18 percent. Determined acceptable redesign of trailers with computational fluid dynamics and advanced modeling and simulation. Confirmed and validated designs with wind tunnel tests. Planned over-the-road vehicle demonstrations with the trucking industry. Analyzed new concepts such as air circulation control for aero drag reduction. Conducted planning for safety concerns arising	**Vehicle Systems Optimization** Continue reduction of parasitic energy losses which account for almost 50 percent of the total energy consumption in heavy trucks. Aerodynamic drag causes more than 52 percent of non-engine losses; 28 percent is from rolling resistance (tire, transmissions, gears), and the remainder is from auxiliary systems and accessories. Conduct a series of targeted technical workshops with industry, government, and academia to identify broad areas of R&D needs, and formulate multi-year program	**Vehicle Systems Optimization** Distribute OHVT peer group- and industry-reviewed Multi-Year Program Plan (MYPP) for each of the heavy vehicle parasitic energy loss categories: Aerodynamic Drag, Friction and Wear, Rolling Resistance, and Underhood Thermal Management. Identify key R&D needs, prioritized potential project areas, and current and outyear funding requirements. Programmatic activities will reflect the stringent demands of the 21st Century Truck Program. Compare longer-term Computational Fluid

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Heavy Vehicle Systems R&D (Cont'd)	from improvements in vehicle aerodynamics, e.g., the need for additional braking capacity and improved tire design. Investigated regenerative shock absorbers, to determine if a significant amount of electrical energy can be generated on trucks and passenger vehicles, and if the energy can be harnessed cost-effectively. Completed proof-of-principle studies for these applications. With industry, State, and trade associations, addressed the reduction of unnecessary idling of heavy truck engines to achieve fuel savings of 1 percent in surface transport, a cost savings of $2 billion a year, and reduction of exhaust gases by up to 1 percent. Completed assessment of the impact of decomposed lubricant on the environment and issue final report. Conducted planning for safety concerns arising from improvements in vehicle aerodynamics, e.g., the need for additional braking capacity and improved tire design. Issued competitive solicitation for reduction of parasitic energy losses	plans. Initiate specific projects to significantly reduce parasitic energy losses in heavy vehicles and measurably contribute to increased energy efficiency, safety, and cost effectiveness. The technical areas addressed are Aerodynamic Drag, Friction, Wear and Lubrication, Thermal Management, and Running Resistance and Brakes. Continue the industry-acceptable redesign of trailers with Computational Fluid Dynamics (CFD) and advanced modeling and simulation. Obtain confirmation and validation in wind tunnel tests to guide construction of over-the-road vehicle demonstrations with the trucking industry. Utilize Circulation Control for aero drag reduction in conjunction with the CFD-generated projections to attain vehicle stability control and braking assist. Continue development and testing of the plasmatron on-board reformer	Dynamics (CFD) approach, advanced modeling and simulations of aerodynamic drag of heavy vehicles as integrated systems to results from tests in 8-foot wind tunnel. Validate, refine formulations with results to be obtained from full size trucks in NASA Ames large wind tunnel. Begin aerodynamic redesign of over-the-road tractor-trailer combinations that meet operational, freight-loading, maintenance needs of the truck industry, dimensional and safety requirements of DOT, OHVT mission of enhanced efficiency and reduced exhaust emissions. Perform wind tunnel tests of 1/8th scale model truck to validate, refine mathematical models developed using Circulation Control theory for aerodynamic drag reduction, achieving greater vehicle stability and braking assist. Design and modify trailers for field-service road testing with industry partners. Determine energy efficiency, operational stability,

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Heavy Vehicle Systems R&D (Cont'd)	in heavy trucks. ($2,907) Participants included: ANL, ORNL, MIT, LLNL, NASA, SNL.	for Spark ignition (SI) and diesel applications. Both diesel and SI engine tests will be performed to validate the large efficiency increases and substantial reductions of both greenhouse gases and particulates. Utilizing industry guidance, evaluate concepts of on-board thermal management systems for Class 7 and 8 heavy vehicles to improve fuel economy, reduce emissions, and enhance engine performance. Determine relative efficiency of new, down-sized coolant system designs, relocation of coolant systems, and the effects of air management and control on heavy-duty coolant systems. Utilize results of the Friction, Wear, and Lubrication Industry/Government Work Shop to attain higher energy efficiency and reduction of emissions, as well as the development of exhaust gas resistant/tolerant coatings for engine components. Select and evaluate candidate braking materials and systems to	sensoring requirements, maintenance issues for redesigned trailers. Complete study of near-term application of "off-the-shelf" technology to achieve 12 mile per gallon heavy truck (current industry average: 6 mpg). With industry cost-share, design, build, test this advanced vehicle. Initiate teaming and R&D efforts. Cooperate with industry, trade associations to reduce unnecessary idling of heavy truck engines to achieve fuel savings of up to 1 percent, cost savings of $2 billion per year and reduction of exhaust gases by up to 1 percent. Continue R&D in heavy vehicle electrification, axle improvements, and improved braking materials in second phase based on competitive awards for greater energy efficiency. Explore feasibility of reducing parasitic energy losses by using on-board Essential Power Unit to provide power-on-demand to electric water, fuel, and oil pumps

Program Activity	FY 2000	FY 2001	FY 2002
Heavy Vehicle Systems R&D (Cont'd)		improve by 50 percent or more the braking performance of conventional heavy-duty vehicles. Evaluate new braking systems to enable utilization of anticipated aerodynamic drag reductions. Continue cooperation with industry and trade associations to reduce unnecessary idling of heavy truck engines to achieve fuel savings of up to 1 percent of the fuel used in U.S. surface transport, cost savings of $2 billion per year and reduction of exhaust gases by up to 1 percent. ($4,230) Participants include: ANL, PNL, ORNL, LLNL, SNL, MIT, CalTech, NASA, USC, PSU, Tufts University, GTRI, Norfolk and Southern Railroad, Burlington Northern-Santa Fe Railroad, CSX, Tranergy, Delphi, Texaco.	of heavy duty truck engines. ($5,369) Participants include: ANL, PNNL, ORNL, MIT, Cal Tech, NASA, USC, PSU, Tufts University, GTRI, Caterpillar Corp., Navistar, LLNL, Sandia, Castrol, and competitive solicitations.
	Truck Safety Systems No Activities. ($0)	**Truck Safety Systems** With the U.S. Department of Transportation, Division of Motor Carriers leading the effort, conduct	**Truck Safety Systems** Support activities in key safety areas for heavy vehicles. Conduct planning activities with trucking

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Heavy Vehicle Systems R&D (Cont'd)		collaborative planning to identify the origins of time- and/or design-dependent deterioration in heavy truck operational safety. Implement planned program to investigate, with truck brake industry partners, mechanisms of heat transfer to develop improved braking materials. Capitalize on the state-of-the-art Aberation Corrected Electron Microscope (ACEM) at the High Temperature Materials Laboratory to characterize candidate improved brake materials. Implement planning to develop Non-Destructive Testing (NDT) methods to predict, through computer simulation and modeling, and detect deterioration such as crack propagation in gas pressure vessels such as those used for Compressed Natural Gas (CNG) and cryogenic liquids such as Liquified Natural Gas (LNG). Currently there is no simple method for interrogating pressure vessels which have been in use for some time. ($500)	industry/government agencies to identify specific R&D needs for future brake requirements including materials, cost-effectiveness, and brake system lightweighting. Conduct risk assessment of high pressure gaseous fuel storage tanks. ($400)

III. Performance Summary: VEHICLE TECHNOLOGIES R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Heavy Vehicle Systems R&D (Cont'd)	**Stimulate Truck Innovative Concepts and Knowledge (STICK)**	**Stimulate Truck Innovative Concepts and Knowledge (STICK)**	**Stimulate Truck Innovative Concepts and Knowledge (STICK)**
	No activities. ($0)	No activities. ($0)	Establish program to stimulate truck innovative concepts and knowledge to consolidate small business / university projects to accelerate progress on innovative technologies and inventions specific and primarily applicable to heavy-duty vehicles. ($100)
	Provide critical technical and program management support services. (Antares). ($8)	Provide critical technical and program management support services. (Antares). ($244)	Provide critical technical and program management support services. (Antares). ($111)
Total, Heavy Vehicle Systems R&D	**$2,915**	**$4,974**	**$5,980**
TOTAL, VEHICLE TECHNO-LOGIES R&D	**$138,365**	**$159,610**	**$154,116**

TRANSPORTATION TECHNOLOGIES
TRANSPORTATION SECTOR
(Dollars in Thousands)

FUELS UTILIZATION R&D

I. Mission Supporting Goals and Objectives:

Mission

The Fuels Utilization R&D Program, along with partners in the energy and transportation industries, pursues R&D that will provide transportation vehicles with fuel options that are cost competitive, achieve high fuel economy, and deliver low emissions.

Goals and Benefits

The Fuels Utilization R&D Program identifies and develops new fuel options that will enable conventional and advanced propulsion vehicles to meet increasingly challenging performance, fuel-efficiency, and emissions targets. The EPA Tier 2 emissions standards for light-duty vehicles, the Consent Decree to be implemented in 2002, and the EPA heavy-duty engine emission standards affecting heavy-duty trucks require advanced fuel formulations to enable these systems to meet emission levels while maintaining fuel efficiency.

Goals and Performance Measures:

- By 2004, complete development of a new fuel formulation for advanced CIDI engines that can use the existing fueling infrastructure, and results in high fuel use efficiency and very low emissions in light duty vehicles.
- By 2004, complete analysis and identification of most promising petroleum-based fuel constituents for fuel cell vehicle power systems from a performance and durability standpoint.
- By 2007, complete development of cost-effective systems for Class 3-8 truck platforms that will make natural gas a preferred vehicle fuel option.

Benefits:
The Fuels Utilization Program supports a number of OTT activities through:

(1) The formulation of fuels that enable the PNGV and the 21st Century Truck programs to meet their fuel economy goals, concurrently with stringent Tier 2 and 2007 heavy duty emission standards.
(2) Supporting non-petroleum based fuel options, such as natural gas, for Class 3-8 trucks, thereby increasing the Nation's energy security.

Fuels Utilization R&D Accomplishments

FY 2000 Accomplishments:
- Complete initial testing of diesel fuel sulfur effects on emission control devices.
- Initiate development of Class 3-6 CNG and Class 7/8 LNG vehicles fully-competitive in life cycle cost and performance with conventionally-fueled counterparts.

FY 2001 Ongoing Accomplishments:
- Complete determination of fuel impacts on criteria emissions, toxics, and particulate matter (PM) for initial list of fuel formulations.
- Complete development of low-cost NG fueling station and low-cost gas clean-up technology.

FY 2002 Planned Accomplishments:
- Complete development of desulfurization and regeneration strategies of NO_x absorbers and diesel particulate filters for light duty and heavy duty applications.
- Complete development of small scale gas liquefaction.

II. A. Funding Table: FUELS UTILIZATION R&D

Program Activity	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
Advanced Petroleum Based Fuels	$ 9,283	$ 10,948	$ 11,549	$ 601	5.5%
Alternative Fuels	$ 11,913	$ 12,561	$ 11,980	$ -581	-4.6%
Total, Fuels Utilization R&D	$ 21,196	$ 23,509	$ 23,529	$ 20	0.1%

II. B. Laboratory and Facility Funding Table: FUELS UTILIZATION R&D

	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
Argonne National Lab (East)	$ 1,474	$ 988	$ 1,000	$ 12	1.2%
Brookhaven National Lab	$ 600	$ 1,050	$ 600	$ -450	-42.9%
Idaho National Engineering & Environmental Lab	$ 500	$ 675	$ 500	$ -175	-25.9%
Lawrence Livermore National Lab	$ 750	$ 865	$ 750	$ -115	-13.3%
Los Alamos National Lab	$ 565	$ 70	$ 400	$ 330	471.4%
National Renewable Energy Lab	$ 5,221	$ 7,387	$ 6,500	$ -887	-12.0%
Oak Ridge National Lab	$ 3,313	$ 3,217	$ 3,200	$ -17	-0.5%
Sandia National Laboratories	$ 720	$ 900	$ 900	$ 0	0.0%
All Other	$ 8,053	$ 8,357	$ 9,679	$ 1,322	15.8%
Total, Fuels Utilization R&D	$ 21,196	$ 23,509	$ 23,529	$ 20	0.1%

III. Performance Summary: FUELS UTILIZATION R&D

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Petroleum Based Fuels	**Automobile/Light Truck and Heavy Truck** Optimized fuel blends to enable PNGV and truck engines to meet projected emission standards concurrently with fuel economy targets. Tested fuel blends in the best available engines to assess their performance, economics, and emission impacts; utilized the data from this effort to assess the air quality impacts of these fuels with regard to particulates and potential for ozone formation. Continued fundamental combustion research on alternative fuel/conventional diesel fuel/gasoline blends, including studies to determine why oxygenates reduce particulate emissions and what effect they have on toxicity. Initiated an assessment of the impacts of fuel changes on fuel production and distribution infrastructure, and on the environment. Determined tolerance levels of the contaminants in advanced petroleum-based fuels identified in FY 1999. Investigated methods to mitigate effects of these contaminants on fuel cell processor catalysts and fuel cells. Began	**Automobile/ Light Truck and Heavy Truck** Conduct systematic development, test, and evaluation of advanced petroleum based fuels and blending additives including biomass, natural gas derived fuels, and oxygenates that enhance the performance and emissions characteristics of diesel engines for application in PNGV, light trucks, and heavy trucks. Iteratively test and develop new lube oils for use in diesel engines that operate on advanced petroleum based fuels and which do not pose any deleterious effects on emissions. Continue to investigate potential compatibility issues with new fuels and engine components and seals. Increase cost sharing through increased coordination with energy, auto, heavy vehicle and emission control industries. Evaluate the overall ability of new fuels and blend options to utilize existing maintenance practices, liquid storage tanks, and refueling infrastructure. Conduct fundamental combustion studies of advanced	**Automobile/ Light Truck and Heavy Truck** Fleet test advanced petroleum based fuels and blending additives. Evaluate new fuel formulations in the context of a complete engine emission control and fuel system which is optimized for emissions and fuel economy. Evaluate new fuels and blend options for safety during refueling and on-board storage. Develop and utilize models to identify the optimum concentration and type of blending component for diesel fuel to minimize emissions. Continue combustion studies of reformulated diesel fuels to help optimize the emissions reduction benefit of the fuel. Evaluate impurities and additives and major fuel properties and formulations on fuel cell systems. Continue iterative testing and development of lube oils for use in diesel engines that operate on advanced petroleum based fuels that do not pose any deleterious

III. Performance Summary: FUELS UTILIZATION R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Petroleum Based Fuels (Cont'd)	testing of fuels in fuel processors to optimize use of the constituents. ($5,039) Participants included: NREL, ORNL, ANL, SWRI, SNL, LLNL, LANL. (PNGV: $5,039) Heavy Trucks: Tested and evaluated advanced lube oils for their effects on particulate formation for both heavy and light duty applications. Continued to conduct experimental combustion research using an optically accessible engine to determine the effects of Fischer-Tropsch diesel, oxygenate additives and fuel blends on NOx and particulate formation in-cylinder. Performed detailed chemical and physical analyses of fuel blends to determine their potential toxicity, and their compatibility with materials used in existing engine components and seals. Initiated testing of advanced petroleum based fuels in diesel engines equipped with near term after treatment systems, to assess the full emissions reduction benefits that these fuels	petroleum based fuels and blends using computer simulation to understand why the fuels and blends improve emissions, and their advantages for engine design. Continue to develop models to determine the optimum concentration and type of blending component for diesel fuel to minimize emissions. Study injection spray characteristics of advanced petroleum based fuels to assess the options for combustion chamber reconfiguration to take advantage of their enhanced properties. Test and evaluate fuel cell systems running on advanced fuels, to determine fuel and fuel contaminant effects on fuel cell systems and components. Continue to evaluate impurities and additives, including oxygenates, on fuel cell components. Determine life cycle emissions, production costs, and infrastructure requirements of fuels for fuel cells. Participants include: NREL, ORNL, SNL, ANL, LLNL, LANL, Southwest Research Institute. (PNGV: $5,444) ($10,298)	emissions effects. ($10,849) Participants include: NREL, ORNL, SNL ANL, LLNL, LANL, Southwest Research Institute. (PNGV: $5,455)

III. Performance Summary: FUELS UTILIZATION R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Petroleum Based Fuels (Cont'd)	enable. Participants included: NREL, ORNL, SNL, ANL. ($3,750) Provide critical technical and program management support services. (CSMI, Antares). (PNGV: $372) (494)	Provide critical technical and program management support services. (PNGV: $525) ($650)	Provide critical technical and program management support services. (PNGV: $525) ($700)
Total, Advanced Petroleum Based Fuels	**$9,283**	**$10,948**	**$11,549**
Alternative Fuels	**Alternative Fuels/ Automobile/ Light Truck** Evaluated natural gas derived fuels, such as DME, in PNGV and light truck direct injection (DI) engines, to determine their ability to meet emission standards and fuel economy targets. Continued C-1 research program to develop technology for the conversion of methanol into transportation fuels and chemicals. ($1,382) Participants included: NREL, ORNL, ANL. (PNGV: $1,382)	**Alternative Fuels/ Automobile/ Light Truck** Perform analyses and research on methanol, ethanol, and natural gas-derived liquid fuels for fuel cell vehicles. In partnership with states and industry, analyses will be conducted to evaluate fuel supply, distribution, and refueling issues surrounding development of alternative fuel infrastructure for fuel cell vehicles. Research will be implemented to overcome barriers associated with infrastructure materials compatibility, fuel processor performance, and	**Alternative Fuels/ Automobile/ Light Truck** In cooperation with the DOE Hydrogen Program, develop critical technologies such as hydride-based on-board storage and related refueling infrastructure technology areas such as purification and compression. Demonstrate fuel cell vehicle performance fueled with gaseous hydrogen including road testing and refueling. Analyze and test, in conjunction with fuel cell vehicle industry programs, vehicle

III. Performance Summary: FUELS UTILIZATION R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Alternative Fuels (Cont'd)		potential additives which may be necessary. Analyses and testing will be performed in conjunction with auto industry programs to measure vehicle performance (efficiency, emissions, etc.) and to resolve fuel infrastructure barriers associated with alternative fuels. ($630) Participants include: States, Fuel Providers, NREL, ANL. (PNGV: $630)	performance measurements and resolve barriers for alternative fuels, including hydrogen and methanol. ($999) Participants include: States, fuel providers, auto manufacturers, NREL, ANL, California Fuel Cell Partnership members. (PNGV: $999)
	Medium Trucks Initiated testing of a 40 percent efficient engine operating on natural gas. Initiated development of a natural gas fueled hybrid electric power system for a Class 6 truck application. Incorporated smart sensor technology into compressed natural gas tank design and began prototype construction of tanks for testing in a medium truck. Continued operation of the West Virginia University Transportable Chassis Dynamometer and Emissions Test Facility. ($2,707)	**Medium Trucks** Select most promising natural gas engine technologies, previously developed in this program, for further development, leading to increasing engine efficiencies from 40 percent to 45 percent. Continue on road development projects, utilizing the WVU Mobile Emissions Test Facility, with the intent of moving high efficiency (40 percent) natural gas engines toward production ready status. Assess natural gas bus technologies, comparing performance and emissions to conventional diesel and	**Medium Trucks** Initiate activities to explore the use of alternative fuels other than natural gas in medium trucks. Complete design/market study for conformable CNG fuel storage tanks for class 3-6 trucks. Initiate design and development of state-of-the-art class 3-6 CNG vehicle from the ground up as a natural gas vehicle utilizing technologies developed over the past years under sponsorship from this program. ($2,943) Participants include: NREL, ORNL, BNL, ANL.

III. Performance Summary: FUELS UTILIZATION R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Alternative Fuels (Cont'd)	Participants included: NREL, ORNL, SNL, ANL, BNL.	fuel celled counterparts. Develop design for lower cost, lighter weight CNG fuel storage tanks for class 3-6 trucks. ($3,240) Participants include: NREL, ORNL, SNL, ANL, BNL.	
	Heavy Trucks Continued developing advanced liquefied natural gas storage and fuel delivery systems in support of direct injection natural gas engine technology. Continue development of direct injection technology for natural gas use in a diesel cycle engine. ($2,738) Participants included: NREL, ORNL, SNL, ANL, BNL.	**Heavy Trucks** Demonstrate, in a test cell, operation of a natural gas fueled engine that incorporates direct injection technology. Complete prototype and begin testing of advanced liquified natural gas storage and fuel delivery system. Evaluate the use of neat natural gas derived liquid fuels in unmodified heavy duty trucks to assess emissions benefits of using these liquids as fuels in emissions non attainment areas. ($3,266) Participants included: NREL, ORNL, SNL, ANL, BNL.	**Heavy Trucks** Complete full scale laboratory testing of advanced liquified natural gas storage and fuel delivery systems. Initiate design development of state-of-the-art LNG fueled class 7-8 Truck from the ground up as a natural gas vehicle, utilizing the technologies developed over the past years under sponsorship from this program. ($2,943) Participants included: NREL, ORNL, BNL, ANL.
Alternative Fuels	**Health Impacts**	**Health Impacts**	**Health Impacts**

III. Performance Summary: FUELS UTILIZATION R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
(Cont'd)	Compared the toxicity of particulates from gasoline and diesel engines. Implemented planned research to compare toxicity of particles from gasoline and diesel engines using samples from dynamometers and one highway tunnel. ($980)	Transferred to VEHICLE TECHNOLOGIES, R&D, Advanced Combustion Engine R&D. ($0)	Transferred in FY 2001 to VEHICLE TECHNOLOGIES, R&D, Advanced Combustion Engine R&D. ($0)
	Environmental Impacts Examined issues related to the EPA's ozone, PM 2.5, and regional haze regulations. Used field studies and real-world emission testing to evaluate the contribution of heavy vehicle emissions to these problems. Compared the results from ambient field studies with vehicle emissions inventories in an attempt to reconcile the differences. ($1,976) Participants: NREL, CRC.	**Environmental Impacts** Assess the on the road contribution of mobile source emissions inventories. Using field studies, evaluate the contribution of heavy vehicle emissions to ozone, PM 2.5, regional haze, and hazardous air pollutants. Conduct studies to determine the reasons for higher ozone concentrations on the weekends in California. Collect gasoline and diesel exhaust samples for comparative toxicity testing. Collect natural gas exhaust samples for toxicity testing and characterization. Perform cold start emissions testing of gasoline vehicles. ($2,973) Participants: NREL, SWRI, CRC.	**Environmental Impacts** Assess field studies of on-road contribution of mobile sources to emissions inventories and contribution of heavy vehicle emissions. Continue collection of on road vehicle exhaust from new technology vehicles for health effect studies. ($2,972) Participants: NREL, CRC, Other industry groups.
Alternative Fuels	**Fueling Infrastructure**	**Fueling Infrastructure**	**Fueling Infrastructure**

III. Performance Summary: FUELS UTILIZATION R&D (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
(Cont'd)	Initiated design of a combined CNG/LNG fueling facility. ($1,936) Participants included: SNL, INEEL, BNL.	Test and evaluate compressor technology prototype, small scale natural gas liquifier and gas clean-up technologies. Accelerate activities in support of industry coordinated infrastructure working group. Develop prototype CNG/LNG refueling facility that addresses safety concerns and allows for easy permitting. ($1,979) Participants include: INEEL, SNL, BNL.	Complete field installation and begin field testing of small scale natural gas liquefier and gas clean up technologies. In coordination with the *Infrastructure Working Group*, support activities, through a competitive solicitation, that are focused on reducing the cost and improving the use of natural gas fueling stations. ($1,966) Participants include: INEEL, SNL, BNL.
	Provide critical technical and program management support services (Antares, CSMI). (PNGV: $76) ($194)	Provide critical technical and program management support services. (Antares, CSMI). (PNGV: $367) ($473)	Provide critical technical and program management support services (Antares, Sentech). (PNGV: $1) ($157)
Total, Alternative Fuels	**$11,913**	**$12,561**	**$11,980**
TOTAL, FUELS UTILIZATION R&D	**$21,196**	**$23,509**	**$23,529**

TRANSPORTATION TECHNOLOGIES
TRANSPORTATION SECTOR
(Dollars in Thousands)

MATERIALS TECHNOLOGIES

I. Mission Supporting Goals and Objectives

Mission

The Materials Technologies Program supports the development of the cost-effective materials and materials manufacturing processes necessary to successfully commercialize the next generation of fuel-efficient, low-emission transportation vehicles.

Goals and Benefits

The Materials Technologies Program partners with industry, with a high percentage of cost sharing, to identify, prioritize, and remove technical barriers to the commercialization of high-performance materials and to increase the viability of new materials and materials manufacturing processes.

Goals and Performance Measures:

- By 2004, develop and validate lightweight materials technologies that will enable reductions in automobile weight of 40 percent (relative to 1994 baseline) and in heavy truck weight of 30 percent (relative to 1998 baseline).
- By 2004, reduce the cost of aluminum sheet to $1.05 per pound.
- By 2004, reduce the cost of carbon fiber to $3.00 per pound, and to $1.00 per pound by 2010.
- By 2004, validate vehicle-ready microwave regenerated particulate filter systems that reduce diesel engine particulates by 90 percent.
- By 2010, increase the number of vehicles on the road with light weight materials to over 9 million by 2010.
- By 2010, have significant amounts of lightweight materials in all the hybrid, electric, and fuel cell vehicles on the road. If the materials programs are successful, there will be over nine million light-duty vehicles using these lightweight materials.

Benefits:
The projected benefits of the Transportation Materials Program are shown in the table below.

	2005	2010	2020
Petroleum Displaced (Millions Barrels per Day)	0.00	0.001	0.023
Total Primary Energy Displaced (Trillion Btu)	1	6	43
Energy Costs or Savings (Millions of $)	12	63	565
Carbon Equivalent Emissions Displaced (MMTCe)	0.02	0.12	1.15

Source: GPRA 2001 EERE Database. Numbers in the above table represent the projected annual benefits in 2005, 2010, and 2020 based on the FY2002 funding request, assuming all program goals are met.

Materials Technologies Accomplishments

FY 2000 Accomplishments:
- Demonstrated in PNGV concept vehicles technical feasibility of reducing body and chassis weight by 50 percent.
- Completed development and demonstration of advanced performing technologies for a pick-up truck bed using glass fiber.

FY 2001 Ongoing Accomplishments:
- Complete planning of Focal Project 3, focused on carbon-fiber-reinforced polymer-matrix composite intensive, hybrid-material "body-in-white."

FY 2002 Planned Accomplishments:
- Complete detailed design of entire hybrid material "body-in-white" along with cost, weight, and performance analysis.
- Demonstrate ceramic particulate filter system for engines that removes 90 percent of particulates with 95 percent filter regeneration efficiency.

II. A. Funding Table: MATERIALS TECHNOLOGIES

Program Activity	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
Propulsion Materials Technology	$ 8,786	$ 8,993	$ 8,962	$ -31	-0.3%
Lightweight Materials Technology	$ 24,534	$ 27,642	$ 27,731	$ 89	0.3%
High Temperature Materials Laboratory	$ 8,260	$ 5,588	$ 4,600	$ -988	-17.7%
Total, Materials Technologies	$ 41,580	$ 42,223	$ 41,293	$ -930	-2.2%

II. B. Laboratory and Facility Funding Table: MATERIALS TECHNOLOGIES

	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
Ames Lab	$ 100	$ 0	$ 0	$ 0	0.0%
Argonne National Lab (East)	$ 1,545	$ 1,792	$ 1,375	$ -417	-23.3%
Idaho National Engineering and Environmental Lab	$ 350	$ 250	$ 250	$ 0	0.0%
Lawrence Berkeley National Lab	$ 400	$ 400	$ 400	$ 0	0.0%
Lawrence Livermore National Lab	$ 475	$ 475	$ 385	$ -90	-18.9%
Los Alamos National Laboratory	$ 0	$ 230	$ 100	$ -130	-56.5%
National Renewable Energy Lab	$ 0	$ 0	$ 0	$ 0	0.0%
Oak Ridge National Lab	$ 26,219	$ 20,271	$ 23,069	$ 2,798	13.8%
Pacific Northwest National Lab	$ 5,075	$ 5,675	$ 4,665	$ -1,010	-17.8%
Sandia National Laboratories	$ 655	$ 395	$ 670	$ 275	69.6%
All Other	$ 6,761	$ 12,735	$ 10,379	$ -2,356	-18.5%
Total, Materials Technologies	$ 41,580	$ 42,223	$ 41,293	$ -930	-2.2%

III. Performance Summary: MATERIALS TECHNOLOGIES

Program Activity	FY 2000	FY 2001	FY 2002
Propulsion Materials Technology	**Automotive Propulsion Materials** Performed R&D of advanced materials for PNGV propulsion technologies, focusing on: materials/devices to increase fuel efficiency and reduce emissions from advanced diesel engines suitable for automotive applications; low cost, lightweight materials/components for fuel cells; and materials to reduce size and enhance performance of power electronics modules. Projects supported included new classes of materials and/or unique processing methods at the laboratory stage of development. Developed near-frictionless carbon coatings for advanced diesel engine components and fuel cell air compressors, to decrease wear and increase efficiency. Continued development of ceramic paper for regenerative diesel exhaust filter to meet PNGV particulate emissions targets. Identified optimum pore size and structure for carbon foam heat sinks	**Automotive Propulsion Materials** Conduct R&D to remove materials based barriers to the introduction of PNGV advanced propulsion systems. The R&D focuses on: improved thermal management for power electronics and fuel cell systems; materials to reduce the size, and improve the performance, manufacturabilility and reliability of power electronics components and modules; advanced diesel engine materials and catalysts to enable reduction of NOx and particulates. Develop surface treatment technologies for advanced diesel engine components and fuel cell air compressors to lower weight, decrease wear, eliminate parts and increase efficiency. Demonstrate a ceramic particulate filter prototype on a diesel engine achieving 75 percent particulate removal efficiency, 95 percent filter regeneration efficiency, and 0.01 g/mile PNGV research target. Initiate testing of carbon foam heat sinks in power electronics modules	**Automotive Propulsion Materials** Develop in-cylinder application techniques for diesel engine aluminum block surface treatment technology to improve durability in a light weight engine block. Develop low friction surface coatings for advanced fuel cell compressors. Optimize ceramic particulate filter system for diesel engines to remove 90 percent of particulates with 95 percent filter regeneration efficiency. Demonstrate full scale carbon foam heat sinks for power electronic modules. Develop improved fuel cell thermal management system integrating use of carbon foam technology. Transfer polymeric dc buss capacitor technology to industry supplier(s). Develop high dielectric ceramic bus capacitor fabrication techniques. Characterize failure mechanisms of fuel cell membrane using surface analysis facility. Develop ceramic backing layers for prototype PEM fuel cell high temperature membranes.

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Propulsion Materials Technology (Cont'd)	to enable improved thermal management of power electronics. Fabricated and tested new ceramic materials for capacitors with a factor of 10 volume reduction, and higher operating temperatures, for power electronics. Participants included: ORNL, LANL, SNL, ANL, Industrial Ceramic Solutions. (PNGV: $2,900) ($2,900)	for improved thermal management. Identify optimum nanofluid composition for fuel cell thermal management system. Fabricate and test new ceramic based capacitors utilizing materials previously developed to achieve volume reduction and increased temperature operation for power electronics. Develop ceramic based membranes and backing materials for higher temperature PEM fuel cell operation. Participants include: ORNL, LANL, SNL, ANL, Industrial Ceramic Solutions, University of Wisconsin. (PNGV: $2,964) ($2,964)	Participants include: ORNL, LANL, SNL, ANL, Industrial Ceramic Solutions. (PNGV: $2,971) ($2,971)
	Heavy Vehicle Propulsion Materials Pursued development of materials technologies that enable advanced, efficient, clean diesel engines suitable for application to sport utility vehicles (SUVs), vans, and trucks. Completed the identification of opportunities for advanced materials such as intermetallic compounds,	**Heavy Vehicle Propulsion Materials** In response to urgent national needs for higher efficiency, lower emission engines for heavy vehicles, SUVs, and vans, accelerate the development of identified materials and processes such as intermetallic compounds in high temperature regions, amorphous metals and alloys, and metal-and ceramic-	**Heavy Vehicle Propulsion Materials** Distribute peer/industry-reviewed Multi-Year Program Plan for the Propulsion Systems Materials Program; materials needs have been identified, assessed for design/ manufacture of components of high efficiency, low emission, high durability, high reliability heavy vehicle engines. Develop catalyst

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Propulsion Materials Technology (Cont'd)	amorphous metals and alloys, nanocrystalline materials, and metal and ceramic matrix composites, along with ceramics, to be key enablers for the advanced diesel engines. Completed development of a zirconia toughened mullite cylinder head insert for advanced diesel engines, using composite fabrication and low cost processing. Completed development of materials for fuel systems, NOx and particulate reduction, advanced air handling, and higher cylinder-pressure engines needed for diesel cycle propulsion. Completed development of "smart materials" for fuel injection systems. Prepared prototypes of all components and systems for testing and evaluation in the final stage of these multiyear developmental projects with the diesel engine companies and their suppliers. Tested and evaluated ceramic piezoelectric materials for rapid fuel injector actuation, NOx catalysts, plasma assisted catalysts, and thick thermal barrier coatings for pistons.	matrix composites. Conduct proof-of-principle tests of selected materials for advanced engine components applications. With the major diesel engine manufacturers, complete the manufacture and evaluation of prototype thick thermal barrier coatings, insulated cylinder heads, and the materials developed for low emissions exhaust gas aftertreatment devices. Continue the development and qualification of "smart" materials for fuel injection applications. Design and test prototypes for specific heavy vehicle engines. Characterize fuel injector holes machined with the Femto-second laser as to size, profile, reproducibility, and durability. Determine if this new technology can meet the stringent requirements of advanced diesel engines and improve candidate engine components materials characteristics. Continue exploratory efforts to develop new particulate filter	and catalyst support systems for exhaust aftertreatment to significantly reduce engine emissions. Study prototype thick thermal barrier coatings for pistons. Complete evaluation of test results. Complete initial development, laboratory testing of "smart materials" in fuel injection applications. Plan proposed follow-on development project. Expand assessment of the Femto-second laser technology for processing of component materials. Develop cermet materials for fuel systems and low cost continuous sintering processes for cermets, ceramics, metallurgical and intermetallic compounds for engine components. Refine component durability evaluations and part-life prediction models. Validate code predictions of cost, performance parameters. Apply refined models to current R&D portfolio.

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Propulsion Materials Technology (Cont'd)	Identified candidate materials with high damping coefficients required for noise and vibration reduction in advanced engines. With teams of engine companies and suppliers, defined the materials and manufacturing technologies required for exhaust gas recirculation and high brake mean effective pressure engine blocks and cylinder heads. Completed the testing of low cost, continuous sintering methods for cermets, ceramics, and powder metallurgy diesel engine components. Prepared a test plan for prototyping, testing, and evaluation of components. Pursued domestic and international cooperative efforts to establish testing standards facilitating specification of properties for the new candidate materials in engine component designs. Maintained cooperative materials analysis and characterization efforts utilizing the electron microscopes and user facilities at the High	materials and designs and new NOx catalyst materials by utilizing computer simulation. Develop computer simulations to evaluate radically new and promising concepts for joining dissimilar materials for enhanced performance, increased manufacturing yield, and lower cost. Continue the development and standardization of high yield sintering of diesel engine components, durability evaluations and formulation of reliable part-life prediction models to achieve industry target costs and confidence levels. Evaluate the effects of exhaust gas recirculation (EGR) on engine component reliability and identify materials solutions. Develop new concepts for precision machining at competitive costs for fuel system components and other engine parts. Develop low cost materials processing and components fabrication for class 1-2 truck engines and higher	Continue development of high reliability non-destructive evaluation technology for diesel engine components, advanced testing/characterization of new engine materials. Evaluate new formulations of NOx, plasma assisted catalysts, catalyst systems, in the presence of exhaust gas recirculation (EGR). Assess materials EGR degradation of engine components. Collaborate with ASTM, SAE to develop domestic, international testing standards for advanced materials for higher efficiency diesel engines. With NIST, continue similar cooperation with International Energy Agency. Incorporate new Aberration Corrected Electron Microscope (ACEM) at the HTML in examination/characterization of heavy vehicle-related materials and components. Investigate breakthrough in titanium production for feasibility of cost-effective titanium alloy

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Propulsion Materials Technology (Cont'd)	Temperature Materials Laboratory (HTML). Participants included: ORNL, Caterpillar, Cummins, Detroit Diesel, North Carolina A&T, ANL, NIST. ($5,871)	temperature alloys for turbocharger compressors to operate in the EGR environment. Continue collaboration with consensus standards organization (ASTM, SAE) to develop materials and testing standards for advanced diesel engines. Ensure cognizance of, and collaboration with activity in friction, wear, and lubrication activities. Continue materials analysis and characterization at the High Temperature Materials Laboratory. Participants include: Caterpillar, Cummins, Detroit Diesel Corporation, ORNL, ANL, NIST, North Carolina A&T, Southern Illinois Univ.. ($6,009)	development for engine components. Participants include: Caterpillar, Cummins, Detroit Diesel Corp., ORNL, NIST, ANL, Ford, North Carolina A&T, Southern Illinois University, and a number of new stakeholders to-be-determined from competitive solicitation.. ($5,896)

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Propulsion Materials Technology (Cont'd)	Provide critical technical and program management support services. (CSMI). (PNGV: $15) ($15)	Provide critical technical and program management support services. (CSMI). (PNGV: $20) ($20)	Provide critical technical and program management support services. (Sentech, Antares). (PNGV: $20) ($95)
Total, Propulsion Materials Technology	**$8,786**	**$8,993**	**$8,962**
Lightweight Materials Technology	**Automotive Lightweight Materials** General program planning and coordination continued with the automakers' US Council for Automotive Research (USCAR)'s US Automotive Materials Partnership (USAMP) and its Automotive Composites Consortium (ACC) and with automaker members of the Partnership for a New Generation of Vehicles' Materials Technical Team (PNGV/MTT). Coordination with efforts supported by Natural Resources of Canada (NRCan), increased. New efforts on high-strength, high-ductility steels were defined in conjunction	**Automotive Lightweight Materials** General program planning and coordination continue with USAMP, ACC, PNGV/MTT, A/SP and NRCan. The two roadmapping efforts from FY 2000 are concluding and new efforts to implement the recommendations are being defined in conjunction with the APC, VRP, SRI, ISRI, APRA and other interested organizations.	**Automotive Lightweight Materials** Program planning and coordination will continue with the USAMP, ACC, PNGV/MTT, A/SP, NRCan, the Aluminum Association, AISI, APC, SRI, ISRI, and APRA. Coordination of composite materials research with the APC, Composite Fabricators Association (CFA), and the Society for the Advancement of Materials and Progress Engineering (SAMPE) will be increasing in order to further involve more automotive materials suppliers in the program planning and coordination process.

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Lightweight Materials Technology (Cont'd)	with the Auto/Steel Partnership (A/SP, between the automakers and the American Iron and Steel Institute (AISI)). A workshop was held in conjunction with the American Plastics Council (APC) to begin roadmapping possible future efforts in polymers for autos. Another workshop to begin roadmapping of future efforts on recycling/recovering value from future end-of-life (ELV) autos, was held with USCAR's Vehicle Recycling Partnership (VRP), APC, Steel Recycling Institute (SRI), Institute of Scrap Recycling Industries (ISRI), and the Auto Parts Rebuilders Association (APRA).		
	Metals: Pre-FY 1999 projects on stamping and warm forming of aluminum sheet, and on induction hardening of steel, concluded. A project on hydroforming of aluminum components was combined with a related USAMP effort. Planning started on a USAMP project on electromagnetically forming (EMF) of aluminum. Work on aluminum in the cast light metals consortium	Metals: All initial efforts on aluminum tailor-welded blanks are concluding. New projects focused on decreasing cost and increasing manufacturability of aluminum components for body and chassis applications, are beginning. Building on results of completed proof-of-concept experiments, new projects aimed at optimizing warm forming of aluminum sheet and developing binder control	Metals: Projects focused on decreasing costs and increasing manufacturability of aluminum components will continue. Efforts to decrease the cost of 6000 series aluminum sheet will be initiated with the goal of demonstrating 25 percent lower cost. A project on EMF of aluminum sheet into components is beginning. Projects aimed at developing optimized processing technologies for the

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Lightweight Materials Technology (Cont'd)	project concluded, but was refocused to cast magnesium. A project to demonstrate production of thin-wall automotive components with at least 15 percent ductility concluded, and work aimed at doubling the useful life of dies used for casting aluminum or magnesium entered into the final validation phase. Plans for advanced work on cost-competitive titanium metal and powder were initiated. Projects aimed at producing magnesium in automotive quantities for $1.25/lb and creep-resistant, easily-cast magnesium alloys have entered into final testing stages. Previous efforts on particle-reinforced aluminum metal-matrix composites PRAMMCs) continued. The PNGV concept vehicles unveiled by all three automakers had aluminum-intensive bodies and chassis using many advances developed in this program. The vehicles demonstrated that 50 percent reduction in body and chassis weight is technically feasible. Further work to make the reduction cost-effective remains.	technology for stamping aluminum are being initiated. Additional emphasis is being placed on joining technologies for aluminum and steel including tools for non-destructive evaluation. New efforts on advanced design and manufacturing of magnesium alloys and to develop alloys with enhanced properties, are beginning. Technologies for optimizing designs and improving product capabilities for cast magnesium are being developed. Cost-efficient, optimized secondary processing and lower cost finishing technologies for aluminum metal matrix composites continue. Projects focused on reducing the cost of titanium components are being started. Several projects on high-strength, high-ductility steels are being initiated. A project on powder-metallurgy based PRAMMCs is ending.	production of hydroformed aluminum components and electromagnetically formed components will be concluded with validation testing. Efforts to develop creep resistant magnesium structural components with improved capabilities will continue, as will efforts to develop alloys with improved strength and fatigue resistance. Initial efforts to evaluate cost effective manufacturing processes for ultralight sandwich materials will begin. Work on developing and optimizing innovative joining technologies will continue. Non-destructive evaluation (NDE) tools will be developed for the on-line evaluation of welded joints. Additional efforts to optimize processing and joining of advanced high strength steels (HSS) will begin in order to provide alternative, cost effective materials for automotive design. New projects aimed at developing durable, corrosion resistant coatings for lightweight alloy components will be initiated. Work to develop technologies for lowering the cost of titanium components will expand.

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Lightweight Materials Technology (Cont'd)	Composites: Truck beds and tailgates produced by advanced glass-fiber preforming molding technologies were tested, thereby concluding Focal Project 2. Efforts in warm forming of thermoplastics continued with the addition of a project aimed at understanding, modeling and optimizing the production process, and understanding the long-term durability of reinforced thermoplastics in an automotive environment. Projects continued on lowering the cost of carbon fiber through alternative precursors and decomposition. Development of a user facility for assessing and optimizing the production of carbon fiber with alternate precursors was coordinated with other government agencies. A preliminary design of a carbon-fiber based vehicle structure was conducted. An existing preform station was modified to allow the use of carbon fiber in making large, rapidly produced preforms. New projects on thermoplastic crosslinking of composites, rapid curing, nano-composites and alternate processing approaches were planned.	Composites: Focal Project 3 (FP3) planning is ending and development is beginning. The FP3 focal component is a carbon-fiber reinforced polymer-matrix composite intensive, hybrid-material "body-in-white." Projects focus on the development of high-volume processes for manufacturing automotive body and chassis components, especially development of thin-wall sections in high-volume processing. Development of new resin systems, and advanced design concepts for polymeric matrix composite structures, taking into account significant parts consolidation, lower cost tooling and use of multiple materials, is beginning. Carbon-fiber precursor projects will be down-selected at year's end to identify and continue work on the most promising technologies. Development of advanced materials design concepts is increasing. The initial efforts on warm forming of thermoplastic composites are concluding. Technologies from the composites program are being used for the first time in commercial vehicles offered	Composites: Efforts will increase on processing technologies critical for successfully conducting FP3, focusing on development of high-volume processes for manufacturing automotive body and chassis components. Detailed design of an entire hybrid material "body-in-white" along with cost, weight, and performance analyses will be completed. Processing technologies that are not based on liquid molding will begin. Advanced joining concepts for polymeric matrix composite structures, taking into account significant parts consolidation, lower cost tooling and use of multiple materials, will begin. Subsequent to the down-select, carbon fiber precursor projects will be ramped up to be inclusive of nontraditional processing technologies. All low-cost carbon fiber projects will be integrated into one complete research initiative. Supplemental to the efforts on warm forming of thermoplastic composites, a project will begin to complete commercialization of this processing technology. Efforts to use micro-sized particles as

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Lightweight Materials Technology (Cont'd)		by at least two of the three U.S. automakers.	reinforcements, either in conjunction or in opposition to fibers, will be increased. High strain rate testing of composites will begin.
	Other: An initial project on aluminum scrap sorting, planned in FY 1999 and FY 2000 in conjunction with the Auto/ Aluminum Alliance (A/AA formed in 1999 between the Aluminum Association and the automakers), started. A project on recycling carbon-fiber-reinforced polymeric composites and another on lower weight automotive window glass continued. Several cost studies were completed. Participants included: Ames Lab, ALRC, ANL, LBNL, LLNL, ORNL, PNNL, SNL ALRC, ALCOA, Aluminum Association, Aluminum Consultants Group, American Foundrymen's Society, Amoco Polymers, ATI Systems, Automated Analysis Corporation, Bayer Corporation, Boston University, Case Western University, Clemson University, Concurrent Technologies,	Other: The aluminum scrap sorting effort is scheduled to end. The project on recycling carbon-fiber-reinforced polymeric composites continues as does the one on lower weight automotive window glass. Further cost studies are being performed. Participants include: Ames Lab, ANL, LBNL, LLNL, ORNL, PNNL, SNL, AISI, ALCOA, Aluminum Association, Aluminum Consultants Group, American Foundrymen's Society, Amoco Polymers, APC, ATI Systems, Automated Analysis Corporation, Bayer Corporation, Boston University, Case Western University, Clemson University, Cornerstone Technologies, Dephi, Delsen Testing Labs, EKK, Inc., Entelechy, Erie Press, Excel Pattern Works, Garfield Alloys, Global Equipment Network, H.S. Die & Engineering, Hexcel, Johnson	Other: Process development work on carbon fiber recovery and recycling, including re-use testing and evaluation of recovered fibers, will continue. Technical evaluation and testing of aluminum sorting technologies and process options will be completed. Research on intelligent disassembly for materials and component recovery, recycle, and/or repair will be initiated. Organizational capabilities will be identified and working structure for a Virtual Recycle Center of Excellence will be established . Participants include: Ames Lab, ANL, LBNL, LLNL, ORNL, PNNL, SNL, AISI, ALCOA, Aluminum Association, Aluminum Consultants Group, American Foundrymen's Society, Amoco Polymers, APC, ATI Systems, Automated Analysis Corporation, Bayer Corporation, Boston University, Case Western

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Lightweight Materials Technology (Cont'd)	Cornerstone Technologies, Dephi, Delsen Testing Labs, EKK, Inc., Electric Power Research Institute, Entelechy, Erie Press, Excel Pattern Works, Garfield Alloys, Global Equipment Network, H.S. Die & Engineering, Hexcel, Johnson Industries, Knight & Packer, MascoTech, MC-21, Michigan State University, Michigan Technological University, Modern Engineering, MSX International, North American Die Casters Association, North Carolina State University, North Iowa Die Casting, Reynolds Metals, Santa Fe Alloys, Technologies Research Corporation, Textron Automotive, Thixomat, Troy Design, Troy Tooling, University of California - Davis, University of Michigan - Ann Arbor, University of Michigan - Dearborn, University of Missouri, University of Tennessee, University of Texas - Austin, USAMP (DaimlerChrysler, General Motors, Ford), Valimet, Virginia Polytechnic Institute, Visteon, Wedco. (PNGV: $18,678) ($18,678) (47 percent cost-share*)	Industries, Knight & Packer, MascoTech, MC-21, Michigan State University, Michigan Technological University, Modern Engineering, MSX International, North American Die Casters Association, North Carolina State University, North Iowa Die Casting, Santa Fe Alloys, Technologies Research Corporation, Textron Automotive, Thixomat, Troy Design, Troy Tooling, University of California - Davis, University of Michigan - Ann Arbor, University of Michigan - Dearborn, University of Missouri, University of Tennessee, University of Texas - Austin, USAMP (DaimlerChrysler, General Motors, Ford), Valimet, Virginia Polytechnic Institute, Visteon, Wedco.. (PNGV: $18,721) ($18,721) (approx. 47 percent cost-share*) * Cost-shares of project will vary, but overall rate expected to remain the same.	University, Clemson University, Cornerstone Technologies, Dephi, Delsen Testing Labs, EKK, Inc., Entelechy, Erie Press, Excel Pattern Works, Garfield Alloys, Global Equipment Network, H.S. Die & Engineering, Hexcel, Johnson Industries, Knight & Packer, MascoTech, MC-21, Michigan State University, Michigan Technological University, Modern Engineering, MSX International, North American Die Casters Association, North Carolina State University, North Iowa Die Casting, Santa Fe Alloys, Technologies Research Corporation, Textron Automotive, Thixomat, Troy Design, Troy Tooling, University of California - Davis, University of Michigan - Ann Arbor, University of Michigan - Dearborn, University of Missouri, University of Tennessee, University of Texas - Austin, USAMP (DaimlerChrysler, General Motors, Ford), Valimet, Virginia Polytechnic Institute, Visteon, Wedco. (PNGV: $18,660) ($18,660) (Cost-share TBD*) *Cost-shares of projects will vary,

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Lightweight Materials Technology (Cont'd)			but overall rate expected to remain the same as before, i.e, 45 percent to 50 percent.
	Heavy Vehicle High Strength Weight Reduction Materials Completed design, and order dies and platens, for prototype aluminum casting which exceeds the component size produced by the ultra-large caster. Designed and tested smaller components. With trucking industry partner, selected prototype large truck component to be used later for initial casting tests. Continued development of strong, durable, low cost lightweight carbon fiber-based materials for truck components. Expanded to prototype scale the casting and fabrication of large, three dimensional, aluminum-based structural components for heavy and medium duty truck frames. Coordinated this activity and other truck lightweighting strategies with the Northwest Alliance for	**Heavy Vehicle High Strength Weight Reduction Materials** Combine innovative design with the use of strong, lightweight and lightweighting materials to reduce the weight of heavy trucks. Lightweighting of pickups, vans, and sport utility vehicles also will be required to significantly reduce fuel consumption and exhaust emissions. Materials such as aluminum, magnesium, metal-matrix composites, high strength-low alloy steels, carbon-based materials and polymers are likely candidates for the required applications. Continue the multi-year development efforts selected from the competitive solicitation of FY 2000, utilizing the available funds to bridge to FY 2002. Test the dies and platens for larger size aluminum and magnesium casting facility. Operate the facility	**Heavy Vehicle High Strength Weight Reduction Materials** Continue competitively selected multi-year cost-shared R&D on cost-effective materials improvement, substitution to lightweight overall truck system, increase reliability and durability of components, and lower life cycle costs. Assess materials substitution opportunities for lightweighting non-engine components to increase heavy vehicle energy efficiency. Having exceeded the goal ratio of 150 volumes of natural gas storage per unit volume of a low pressure (500 psi) storage vessel, initiate planning for an engine/gas storage system demonstration to evaluate system characteristics and performance. Plan to achieve at least 180 ratio. Prepare samples of the carbon storage material for

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Lightweight Materials Technology (Cont'd)	Transportation Technologies and the National Transportation Research Center at ORNL. Issued a broad-based competitive solicitation for cost-effective innovative concepts for lightweighting and fabricating truck frames and other vehicular components. Designated focused teams to proof-test the peer-selected concepts utilizing industry standards and performance and cost requirements. Explored the application of equal channel angular extrusion (ECAE) to aluminum and magnesium lightweight alloy materials for vehicle components, with the intent to achieve improved microstructure, properties, performance and control. Applied the metal compression forming technology to ultra-lightweight monolithic magnesium alloy, and magnesium-based metal matrix composite, vehicular components. Investigated the feasibility of using monolithic lightweight carbon-based materials for natural gas storage.	for qualifying, certification, and acceptance. Cast a prototypic large truck component in initial tests and characterize the component. Modify equipment as needed and plan succeeding production-like casting tests. Evaluate parts with trucking industry partners. Continue the development of cost-effective energy-efficient monolithic carbon-based gas storage materials with unique, fully-reversible fuel retrieval capability. Evaluate the potential for using greatly reduced storage pressures, 0-500 vs. 3600 psig in the case of natural gas, at comparable energy storage densities. Continue the development of the required design, materials selection, and manufacturing process for advanced lightweight frames for pickups and sport utility vehicles that meet cost/weight targets. Plan tests for component performance evaluation. Continue to coordinate this and other lightweighting activities for trucks with the Northwest Alliance for Transportation Technologies and the National Transportation Research	detailed characterization/analysis to study alternatives for optimizing storage capacity. Study applicability to other energetic gases, hydrogen in particular. Continue industry cost-shared projects to achieve a 30-40 percent reduction in the weight of an SUV frame, while cost-effectively satisfying all component performance requirements. Assess manufacturability, durability, life cycle costs, corrosion and crash worthiness; compare to current frame technology. Coordinate lightweighting activities with Northwest Alliance for Transportation Technologies, National Transportation Research Center. Continue development of advanced processing technologies for materials applications in heavy vehicles. Initiate construction of full size prototype stainless steel bus frame with bus manufacturer to validate 50 percent reduction in weight based on modeling efforts. Evaluate manufacturability, cost, and

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Lightweight Materials Technology (Cont'd)	Participants included: American Trucking Associations, truck manufacturers, Alcoa, Thompson Aluminum Casting, Cummins, Amoco, Detroit Diesel, Caterpillar, ORNL, ANL, INEEL, PNNL, WVU, MIT. ($5,643)	Center. Continue the application of Equal Channel Angular Extrusion (ECAE) to copper and copper alloys for the production of spot-welding electrode tips of substantially longer component life and, potentially, lower cost than conventional materials. Test the powder consolidation potential of ECAE on intermetallic compounds, lightweight alloys, and candidate high-permeability magnetic alloys to characterize the applicability of the process to otherwise intractable materials. Confirm the technical approach to reduce by about one-half the weight of transit buses through a novel space frame design using stainless steel and/or aluminum. Such a weight reduction could permit use of smaller engines with about a 45 percent reduction in both fuel use and exhaust emissions. Identify and develop new, cost-effective joining methods of high reliability and durability for similar and dissimilar lightweight materials.	performance parameters. Determine feasibility of light weight, high cycle fatigue resistant titanium alloys for heavy vehicle components (e.g., leaf springs). Integrate heavy vehicle brake material and brake system energy loss activities in Vehicle Systems Optimization program. Participants include: American Trucking Association, PACCAR, Freightliner, ALCOA, Cummins, Caterpillar, Detroit Diesel Corp., Ford, Daimler Chrysler, Autokinetics, General Motors, ANL, LANL, INEEL, PNNL, MIT, Tenn. Tooling and Engineering, ORNL. ($8,720)

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Lightweight Materials Technology (Cont'd)		Participants include: American Trucking Associations, PACCAR, Freightliner, ALCOA, Cummins, Caterpillar, Detroit Diesel Corporation, ORNL, ANL, INEEL, PNNL, WVU, MIT, Tenn. Tooling and Engineering. ($8,804)	
	Provided critical technical and program management support services. (Antares, CSMI). (PNGV: $75) ($213)	Provide critical technical and program management support services. (Antares, CSMI). (PNGV: $100) ($117)	Provide critical technical and program management support services. (Antares, Sentech). (PNGV: $200) ($351)
Total, Lightweight Materials Technology	**$24,534**	**$27,642**	**$27,731**
High Temperature Materials Laboratory	**High Temperature Materials Laboratory** Maintained world class, state-of-the-art technical and scientific level diagnostic and characterization capabilities for advanced materials, by continuously developing advanced analytical techniques and periodically acquiring the most modern equipment to support development of new and improved	**High Temperature Materials Laboratory** Continue to maintain world class, state-of-the-art technical and scientific level diagnostic and characterization capabilities for advanced materials, by continuously developing advanced analytical techniques and periodically acquiring the most modern equipment to support development	**High Temperature Materials Laboratory** Maintain world class, state-of-the-art technical, scientific level diagnostic/characterization capabilities for advanced materials. Develop advanced analytical techniques. Support the material characterization requirements of DOE's Office of Energy Efficiency and Renewable Energy (EERE).

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
High Temperature Materials Laboratory (Cont'd)	materials for application in surface transportation vehicles.	of new and improved materials for application in surface transportation vehicles. The HTML supports the material characterization requirements of DOE's Office of Energy Efficiency and Renewable Energy (EERE). Utilize the expertise and facilities of the HTML to characterize the materials and fabrication methods selected in the component development programs of EERE. Specific to the Office of Heavy Vehicle Technologies (OHVT), examine and characterize exhaust gas catalysts to determine functional mechanisms, degradation phenomena, compositions of products, and level of impurities and contaminants. Determine, as needed, microstructural, compositional, and crystallographic conditions of structural metals, alloys, ceramics, and novel materials under development for truck applications both from within the OHVT program, and from outside the program through the HTML's user centers.	Determine as needed, microstructural, compositional, crystallographic conditions of structural metals, alloys, ceramics, novel materials under development for truck applications both from within OHVT programs, and from stakeholders outside the program through HTML's user centers. Develop protocols for obtaining, preparing prototypic nanosize samples for atomic-level characterization, analysis on Aberration Corrected Electron Microscope (ACEM). Prepare test articles to scope application of ACEM to key materials issuer. Characterize fine exhaust particles from both SI and diesel engines.

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
High Temperature Materials Laboratory (Cont'd)		Coordinate with OHVT in the development, examination, and evaluation of new truck brake materials, characterization of minute exhaust particles from both diesel and spark ignition engines, and evaluation of new materials for reduction of friction and wear phenomena in various truck engine and power train components.	
	Capital Equipment Purchased and arranged for delivery of a one-of-a-kind (in the U.S.) high resolution (0.7 vs 1.6 Angstrom) Aberration Corrected Electron Microscope (ACEM) ($3,500), which will greatly enhance the ability to detect, image, and quantify chemical species that control the structural, microstructural, electronic, and other physical properties of the full range of vehicular materials. The specific, near-term application of the microscope to the full characterization (chemical composition and internal structure, occupied atom sites, particle sizes, shapes, surface morphology and	**Capital Equipment** Introduce the new, high resolution Aberration Corrected Electron Microscope (ACEM) into routine service within the HTML. Test the methodology developed for remote operation of the electron microscope in the DOE 2000 Materials Micro Characterization Collaboratory, using the new high resolution microscope. Acquire, as needed, new high priority equipment ($600) to maintain at world-class levels the state-of-the-art technical expertise of the HTML.	**Capital Equipment** No activity. ($0)

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
High Temperature Materials Laboratory (Cont'd)	defects, internal and surface adherent impurity species, and active sites of catalysis) of lean burn NOx catalysts is critical for the development of optimized catalysts required by advanced spark ignition and diesel vehicles. A 32 percent cost share is anticipated from industry users of the current microscope. The cost of the microscope constitutes a one-time expenditure in FY 2000. Investigated the extension of the methodology developed for remote operation of the electron microscope in the DOE 2000 Materials Micro Characterization Collaboratory to include the new high resolution microscope. Through the user centers and cooperative efforts with industry, enhanced the scientific data base on the expanding range of materials and helped prepare the next generation of U.S. technologists for the increasingly sophisticated techniques needed to develop cost-effective materials that met more stringent performance demands, including enhanced engine energy	Continue, through the user centers and cooperative efforts with industry, to enhance the scientific database on the expanding range of materials and help prepare the next generation of U.S. technologists and scientists for the increasingly sophisticated techniques needed to develop cost-effective materials that meet more stringent performance demands, including enhanced engine energy efficiency, significantly reduced exhaust gas emissions, and substantially improved engine component durability and reliability.	

III. Performance Summary: MATERIALS TECHNOLOGIES (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
High Temperature Materials Laboratory (Cont'd)	efficiency, significantly reduced exhaust gas emissions, and substantially improved engine component durability and reliability.		
	Maintained support of 16 scientific staff for the user programs and managed the sophisticated experimentation in support of the transportation developments described above. (ORNL) ($8,260)	Maintain support of 16 scientific staff for the user programs and to manage the sophisticated experimentation in support of the transportation developments described above. ($5,588)	Maintain support of 13 scientific staff for the user programs and manage the sophisticated experimentation in support of transportation developments. ($4,600)
Total, High Temperature Materials Laboratory	**$8,260**	**$5,588**	**$4,600**
TOTAL, MATERIALS TECHN-OLOGIES	**$41,580**	**$42,223**	**$41,293**

TRANSPORTATION TECHNOLOGIES
TRANSPORTATION SECTOR
(Dollars in Thousands)

TECHNOLOGY DEPLOYMENT

I. Mission Supporting Goals and Objectives

Mission

Transportation Technologies deployment programs accelerate the adoption and use of alternative-fuel and advanced-technology vehicles to help meet national energy and environmental goals.

Goals and Benefits

The Department's deployment efforts logically follow and complement successful technology development by industry and government. For the period 2002-2006, the program will promote both alternative-fuel vehicles (AFVs) and advanced-technology vehicles (ATVs). To help build consumer confidence in these technologies and encourage private sector investment in supporting infrastructure, the program will: forge new partnerships and nurture existing partnerships with fleet owners, fuel providers, vehicle manufacturers, and State and local governments; provide current, accurate, reliable information on all types of alternative fuels and vehicles; pursue rigorous, structured programs to test and evaluate cars and trucks that use alternative fuels and advanced technologies; implement the alternative fuel requirements of the Energy Policy Act; promote consumer acceptance of advanced technology cars and trucks with significantly improved fuel economy; and work with industry and universities to sponsor advanced vehicle competitions that push the technology envelope and expose numerous people, particularly future vehicle engineers, to these technologies. These deployment programs will help ensure that advanced transportation technologies developed by OTT will achieve sufficient market share to provide significant energy and environmental benefits.

Goals and Performance Measures:

- By 2004, successful program implementation will result in increased penetration of alternative-fuel vehicles and advanced-technology vehicles in selected niche markets, laying a foundation for mass market use of many advanced vehicles by 2010.
- By 2004, student vehicle competitions will yield hundreds of highly trained automotive engineers.
- By 2004, the test and evaluation program will have conducted performance and reliability testing of four additional near market-ready advanced technology vehicles, and provided this information to consumers, fleets, and industry through web-sites and reports.
- By 2005, Federal agencies will have added 50,000-60,000 new alternative-fuel vehicles and improved fleet fuel economy, resulting in a 20 percent reduction in petroleum consumption by Federal fleets compared with FY 1999.

Benefits:

The Department's efforts to encourage the deployment of alternative-fuel and advanced-technology vehicles are linked with and support State and local government initiatives. The Federal investment, together with these complementary efforts, will result in significant changes in the transportation market over the next five years. By 2004, AFVs will have achieved significant commercial success, and ATVs will be poised to enter the market as increasing awareness of the benefits of fuel diversity and fuel-efficient vehicles spurs demand. This program also supports other OTT programs for which GPRA benefit metrics are estimated.

	2005	2010	2020
Petroleum Displaced (Millions Barrels per Day)	0.09	0.11	0.24
Total Primary Energy Displaced (Trillion Btu)	0	0	0
Energy Costs or Savings (Millions of $)	312	348	1,028
Carbon Equivalent Emissions Displaced (MMTCe)	0.8	1.0	2.3

Source: GPRA 2001 EERE Database. Numbers in the above table represent the projected annual benefits in 2005, 2010, and 2020 based on the FY2002 funding request, assuming all program goals are met.

Technology Deployment Accomplishments

FY 2000 Accomplishments:

- Exceeded goal by launching several projects that will lead to 100 percent penetration of alternative fuel vehicles in selected niche applications such as a local taxi fleet or the busses for a particular school.

FY 2001 Ongoing Accomplishments:

- Support the annual acquisition on 12,000 alternative fuel vehicles in the Federal Fleet.

FY 2002 Planned Accomplishments:

- Complete baseline performance testing of a light duty hybrid-electric vehicle.

II. A. Funding Table: TECHNOLOGY DEPLOYMENT

	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request	$ Change	% Change
Clean Cities	$ 7,696	$ 9,927	$ 6,560	$ -3,367	-33.9%
Testing and Evaluation	$ 3,000	$ 2,950	$ 1,800	$ -1,150	-39.0%
EPACT Replacement Fuels Program	$ 1,290	$ 1,300	$ 1,000	$ -300	-23.1%
Advanced Vehicle Competitions	$ 840	$ 840	$ 840	$ 0	0.0%
Total, Technology Deployment	$ 12,826	$ 15,017	$ 10,200	$ -4,817	-32.1%

II. B. Laboratory and Facility Funding Table: TECHNOLOGY DEPLOYMENT

	FY 2000 Enacted	FY 2001 Enacted	FY 2002 Request	$ Change	% Change
Argonne National Lab	$ 1,140	$ 990	$ 900	$ -90	-9.1%
Idaho National Engineering & Environmental Lab	$ 1,460	$ 900	$ 500	$ -400	-44.4%
National Renewable Energy Lab	$ 3,725	$ 4,100	$ 2,800	$ -1,300	-31.7%
Oak Ridge National Lab	$ 600	$ 800	$ 750	$ -50	-6.3%
All Other	$ 5,901	$ 8,227	$ 5,250	$ -2,977	-36.2%
Total, Technology Deployment	$ 12,826	$ 15,017	$ 10,200	$ -4,817	-32.1%

III. Performance Summary: TECHNOLOGY DEPLOYMENT

Program Activity	FY 2000	FY 2001	FY 2002
Clean Cities			
	Core Program Continued to strengthen Clean Cities efforts to deploy alternative fuel vehicles and build alternative fuel refueling stations. Focused efforts on proven niche markets, such as taxis, airport shuttles, transit buses, school buses, delivery fleets, and others. Achieved 100 percent AFV use in specific niche markets in at least two cities. Increased the number of refueling stations by encouraging private investments. Submitted report to Congress on program effectiveness. (EPACT Section 505) (NREL, Other)	**Core Program** Strengthen efforts to deploy additional alternative fuel vehicles and build alternative fuel refueling stations through industry and other partnerships, with a concentration on proven niche markets, such as taxis, airport shuttles, transit buses, school buses, delivery fleets, and welfare to work shuttles. Achieve 100 percent AFV use in specific niche markets in at least ten additional cities. Offer simple, direct rebates to stimulate activity in Clean Cities niche market programs. As number of participating cities grows, increase technical assistance through DOE Regional Offices. Develop performance metrics for coalitions and strategies for strengthening lower performing coalitions. (EPACT Section 505) (NREL, Other)	**Core Program** In support of EPACT Section 505, continue to focus alternative fuel efforts in selected niche markets, and strengthen focus on medium and heavy-duty vehicles. Discontinue rebate activity. Help local coalitions identify non-Federal sources of support to create self-sustaining local programs. Facilitate, through DOE regional offices, local coalition market development, training, and grants management. Continue use of technical assistance teams to help address technical niche market issues raised by local Clean Cities coalitions. (NREL, Other)
	Tools and Training Continued to promote use of	**Tools and Training** Promote use of alternative fuel and	**Tools and Training** In support of EPACT Section 505,

Program Activity	FY 2000	FY 2001	FY 2002
	alternative fuel and fuel efficient advanced technology vehicles. Updated tools with latest technical information. Continued to offer tools through workshops, print media, and the Internet. Co-sponsored, with EPA, regional workshops to discuss and provide information on how advanced technology vehicles can help meet local air quality goals. (EPACT Section 505) (NREL)	fuel efficient advanced technology vehicles through Clean Cities networks. Update tools with latest technical information. Fully integrate advanced technology (fuel efficient) vehicles into fleet buyers guide. Expand access to tools through workshops, print media, and the Internet. Ensure local coordinators have tools to build effective coalitions. (EPACT Section 505) (NREL)	continue efforts to provide targeted niche market assistance and training to a limited number of coalitions. Continue support for the Alternative Fuels Data Center, hotline, and other information dissemination activites. Provide training to coalitions to enable development of stronger organizational coalitions. (NREL)
	Competitive Grants Continued State grants and other public/private partnerships to competitively fund projects that support infrastructure development, vehicle use in niche markets, and technology demonstration. Provided $2.7 million for 54 Special Project State Energy Grants. Continued the National Parks initiative, providing $0.25 million for 27 projects. (EPACT Sections 302, 409) (States)	**Competitive Grants** Issue State grants and other public/private partnership grants to competitively fund projects that support infrastructure development, vehicle use in niche markets, and technology demonstration. Increase grants to $3.8 million for 30-50 Special Project State Energy Grants. Of that, at least $0.75 million will be for Energy Smart School bus projects. Continue, but consolidate the National Parks initiative, providing $0.10 million for 1-2 projects.	**Competitive Grants** In support of EPACT Sections 302 and 409, issue State grants and other public/private partnership grants to competitively fund projects that support infrastructure development, vehicle use in niche markets, and technology demonstration. Provide $2.1 million for 20-35 Special Project State Energy Grants. Of that, at least $0.50 million will be for Energy Smart School bus projects. (States)

III. Performance Summary: TECHNOLOGY DEPLOYMENT (cont.)

Program Activity	FY 2000	FY 2001	FY 2002
		(EPACT Sections 302, 409) (States)	
	Education and Outreach	**Education and Outreach**	**Education and Outreach**
	Continued technical information development, adding additional products addressing near-term advanced fuel efficient technologies, including fuel cells. Sponsored 6th annual Clean Cities conference to showcase commercially available AFVs. Continued to refine the Fuel Economy Guide to improve utilization. Researched the concept for a Clean Cities "Early Adopters" Club to promote fuel efficient advanced technology vehicles. (EPACT Section 405) (ANL, NREL, ORNL, GPO)	Provide technical information on near-term advanced technologies, including fuel cells. Sponsor 7th annual Clean Cities conference to showcase commercially available AFVs and advanced technology vehicles. Expand use of improved Fuel Economy Guide. Initiate efforts to build an alliance with industry and other groups to promote fuel efficient advanced technology vehicles. (EPACT Section 405) (ANL, NREL, ORNL, GPO)	In support of EPACT Section 405, sponsor 8th Annual Clean Cities Conference to showcase commercially available AFVs and advanced technology vehicles. Publish case studies of successful alternative fuel niche market applications. Update the improved Fuel Economy Guide. Continue building alliance to promote fuel efficient advanced technology vehicles. Promote the use of fuel saving anti-idling devices for heavy truck fleets. (ANL, NREL, ORNL, GPO)
	International Coordination: Continued support for international participation in the Clean Cities by helping develop proposals and facilitating U.S. industry partnerships for alternative fuel vehicle use. Worked with Gas Research Institute to help U.S.	International Coordination: Conduct reverse trade missions with selected international partners to showcase U.S. alternative fuel successes. Respond to international requests for information on Clean Cities and invite international partners to the Clean Cities Conference.	International Coordination: Continue one reverse trade mission to showcase U.S. alternative fuel successes. (NREL, Other)

III. Performance Summary: TECHNOLOGY DEPLOYMENT (cont.)

Program Activity	FY 2000	FY 2001	FY 2002
	industry deploy natural gas buses in Santiago, Chile. (NREL) Provided critical technical and program management support services. (QSS) ($248)	(NREL, Other) Provide critical technical and program management support services. (QSS) ($390)	Provide critical technical and program management support services. (QSS) ($300)
Total, Clean Cities	**$7,696**	**$9,927**	**$6,560**
Testing and Evaluation			
	Vehicle Evaluation Completed final year of electric vehicle test and evaluation program. Continued selected AFV testing in partnership with industry. Continued hybrid portion of field testing program, focusing on cost-shared competitive solicitation and placement of vehicles by industry partners. Initiate development of hybrid transit bus testing procedures. (EPACT Sections 601 and 505) (INEEL, NREL, ANL, FTA)	**Vehicle Evaluation** Conduct testing and evaluation of selected first generation light-duty hybrid-electric vehicles. Complete development of hybrid-electric transit bus testing and evaluation procedures. Work in partnership with industry to identify critical performance attributes and help medium and heavy-duty vehicle manufacturers design new advanced technology models to address customer requirements. (EPACT Sections 601 and 505)	**Vehicle Evaluation** In support of EPACT sections 502, and 601, conduct baseline performance testing and accelerated reliability testing of selected light-duty hybrid-electric vehicle models. Conduct baseline performance testing of one additional urban electric vehicle. Discontinue development of hybrid-electric medium and heavy-duty vehicle testing procedures. Complete collecting data from advanced technology transit bus demonstration project.

III. Performance Summary: TECHNOLOGY DEPLOYMENT (cont.)

Program Activity	FY 2000	FY 2001	FY 2002
		(INEEL, NREL, ANL, FTA)	(INEEL, NREL, ANL, FTA, APTA)
	Federal Fleets Continued to support and evaluate electric vehicle use in the Federal fleet in response to the requirements of Executive Orders 13031 and 13149. Helped Federal agencies acquire 12,000 AFVs. Implemented on-line data reporting system for Federal agencies. (EPACT Section 303) (INEEL, NREL, GSA, DOI)	**Federal Fleets** Strengthen the joint DOE/GSA AFV USER program to promote development of alternative fuel refueling infrastructure. Facilitate evaluation and use of advanced technology vehicles by Federal agencies. Help Federal agencies acquire 12,000 AFVs and use more alternative fuel as required by Executive Order 13149. (EPACT Section 303) (INEEL, NREL, GSA, DOI)	**Federal Fleets** In support of EPACT Sections 303 and 502, assist Federal agencies in acquiring 15,000 AFVs and increase the amount of alternative fuel consumed by Federal alternative fuel vehicles. (INEEL, NREL, GSA, DOI)
	Infrastructure Testing Supported expanded demonstration and validation of low cost refueling and liquefaction systems. Expanded deployment of LNG liquefaction technology. (EPACT Section 502) (INEEL, Other)	**Infrastructure Testing** Work with industry partners to identify key infrastructure projects that address technical barriers to expanded use of natural gas, propane, ethanol, and electricity. Initiate interagency effort to work with fuel industry to address deficiencies in tracking sales of alternative fuels. (EPACT Section	**Infrastructure Support** In support of EPACT Sections 303 and 502, continue leading interagency effort to assist industry in developing procedures for accurately tracking sales of alternative fuels. (INEEL, Other)

Program Activity	FY 2000	FY 2001	FY 2002
		502)	No activities.
	Provided critical technical and program management support services (QSS) ($150)	(INEEL, Other) No activities.	
Total, Testing and Evaluation	**$3,000**	**$2,950**	**$1,800**
EPACT Replacement Fuels Program			
	Analysis and Modeling Modeled spillover impacts of light duty regulatory programs on medium and heavy duty fleet use of AFVs. Modeled the potential for use of non-petroleum fuels in blends with conventional fuels. (EPACT Section 502) (ANL, ORNL)	**Analysis and Modeling** Update models with results from regulatory data collection. Incorporate changes due to EPA fuel quality regulations. Expand modeling of hybrid vehicles. Integrate medium and heavy duty vehicles into alternative fuel models. (EPACT Section 502) (ANL, ORNL)	**Analysis and Modeling** In support of EPACT Sections 502, 504, and 506, use updated models to develop improved estimates for penetration of alternative fuels into medium and heavy-duty markets. (ANL, ORNL)
	Regulatory Support Continued enforcement of EPACT State and fuel provider fleet programs, and supported	**Regulatory Support** Expand efforts to improve compliance of EPACT State and fuel provider fleet programs, and support implementation through voluntary	**Regulatory Support** In support of EPACT Sections 501, 502, 504, 506, 507, 508, and 509, continue EPACT compliance

III. Performance Summary: TECHNOLOGY DEPLOYMENT (cont.)

Program Activity	FY 2000	FY 2001	FY 2002
	implementation through voluntary and credit based approaches. Initiated determination of whether to proceed with private and local government fleet program. Completed and submitted the second technical and policy analysis of the Act's replacement fuels goals to the President and Congress. (EPACT Sections 501, 502, 506, 507, and 508) (NREL, ANL, ORNL)	and credit based approaches. Improvements to regulatory fleet programs will include expanded database development, improved processing of exemption requests, and expanded outreach to covered fleets. Review and process petitions to designate new alternative fuels under EPACT. Initiate evaluation of the EPACT replacement fuel goals. (EPACT Sections 501, 502, 506, 507, and 508) (NREL, ANL, ORNL)	efforts for State and fuel provider fleet programs. Review and process petitions to designate new alternative fuels under EPACT. Complete evaluation of EPACT replacement fuel goals and submit for stakeholder and Congressional review. (NREL, ANL, ORNL)
	Provide critical technical and program management support services (QSS) ($143)	Provide critical technical and program management support services (QSS) ($141)	Provide critical technical and program management support services (QSS) ($100)
Total, EPACT Replacement Fuels Program	**$1,290**	**$1,300**	**$1,000**

III. Performance Summary: TECHNOLOGY DEPLOYMENT (cont.)

Program Activity	FY 2000	FY 2001	FY 2002
Advanced Vehicle Competitions			
	Alternative Fuels R&D Initiated the Future Truck 2000 Challenge with a new automotive partner and the inclusion of new university participants. Expanded the demonstration and use of advanced power plants, alternative and reformulated fuels, and advanced lightweight and propulsion materials technologies in large sport utility vehicles. Fuels and vehicle industry partners, suppliers, and professional societies, as well as State and other Federal agencies, provided matching funds. (ASEE, ANL, universities). (PNGV: $840)	**Advanced Vehicle Competitions** Future Truck student participants using first year experience with advanced power plants, alternative and reformulated fuels, and advanced lightweight and propulsion materials technologies in competition vehicles to improve fuel economy and reduce emissions. Fuels and vehicle industry partners, suppliers, and professional societies, as well as State and other Federal agencies providing matching funds. (ASEE, ANL). (PNGV: $840)	**Advanced Vehicle Competitions** Conduct third year of Future Truck Challenge with a new automotive partner, increasing use of fuel cell propulsion systems in student-designed vehicles. Initiate new alternative fuel vehicle competition. (ASEE, ANL). (PNGV: $840)
Total, Advanced Vehicle Competitions	**$840**	**$840**	**$840**
TOTAL, TECHNOLOGY DEPLOYMENT	**$12,826**	**$15,017**	**$10,200**

TRANSPORTATION TECHNOLOGIES
TRANSPORTATION SECTOR
(Dollars in Thousands)

COOPERATIVE PROGRAMS WITH STATES

I. Mission Supporting Goals and Objectives

The Cooperative Programs with States pursues collaborative applied research, development, and demonstration (RD&D) that accelerates the use of clean energy technologies. Collaborating with states provides opportunities to leverage funding for important RD&D that might not otherwise receive adequate support at either the Federal or the State level. These joint efforts, both in applied research and technology field tests, maximize the benefits of clean and efficient building technologies.

In the transportation sector, the Office of Energy Efficiency and Renewable Energy and the States will pursue the work in the following areas: fuel cell vehicles and their associated refueling infrastructure, alternative fuel vehicles and their associated refueling infrastructure and advanced, highly fuel-efficient internal combustion vehicles. Other areas of collaboration with states include materials, motors, controllers and sensors that can improve vehicle component performance and reduce costs.

In FY 2001, this program will complete its second year. Projects funded to date are being performed in collaboration with States and State energy offices. As a result of a slow start for this new program in FY 2000, the project performers funded in FY 2000 and FY 2001 will continue work into FY 2001 and FY 2002, respectively. As a part of EERE's ongoing program evaluation activities, this program will be rebaselined in FY 2002 based on the results of projects completed during FY 2001and FY 2002. For this reason, no additional funds are requested in FY 2002. Upon completion of the new baseline, funds will be requested in FY 2003.

II. A. Funding Table: COOPERATIVE PROGRAMS WITH STATES

Program Activity	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
Cooperative Program with States	$ 1,964	$ 1,996	$ 0	$ -1,996	-100.0%
Total, Cooperative Program with States	$ 1,964	$ 1,996	$ 0	$ -1,996	-100.0%

II. B. Laboratory and Facility Funding Table: COOPERATIVE PROGRAMS WITH STATES

	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
All Other	$ 1,964	$ 1,996	$ 0	$ -1,996	(100.0)%
Total, Cooperative Program with States	$ 1,964	$ 1,996	$ 0	$ -1,996	(100.0)%

III. Performance Summary: COOPERATIVE PROGRAMS WITH STATES

Program Activity	FY 2000	FY 2001	FY 2002
Cooperative Programs with States	Provided cooperative agreements to approximately 6 to 10 States for collaborative applied research, development, and field testing. Partnerships were encouraged with industry, national laboratories, and other entities. Areas of effort were fuel cell vehicles and refueling infrastructure; alternative fuel vehicles and refueling infrastructure; and advanced highly fuel efficient vehicles. Other areas for collaboration with the states included materials, motors, controllers, sensors, etc. Existing state fleets provided an excellent test bed for vehicles with PEM fuel cell, alternative fuel, or advanced fuel efficient propulsion units. Similarly, establishing refueling infrastructure at centralized fleet sites also provided excellent test beds. Projects were designed to provide important feedback to manufacturers, researchers, and operators as the technology matures. ($1,964)	Provide cooperative agreements to approximately 6 to 10 States for collaborative applied research, development, and field testing. Partnerships will be encouraged with industry, national laboratories, and other entities. Areas of effort are expected to be fuel cell vehicles and refueling infrastructure; alternative fuel vehicles and refueling infrastructure; and advanced highly fuel efficient vehicles. Other areas for collaboration with the states could include materials, motors, controllers, sensors, etc. Existing state fleets would provide an excellent test bed for vehicles with PEM fuel cell, alternative fuel, or advanced fuel efficient propulsion units. Similarly, establishing refueling infrastructure at centralized fleet sites also would provide excellent test beds. Projects will be designed to provide important feedback to manufacturers, researchers, and operators as the technology matures. ($1,996)	As part of EERE's ongoing program evaluation activities, this program will be rebaselined in FY 2002 on the results of projects completed during FY 2001 and FY 2002. For this reason, no additional funds are requested in FY 2002. Upon completion of the new baseline, funds will be requested in FY 2003. ($0)
TOTAL, COOPERATIVE PROGRAMS WITH STATES	**$1,964**	**$1,996**	**$0**

TRANSPORTATION TECHNOLOGIES
TRANSPORTATION SECTOR
(Dollars in Thousands)

ENERGY EFFICIENCY SCIENCE INITIATIVE

I. Mission Supporting Goals and Objective

The Energy Efficiency Science Initiative seeks to identify and fund "bridging" research and development (R&D) that falls between fundamental exploratory science and pre-commercial applied R&D. By stimulating R&D that maximizes synergies among different research fields, technologies, investigator communities, and end-use applications, this initiative expands EERE's R&D activities among energy efficiency technologies. It also cuts across traditional energy end-use sectors by emphasizing distributed power generation applications for industrial and buildings systems, transportation, and stationary power.

This initiative expands on existing cooperative efforts with the Office of Fossil Energy in areas such as natural gas-fueled turbine and fuel cell technologies, combined heat, power and cooling applications, hydrogen production, and carbon emission sequestration. This effort also involves extensive coordination with the Office of Science in pursuing follow-on research in areas critical to energy efficiency and clean energy development, such as basic biosciences, plant genetics, photo emission, heat transfer, new materials, catalysts, and computational science.

In FY 2001, this program will complete its second year. Projects funded to date are being performed in collaboration with academia in partnership with the National Laboratories. As a result of a slow start for this new program in FY 2000, the project performers funded in FY 2000 and FY 2001 will continue work into FY 2001 and FY 2002, respectively. As a part of EERE's ongoing program evaluation activities, this program will be rebaselined in FY 2002 based on the results of projects completed during FY 2001and FY 2002. For this reason, no additional funds are requested in FY 2002. Upon completion of the new baseline, funds will be requested in FY 2003.

II. A. Funding Table: ENERGY EFFICIENCY SCIENCE INITIATIVE

Program Activity	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
Energy Efficiency Science Initiative	$ 3,830	$ 3,891	$ 0	$ -3,891	-100.0%
Total, Energy Efficiency Science Initiative	$ 3,830	$ 3,891	$ 0	$ -3,891	-100.0%

II. B. Laboratory and Facility Funding Table: ENERGY EFFICIENCY SCIENCE INITIATIVE

	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
All Other	$ 3,830	$ 3,891	$ 0	$ -3,891	-100.0%
Total, Energy Efficiency Science Initiative	$ 3,830	$ 3,891	$ 0	$ -3,891	-100.0%

III. Performance Summary: ENERGY EFFICIENCY SCIENCE INITIATIVE

Program Activity	FY 2000	FY 2001	FY 2002
Energy Efficiency Science Initiative	**Energy Efficiency Science Initiative** This new initiative supported R&D to bridge the gap between fundamental exploratory science and pre-commercial applied R&D. Conducted a first-of-a-kind strategic visioning workshop (e-vision 2000) involving forefront building designers, industrial and transportation experts and academics whose energy efficiency ideas expand the possibilities of technology options for our Nation's future. This workshop informed program design in the FY 2002 Budget Request and defined specific R&D projects for FY 2001 implementation. Awarded 4 cooperative agreements under a competitive solicitation. One project is to develop and demonstrate a hybrid solar lighting system for daylighting commercial buildings. One project is to advance micro-technology based gas-fired heat pumps. Two other projects will develop new materials with enhanced properties. ($3,830)	**Energy Efficiency Science Initiative** As part of the continuing initiative to support R&D to bridge the gap between fundamental exploratory science and pre-commercial applied R&D, EERE will conduct a follow-on strategic visioning workshop (e-vision 2001). This workshop will build on the tremendous technology possibilities identified during e-vision 2000, and will broaden the understanding of the proposed options for the Nation's energy future. In the future, it is expected that the e-vision workshops will be conducted biennially. Up to 5 research projects will be awarded as a follow-on to recommendations from e-vision 2000. Additionally, provide for continuation of the hybrid solar lighting project. Award 4 to 8 new cooperative agreements to support R&D that bridges the gap between fundamental exploratory science and pre-commercial applied R&D. The goal is to stimulate R&D in the private and public sectors that maximizes funding and investment opportunities by	**Energy Efficiency Science Initiative** As a part of EERE's ongoing program evaluation activities, this program will be rebaselined in FY 2002 based on the results of projects completed during FY 2001 and FY 2002. For this reason, no additional funds are requested in FY 2002. Upon completion of the new baseline, funds will be requested in FY 2003. ($0)

III. Performance Summary: ENERGY EFFICIENCY SCIENCE INITIATIVE (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Energy Efficiency Science Initiative (Cont'd)	Participants included: U. of NV, Battelle, U. of WI, Holyoke Center.	exploring and exploiting synergies among different research fields, technologies, investigator communities, and end-use applications. ($3,891) Participants include: TBD.	
TOTAL, ENERGY EFFICIENCY SCIENCE INITIATIVE	**$3,830**	**$3,891**	**$0**

TRANSPORTATION TECHNOLOGIES
TRANSPORTATION SECTOR
(Dollars in Thousands)

MANAGEMENT AND PLANNING

I. Mission Supporting Goals and Objectives

The OTT Management and Planning function supports the Office of Transportation Technologies by providing sector-level analysis, assessment, evaluation, and planning functions.

Effective management requires efficient organizational design, adequate human resources, sufficient and high quality information and excellent communication both within the organization and with outside parties. Moreover, understanding the potential for increasing the penetration of energy-efficient and clean energy technologies in the transportation sector and for achieving the correct balance requires a solid analytical foundation. The Management and Planning function provides this foundation by carrying out the evaluation, planning, analysis and program direction functions necessary to effectively guide and support all OTT programs.

Management and Planning provides fully integrated program direction to plan, manage, and oversee the research, development, and technology deployment efforts within the transportation program. Management and Planning also provides the information, guidance, and direction necessary for the OTT staff to implement the National Academy of Public Administration (NAPA) Implementation Plan, the EERE Strategic Management System, and Strategic Plan.

The Management and Planning function includes Analysis, Technology Assessment, and Program Direction. The analysis function is accomplished by collecting and analyzing technology and market data, using computer models to project technology potential and market share, and calculating program benefits. The analysis function also produces the annual *Transportation Energy Data Book* which is used by OTT program managers and by individuals in many federal and state agencies as a desk-top reference for statistics and information that characterize transportation activity and which present data on other factors that influence transportation energy use.

The technology assessment function measures impacts, benefits, and costs of advanced transportation vehicle and fuel technologies. A system of models has been created that: (1) estimates the market shares of new light duty vehicle sales for alternative fuel and advanced vehicle technologies; and (2) calculates the alternative fuel use, petroleum use reductions and changes in criteria pollutant and global climate change emissions. These models are continually improved and updated to account for new technology developments and to be consistent with projections prepared by the Energy Information Administration. The models are also used to estimate the benefits and likely consequences of individual technology programs during budget formulation and program planning process within the Office of Transportation Technologies.

Program Direction includes R&D feasibility studies; R&D option development and trade off analyses; technical, economic and market evaluations of R&D; and contract audit costs. These activities provide important benefits directly to the R&D programs.

II. A. Funding Table: MANAGEMENT AND PLANNING

Program Activity	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
Technology Assessment and Analysis	$ 1,700	$ 1,700	$ 1,700	$ 0	0.0%
Program Direction	$ 7,295	$ 7,452	$ 8,532	$ 1,080	14.5%
Total, Management and Planning	$ 8,995	$ 9,152	$ 10,232	$ 1,080	11.8%

II. B. Laboratory and Facility Funding Table: MANAGEMENT AND PLANNING

	FY 2000 Comparable	FY 2001 Comparable	FY 2002 Request	$ Change	% Change
Argonne National Lab	$ 1,000	$ 940	$ 1,000	$ 60	6.4%
National Renewable Energy Lab	$ 200	$ 250	$ 250	$ 0	0.0%
Oak Ridge National Lab	$ 360	$ 460	$ 460	$ 0	0.0%
All Other	$ 7,435	$ 7,502	$ 8,522	$ 1,020	13.6%
Total, Management and Planning	$ 8,995	$ 9,152	$ 10,232	$ 1,080	11.8%

III. Performance Summary: MANAGEMENT AND PLANNING

Program Activity	FY 2000	FY 2001	FY 2002
Technology Assessment and Analysis	**Technology Assessment and Analysis** Continued to improve the quality metrics methodology for estimating the impacts (oil savings, energy reduction, greenhouse gas reduction, employment, Gross Domestic Product (GDP) changes, and criteria pollutant changes) of the technologies supported by the Office of Transportation Technologies (OTT). Continued to provide data and analytic assistance to OTT program managers. Published and distributed Edition 20 of the *Transportation Energy Data Book*. Undertook a major effort to estimate the costs of advanced vehicle technologies, with emphasis on the cost of vehicles capable of tripling fuel economy. ($1,674) Participants included: ANL, ORNL, NREL.	**Technology Assessment and Analysis** Expand the quality metrics methodology to deal in greater detail with the deployment of advanced technologies in niche markets and out to the year 2030. Improve the methodology for estimating oil savings, energy reductions, greenhouse gas reductions, employment changes, Gross Domestic Product changes, and criteria emission impacts resulting from the introduction of advanced vehicle and fuel technologies into the market place. Publish and distribute Edition 21 of the *Transportation Energy Data Book* and include information on advanced vehicle sales and prices. Expand the effort to estimate the costs of advanced vehicle technologies such as hybrid vehicles, fuel cell vehicles and electric vehicles. ($1,650) Participants include: ANL, ORNL, NREL.	**Technology Assessment and Analysis** Expand the quality metrics methodology to deal in greater detail with the deployment of advanced technologies in fleet applications to the year 2030. Publish and distribute Edition 22 of the *Transportation Energy Data Book* and include information on hybrid vehicle sales and prices. ($1,650) Participants include: ANL, ORNL, NREL.

III. Performance Summary: MANAGEMENT AND PLANNING (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Technology, Assessment and Analysis (Cont'd)	Provide critical technical support services. (Antares). ($26)	Provide critical technical support services. (Antares). ($50)	Provide critical technical support services. (TBD). ($50)
Total, Technology Assessment and Analysis	**$1,700**	**$1,700**	**$1,700**
Program Direction	The following is a breakdown of the funding by Object Class: 11.9 Personnel compensation $ 4,754 12.1 Civilian personnel benefits $ 1,155 21.0 Travel and transportation of persons $ 458 25.0 Other contractual services $ 23 Provided funds for salaries, benefits, and travel (including normal increases in both salaries and benefits) to support 57 FTEs needed to conduct and monitor research, development, and other activities associated with various transportation technologies, at Headquarters (56) and in the field (1). FY 2000 funding provided for staffing adjustments resulting from Workforce 21 plans. Total obligational authority of $6,390,000 included an estimated $242,000 of FY 1999 unobligated carryover. ($6,148)	The following is a breakdown of the funding by Object Class: 11.9 Personnel compensation $ 5,540 12.1 Civilian personnel benefits $ 1,385 21.0 Travel and transportation of persons $ 510 25.0 Other contractual services $ 25 Provide funds for salaries, benefits, and travel (including normal increases in both salaries and benefits) to support 63 FTEs needed to conduct and monitor research, development, and other activities associated with various transportation technologies, at Headquarters (62) and in the field (1). Total obligational authority of $7,460,000 for Program Direction includes $1,158,000 from FY 2000 unobligated carryover funds in Program Direction. ($6,302) Also supports a systematic analysis of	The following is a breakdown of the funding by Object Class: 11.9 Personnel compensation $ 5,870 12.1 Civilian personnel benefits $ 1,470 21.0 Travel and transportation of persons $ 550 25.0 Other contractual services $ 642 The request provides funds for salaries, benefits, and travel (including normal increases in both salaries and benefits) to support 63 FTEs needed to conduct and monitor research, development, and other activities associated with various transportation technologies, at Headquarters (62) and in the field (1). Provide increased management support for the 21st Century Truck Program. ($7,890)

III. Performance Summary: MANAGEMENT AND PLANNING (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
Program Direction (Cont'd)		critical staffing needs within the context of current and projected R&D program missions, and the development of a comprehensive plan that will focus on building and sustaining a talented and diverse workforce of R&D Technical Managers.	
Management Support Services	TRANSFER FROM: Vehicle Technologies R&D, Fuels Utilization R&D, Materials Technologies, Technology Deployment, and Management and Planning	TRANSFER FROM: Vehicle Technologies R&D, Fuels Utilization R&D, Materials Technologies, Technology Deployment, and Management and Planning	
	Consistent with other DOE programs under the jurisdiction of the Interior and Related Agencies Appropriations Committees, the Energy Conservation programs provided funding for Management Support Services, which includes activities such as improving the effectiveness, efficiency, and economy of management and general administrative services. These activities are critical to the planning, formulation, and execution of the Energy Conservation programs.	Consistent with other DOE programs under the jurisdiction of the Interior and Related Agencies Appropriations Committees, the Energy Conservation programs provides funding for Management Support Services, which includes activities such as improving the effectiveness, efficiency, and general administrative services. These activities are critical to the planning, formulation, and execution of the Energy Conservation programs. (PNGV: $451) ($1,150)	Consistent with other DOE programs under the jurisdiction of the Interior and Related Agencies Appropriations Committees, the Energy Conservation programs provides funding for Management Support Services, which includes activities such as improving the effectiveness, efficiency, and general administrative services. These activities are critical to the planning, formulation, and execution of the Energy Conservation programs. (PNGV: $460) ($642)

III. Performance Summary: MANAGEMENT AND PLANNING (Cont'd)

Program Activity	FY 2000	FY 2001	FY 2002
	(PNGV: $248) ($1,147)		
Total, Program Direction	**$7,295**	**$7,452**	**$8,532**
TOTAL, MANAGE-MENT AND PLANNING	**$8,995**	**$9,152**	**$10,232**

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST
ENERGY EFFICIENCY AND RENEWABLE ENERGY
ENERGY CONSERVATION
(Dollars in Thousands)

FY 2002 Management Support Services Comparability Matrix

	New Structure	Management and Planning	
		Program Direction	
F	FY 2000 Structure	Management Support Services	Total
Y	Transportation Sector		
	Vehicle Technology R&D	375	375
2	Fuels Utilization R&D	18	18
0	Materials Technologies	68	68
0	Technology Deployment	14	14
0	Management and Planning	672	672
	Total	1,147	1,147

DEPARTMENT OF ENERGY
FY 2002 CONGRESSIONAL BUDGET REQUEST
ENERGY EFFICIENCY AND RENEWABLE ENERGY
ENERGY CONSERVATION
(Dollars in Thousands)

FY 2002 Management Support Services Comparability Matrix

	New Structure	Management and Planning	
		Program Direction	
F	FY 2001 Structure	Management Support Services	Total
Y	Transportation Sector		
	Vehicle Technology R&D	338	338
2	Fuels Utilization R&D	39	39
0	Materials Technologies	184	184
0	Technology Deployment	90	90
1	Management and Planning	499	499
	Total	1,150	1,150