FreedomCAR and Vehicle Technologies Program

Program Mission

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

This mission is accomplished by targeted Federal investments in technology development in partnership with auto manufacturers, heavy vehicle manufacturers, equipment suppliers, energy companies, other Federal agencies, State government agencies, universities, national laboratories, and other stakeholders. These partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits for the American taxpayer. The program focuses its technology development investments specifically on areas that would not be pursued by industry alone due to high risks and uncertain or long-term outcomes.

Program activities include research, development, demonstration, testing, technology validation, technology transfer, and education. These activities are aimed at developing technologies that could achieve: 1) significant improvements in vehicle fuel efficiency; and 2) displacement of oil by other fuels which ultimately can be domestically produced in a clean and cost-competitive manner.

Two efforts represent the major crosscutting elements of the program, the FreedomCAR Partnership and the 21st Century Truck (21CT) Partnership. The FreedomCAR Partnership addresses both of these aims and is jointly executed with the Hydrogen, Fuel Cells, and Infrastructure Technologies (HFCIT) Program. The CAR in FreedomCAR stands for Cooperative Automotive Research. The FreedomCAR Partnership is undertaken in collaboration with the U.S. Council for Automotive Research (USCAR). USCAR is a partnership between the Ford, General Motors and DaimlerChrysler corporations to strengthen the technology base of the U.S. domestic automotive industry through cooperative, pre-competitive research. The 21st Century Truck Partnership, the other major crosscutting effort, has similar aims, but is focused on improving technologies for heavy vehicles. The truck partnership involves key members of the heavy vehicle industry, truck original equipment manufacturers, hybrid propulsion developers, and engine manufacturers.

Accomplishing this mission and these activities contributes to several national energy and environmental policy objectives. For example, the National Energy Policy calls for reducing dependence on oil imports and modernizing conservation technologies and practices. President Bush observed that ". . . any effort to reduce (oil) consumption must include ways to safely make cars and trucks more fuel efficient. New technology is the best way to do so."[a] In fact, more energy efficient vehicles will enable U.S. citizens and businesses to accomplish their daily tasks while reducing their consumption of gasoline and diesel fuels, thus reducing demand for petroleum, lowering carbon emissions, and decreasing energy expenditures. These changes can help to

[a] Remarks by President George W. Bush on Energy Efficiency, Feb. 25, 2002.

make the Nation more secure and more prosperous while protecting the environment.

America currently imports more than half of the oil we consume, and transportation accounts for 69 percent of the Nation's oil use. Transportation is dependent on oil for 95 percent of its energy. Unless highway vehicles become more efficient and suited for alternative fuels, the historical trend toward increasing dependence on foreign oil will continue. For example, the percentage of oil imports is expected to rise to 64 percent by 2015.

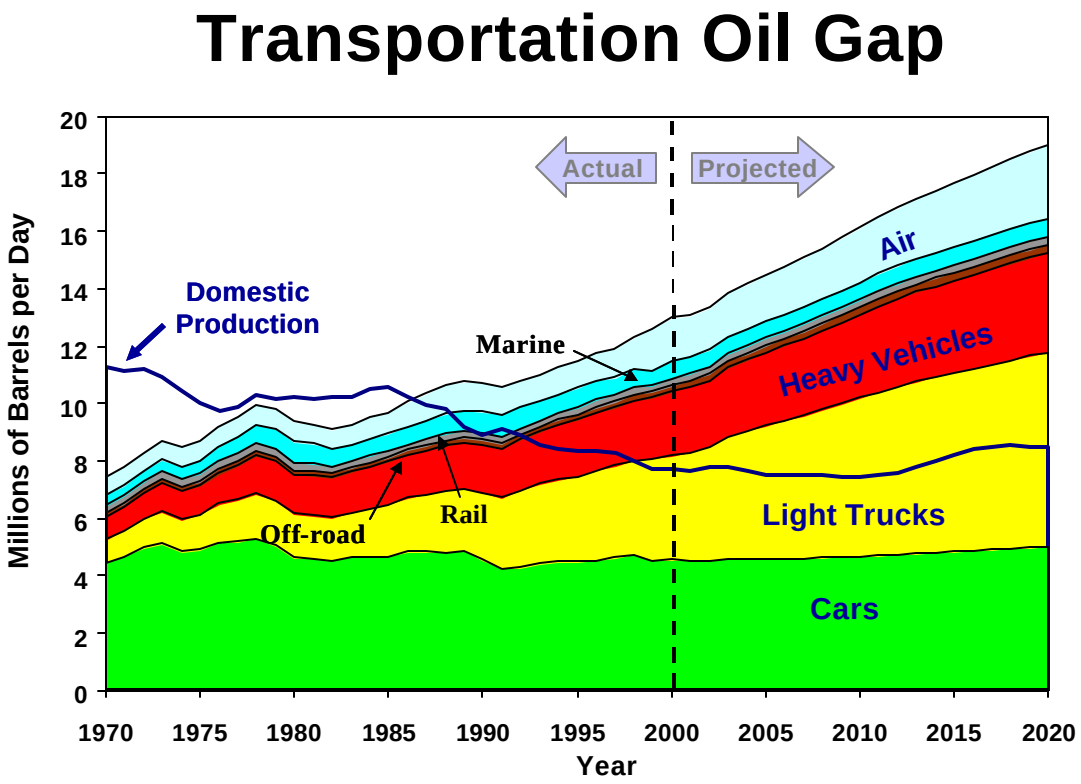
Cleaner and more energy efficient highway transportation technologies face several market barriers in gaining consumer acceptance and private investment from manufacturers. For example, American consumers do not place fuel economy near the top of the list of desired attributes in car purchasing decisions (due to the relatively low prices paid in the U.S. for petroleum-based fuels). Surveys show that the average new vehicle buyer wants about a three year payback period for investment in fuel efficient technologies. As a result, manufacturers have been reluctant to provide the significant levels of investment required for the production and distribution of advanced vehicle technologies and alternative vehicle fuels.

The program is focused on technologies to reduce oil use by cars, light trucks, and heavy vehicles, the vehicles that account for over three-fourths of the oil used by transportation and over 50 percent of U.S. oil use in 2000 and projected to be used in 2020 (see the following graph). The largest portion of projected future oil use growth is accounted for by light trucks and heavy vehicles. Light trucks include vehicles (pickups, vans and sport utility vehicles) with a gross vehicle weight (GVW) up to 10,000 pounds. Heavy vehicles include medium trucks (classes 3 to 6, with GVW of 10,000 to 26,000 pounds), heavy trucks (classes 7 to 8, with GVW over 26,000 pounds), and buses.

In establishing technical directions and priorities, the program has obtained substantial inputs from energy and transportation experts from outside of DOE through interaction of government-industry-laboratory technical teams, project reviews with selected panelists, solicited review of DOE R&D plans, and critiques by organizations such as the National Academy of Sciences (NAS). The perspectives of these outside experts are extremely valuable in helping to assure that the program's research directions and priorities are aligned properly with the needs of auto and heavy vehicle manufacturers, equipment suppliers, energy companies, other Federal agencies, State agencies, consumers, and other stakeholders. In addition, the program invests in technical program and market analysis and performance assessment in order to direct effective strategic planning.

The FreedomCAR Partnership supersedes and builds upon the successes of the Partnership for a New Generation of Vehicles (PNGV) that began in 1993. It is, however, different in scope and breadth. FreedomCAR shifts government research to more fundamental, higher risk activities, with applicability to multiple passenger vehicle models and special emphasis on development of fuel cells. FreedomCAR is being jointly developed and implemented with the HFCIT Program. Funding for FreedomCAR comes from both Programs. For example, all of FreedomCAR's planned activities dealing with polymer electrolyte fuel cells are funded by the HFCIT Program. The remainder of FreedomCAR's planned R&D activities, including Partnership direction and support, are funded by the FCVT Program. The hydrogen production, storage, and infrastructure technologies needed to advance commercialization of fuel cell vehicles are now part of a larger and complementary Administration effort on hydrogen fuel, which involves partnering with energy companies. (See the HFCIT section.)

The FreedomCAR Partners have identified nine challenging high-level technical goals and timetables for government and industry R&D efforts, to measure progress in technologies that could enable reduced oil consumption and increased energy efficiency in passenger vehicles.



Source: Transportation Energy Data Book: Edition 21, DOE/ORNL-6966, September 2001, and EIA Annual Energy Outlook 2002, DOE/EIA-0383(2002), December 2001

FreedomCAR 2010 Technology Goals

Responsibility for the goals is divided between two EERE program offices as follows:

The Office of FreedomCAR and Vehicle Technologies has exclusive responsibility for four goals, and shares one with the Office of Hydrogen, Fuel Cells, and Infrastructure Technologies:

Electric Propulsion Systems with a 15-year life capable of delivering at least 55 kW for 18 seconds, and 30 kW continuous at a system cost of $12/kW peak.

Internal Combustion Engine Powertrain Systems costing $30/kW, having a peak brake engine efficiency of 45%, and that meet or exceed emissions standards.

Electric Drivetrain Energy Storage with 15-year life at 300 Wh with discharge power of 25 kW for 18 seconds and $20/kW.

Material and Manufacturing Technologies for high volume production vehicles which enable/support the simultaneous attainment of: 50% reduction in the weight of vehicle structure and subsystems, affordability, and increased use of recyclable/renewable materials.

Internal Combustion Engine Powertrain Systems operating on hydrogen with a cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45%, and that meet or exceed emissions standards. (Shared)

The Office of Hydrogen, Fuel Cells, and Infrastructure Technologies has exclusive responsibility for four goals, and shares one with the Office of FreedomCAR and Vehicle Technologies:[a]

60% peak energy-efficient, durable Fuel Cell Power Systems (including hydrogen storage) that achieves a 325 W/kg power density and 220 W/L operating on hydrogen. Cost targets are $45/kW by 2010 and $30/kW by 2015.

Fuel Cell Systems (including a fuel reformer) having a peak brake engine efficiency of 45%, and that meet or exceed emissions standards with a cost target of $45/kW by 2010 and $30/kW by 2015.

Hydrogen Refueling Systems demonstrated with developed commercial codes and standards and diverse renewable and non-renewable energy sources. Targets: 70% energy efficiency well-to-pump; cost of energy from hydrogen equivalent to gasoline at market price, assumed to be $1.50 per gallon ($ 2001).

Hydrogen Storage Systems demonstrating an available capacity of 6 weight percent hydrogen, specific energy of 2000 W-h/kg, energy density of 1100 W-h/liter at a cost of $5/kWh.

Internal Combustion Engine Powertrain Systems operating on hydrogen with a cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45%, and that meet or exceed emissions standards. (Shared)

[a]To be coordinated with Hydrogen Fuel Partnership.

FCVT Component of FreedomCAR Partnership
Funding Profile
(additional funds are in the HFCIT Budget)

(dollars in thousands)

	FY 2003 Comp. Request	FY 2004 Amended Request	$ Change	% Change
Vehicle Systems				
Ancillary Systems	1,100	1,200	+100	+9.1%
Simulation and Validation	2,600	2,600	0	0.0%
Innovative Concepts				
CARAT	500	0	-500	-100.0%
GATE	500	500	0	0.0%
Hybrid and Electric Propulsion				
Energy Storage (EV & HPES)	21,110	28,700	+7,590	+36.0%
Advanced Power Electronics	13,690	13,690	0	0.0%
Subsystem Integration and Dev.	3,135	3,135	0	0.0%
Advanced Combustion Engine				
Combustion and Emission Control	13,976	12,799	-1,177	-8.4%
Materials Technology				
Propulsion Materials Technology	1,000	3,000	+2,000	+200.0%
Lightweight Materials Technology	9,600	17,840	+8,240	+85.8%
Fuels Technology				
Advanced Petroleum Based Fuels	5,100	4,000	-1,100	-21.6%
Non-Petro. Based Fuels & Lubes	300	300	0	0.0%
Technology Introduction				
Advanced Vehicle Competitions	1,000	1,000	0	0.0%
Technical/Program Mgmt Support	865	865	0	0.0%
Biennial Peer Review of FreedomCAR	-	1,500	+1,500	NA
TOTAL	74,476	91,129	+16,653	+22.4%

The nine 2010 technology specific goals were developed by government/industry technical teams in early calendar year 2002 based on FY 2002 DOE funding levels and ratified by the Partnership's Executive Steering Group comprised of senior government and industry officials. FreedomCAR goals added greater emphasis on efficiency and cost of technologies.

The funding request for the FCVT component of the FreedomCAR crosscut increases by 22.4 percent and reallocates funding to longer-term, higher-risk activities that the private sector is less likely to undertake without Federal support.

The 21st Century Truck Partnership is a significant cooperative effort between the heavy-duty truck and bus industry and major Federal agencies to develop technologies that will make our Nation's trucks safer, cleaner, and more efficient. The government agency participants are the Departments of Energy, Defense (represented by the U.S. Army), Transportation, and the Environmental Protection Agency. Industry partnership members are Allison Transmission, BAE Systems, Caterpillar, Cummins, DaimlerChrysler, Detroit Diesel, Eaton Corporation, Freightliner, Honeywell, International Truck and Engine, Mack Trucks, NovaBUS, Oshkosh Truck, PACCAR, and Volvo Trucks North America.

The industry and government Partners have developed a common vision -- "that our nation's trucks and buses will safely and cost-effectively move larger volumes of freight and greater numbers of passengers while emitting little or no pollution and dramatically reducing the dependency on foreign oil." Ultimately, the Partnership seeks safe, secure, and environmentally friendly trucks and buses that use sustainable and self-sufficient energy sources thereby enhancing America's global competitiveness.

Research focus areas for the 21st Century Truck Partnership include:

- Engine, combustion, exhaust aftertreatment, and advanced materials to achieve both significantly higher efficiency and lower emissions.
- Advanced heavy-duty hybrid propulsion systems that will reduce energy consumption and pollutant emissions.
- Reduction of parasitic losses to achieve significantly reduced energy consumption.
- Development of technologies to improve truck safety, resulting in the reduction of fatalities and injuries in truck-involved crashes.
- Development and deployment of technologies that substantially reduce energy consumption and exhaust emissions during idling.

FCVT Component of 21st Century Truck Partnership
Funding Profile

(dollars in thousands)

	FY 2003 Comp. Request	FY 2004 Amended Request	$ Change	% Change
Vehicle Systems				
Heavy Vehicle Systems	10,714	10,714	0	0.0%
Innovative Concepts				
STICK	600	0	-600	-100.0%
Hybrid and Electric Propulsion				
Subsystem Integration and Dev.	4,038	4,038	0	0.0%
Advanced Combustion Engine				
Combustion and Emission Control	3,595	2,201	-1,394	-38.8%
Light Truck Engine	13,106	13,106	0	0.0%
Heavy Truck Engine	6,979	6,979	0	0.0%
Waste Heat Recovery	500	500	0	0.0%
Off-Highway Vehicles	500	0	-500	-100.0%
Health Impacts	1,500	1,500	0	0.0%
Materials Technology				
Propulsion Materials Technology	5,850	5,850	0	0.0%
Lightweight Materials Technology	8,950	8,950	0	0.0%
Fuels Technology				
Advanced Petroleum Based Fuels	8,224	0	-8,224	-100.0%
Non-Petro. Based Fuels & Lubes	2,000	2,500	+500	+25.0%
Environmental Impacts	2,375	0	-2,375	-100.0%
Technical/Program Mgmt Support	1,156	1,156	0	0.0%
TOTAL	70,087	57,494	-12,593	-18.0%

The FCVT Program is organized into the following subprograms and activities. Nearly all of the activities are coordinated with the U.S. auto or trucking industries under the FreedomCAR or 21st Century Truck partnerships, respectively.

Vehicle Systems
- Heavy Vehicle Systems
- Ancillary Systems
- Simulation and Validation

Innovative Concepts
- Cooperative Automotive Research for Advanced Technology (CARAT)
- Graduate Automotive Technology Education (GATE)
- Stimulate Truck Innovative Concepts and Knowledge (STICK)

Hybrid and Electric Propulsion
- Energy Storage
- Advanced Power Electronics
- Subsystem Integration and Development

Advanced Combustion R&D
- Combustion and Emission Control
- Light Truck Engine
- Heavy Truck Engine
- Waste Heat Recovery
- Off-Highway Vehicles
- Health Impacts

Materials Technologies
- Propulsion Materials Technologies
- Lightweight Materials Technologies
- High Temperature Materials Laboratory

Fuels Technology
- Advanced Petroleum-Based Fuels
- Non-Petroleum Fuels and Lubricants
- Environmental Impacts

Technology Introduction
- Legislative and Rulemaking
- Testing and Evaluation
- Advanced Vehicle Competitions

Program Benefits

Each year, EERE estimates the benefits of program activities to support Government Performance and Results Act (GPRA) reporting. Methods are complex and vary by program. A complete explanation of methodology and assumptions will be posted this spring on line at www.eren.doe.gov/eere/budget.html. An overview of the methods and results for the FCVT Program is provided below.

EERE's benefits estimate modeling starts with the Energy Information Administration's (EIA's) National Energy Modeling System (NEMS) and modifies it to create NEMS-GPRA04. The Baseline for transportation programs is essentially the EIA's Annual Energy Outlook (AEO) 2002 reference case, which already includes some small amount of penetration for the program's vehicle technologies. The program goals for hybrid vehicles and advanced combustion R&D are modeled directly in NEMS-GPRA04 by incorporating the vehicle costs, efficiencies, and other attributes in NEMS-GPRA04 for the program case. The Materials Technologies program develops lightweight materials for use in primarily light-duty vehicles. Because of its interaction with the other light-duty vehicle R&D efforts, the benefit estimates for materials are assumed to be a small share of these programs. Program outreach activities are modeled by removing the consumer bias towards conventional gasoline vehicles assumed in the Baseline. Heavy truck benefits are modeled by incorporating into NEMS-GPRA04 the energy savings results of separate analysis performed by T.A. Engineering, Inc.[a]

[a] Benefits reported in the table are annual, not cumulative, for each year given. Estimates reflect the benefits associated with program activities from FY 2004 to the benefit year or to program completion (whichever is

FY 2004 GPRA Benefits Estimates for FreedomCAR & Vehicles Program (NEMS-GPRA04)			
	2005	2010	2020
Non-Renewable Energy Savings (quads)	0.08	0.32	1.58
Oil Savings (quads)	0.06	0.34	1.51
Carbon Savings (MMT)	1.3	6.4	29.8
Energy Expenditure Savings (B2000$)	3.0	9.4	25.5

Hybrid Systems R&D and Advanced Combustion R&D results are applicable to both passenger cars and light-duty trucks. In the NEMS-GPRA04 integrating model, the light-duty vehicle (LDV) market consists of six car classes (mini compact, sub-compact, compact, midsize, large, 2-seater) and six light duty truck classes (small and large pickup, small and large van, small and large sport utility vehicle) in nine census regions. For each vehicle type and class and for each region, a number of LDV technologies compete against each other for vehicle sales. These include conventional gasoline, advanced combustion diesel, gasoline hybrids, diesel hybrids, gasoline fuel cell, hydrogen fuel cell, electric, natural gas, and alcohol. The penetration (sales) of the various technologies in the market for each type of light-duty vehicles over time reflect expected vehicle and fuel prices and assumed consumer preferences.

The FreedomCAR and Vehicle Technologies Program works with its research partners to develop the technologies necessary to significantly increase the fuel efficiency of cars and trucks. Estimates for energy savings, oil savings, carbon emission reductions, and energy expenditure savings resultant from realization of FCVT Program goals are shown in the table above for the 2020 time frame. These estimates reflect EIA reference case assumptions about future energy markets. At an oil price of about $25 per barrel, as projected by EIA, consumers are likely to use these technologies in ways that save the country 0.7 mmbd in oil by the year 2020 – about 3.5 percent of the expected total oil use for transportation. The development of these technologies will provide the country with greater opportunity for energy and oil savings in the event oil prices are higher or more volatile than expected, or if air quality, security, or other concerns result in changes in energy policy or encourage consumers to change the extent to which they purchase more efficient vehicles.

These results are sensitive to the modeling assumptions about consumer preferences made in the model, especially with regard to vehicle purchase price. Use of the same vehicle characterizations in EERE's Transportation Quality Metrics Model would result in substantially greater oil savings in 2020. Both modeling approaches are based on existing consumer studies, with the differences in results attributable to differences in the survey design. The modeling also did not take into account the potential for hybrid and other efficient vehicle sales in response to local market conditions, such as State and local vehicle preferences (e.g., use on carpool lanes). Fuel cell vehicles were modeled along with the Hydrogen, Fuel Cells & Infrastructure Technologies Program, which reduces the reported benefits of each program (in comparison to their being modeled separately), given their overlapping markets.

By providing technologies able to increase the fuel efficiency of vehicles, the FCVT Program can help reduce

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nearer), and are based on program goals developed in alignment with assumptions in the President's Budget.

local air pollution and make it easier for metropolitan areas to meet local Clean Air Act attainment requirements.

Program Strategic Performance Goals

The FCVT Program has the following overall performance goal: 1) by 2006, the Heavy Vehicle Systems activities develop technologies that will enable reduction of parasitic energy losses, including losses from aerodynamic drag, from 39 percent of total engine output in 1998 to 24 percent; 2) by 2010, Hybrid and Electric Propulsion R&D activities will reduce the production cost of a high power 25kW battery for use in light vehicles from $3,000 in 1998 to $500, with an intermediate goal of $750 in 2006 enabling cost competitive market entry of hybrid vehicles; 3) Advanced Combustion Engine R&D activities will focus on maintaining or improving engine efficiency while reducing NOx emissions in light duty diesel vehicles from 1.0 grams per mile (g/mi) in 2000 to 0.07 g/mi in 2007 and 0.03 g/mi in 2010 and in heavy duty diesel engines from 4.0 grams per brake horsepower hour (g/bhp-hr) in 2000 and 2.0 g/bhp-hr in 2002 and to 0.2 g/bhp-hr in 2006 to satisfy the greater than 90 percent reduction required by the light duty Tier 2 and heavy duty 2007 Federal standards; 4) by 2006, Transportation Materials Technologies R&D activities will reduce the production cost of carbon fiber from $12 per pound in 1998, to $3 per pound; and 5) by 2007, Fuel Utilization R&D activities will identify an advanced petroleum-based fuel formulation, incorporating the use of non-petroleum based feedstocks, that enables light duty CIDI engine/vehicle systems to meet regulated emissions levels with minimum effect on fuel economy, and perform in full compliance with specified durability requirements.

Vehicle Systems

(1) Vehicle Systems - By 2006, the Heavy Vehicle Systems activity develops technologies that will enable reduction of parasitic energy losses, including losses from aerodynamic drag, from 39 percent of total engine output in 1998 to 24 percent.

Performance Indicators

The parasitic loss (e.g., aerodynamic drag) for heavy duty vehicle systems.

Annual Performance Results and Targets

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Reduce parasitic losses of heavy vehicle systems to 36 percent of total engine output.	Reduce parasitic losses of heavy vehicle systems to 30 percent of total engine output and benchmark additional reductions through heavy truck electrification.	Reduce parasitic loses to 27 percent of total engine output in a laboratory test.

- By 2004, validate integrated systems model for climate control systems.
- By 2005, demonstrate that a 9 percent to 18 percent increase in fuel efficiency for a fully loaded heavy truck can be achieved by removing belt-driven pumps, substituting electric turbo-compounding, and adding a more efficient air conditioning.
- By 2005, complete technology requirements for a range of vehicle platforms to facilitate FCVT

Program year 2030 vision of significantly reducing petroleum usage for transportation, based on fleet projections.

- By 2005, demonstrate stability and safety characteristics of tractor-trailers utilizing active airflow control.
- By 2005, construct and test prototype cooling system to achieve 8-10 percent increase in efficiency.
- By 2006, verify, using Digital Functional Vehicle (DFV), that developed light vehicle technologies will achieve vehicle-level mileage and component cost objectives.

Hybrid and Electric Propulsion

(2) Hybrid and Electric Propulsion - By 2010, Hybrid and Electric Propulsion R&D activities will reduce the production cost of a high power 25kW battery for use in light vehicles from $3,000 in 1998 to $500, with an intermediate goal of $750 in 2006 enabling cost competitive market entry of hybrid vehicles.

Performance Indicators

The costs per 25kW battery system, at a production level of 100,000 battery systems per year.

Annual Performance Results and Targets - Hybrid and Electric Propulsion

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Complete development of second generation lithium ion electrochemistry for hybrid vehicle power.	Reduce high power 25 kW estimated lithium ion battery cost to $1,180 per battery system.	Reduce high power 25 kW light vehicle estimated lithium ion battery cost to $1,000 per battery system.

- In 2004, identify future heavy hybrid vehicle capital cost reduction targets.
- By 2005, define component requirements for heavy vehicle hybrid systems to guide component/system research efforts.

Advanced Combustion Engine R&D

(3) Advanced Combustion Engine R&D - Advanced Combustion Engine R&D activities will focus on maintaining or improving engine efficiency while reducing NOx emissions in light duty diesel vehicles from 1.0 grams per mile (g/mi) in 2000 to 0.07 g/mi in 2007 and 0.03 g/mi in 2010 and in heavy duty diesel engines from 4.0 grams per brake horsepower hour (g/bhp-hr) in 2000 and 2.0 g/bhp-hr in 2002 and to 0.2 g/bhp-hr in 2006 to satisfy the greater than 90 percent reduction required by the light duty Tier 2 and heavy duty 2007 Federal standards.

Performance Indicator

Level of NOx emissions.

Annual Performance Results and Targets - Advanced Combustion Engine R&D

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Complete initial testing of light trucks with prototype diesel engines to demonstrate a 35 percent increase in fuel efficiency and Tier 2 emissions. Demonstrate 45 percent thermal efficiency for heavy duty diesel engine while meeting EPA 2004 emission standards.	Demonstrate optimized emission control system that achieves 0.07 g/mile NOx and 0.01 g/mile PM short-term performance in light duty vehicles.	Complete Light Truck activity with 35 percent fuel efficiency improvement over a gasoline powered light truck and Tier 2 emissions levels (0.07g/mile NOx). Demonstrate 50 percent thermal efficiency for heavy duty diesel engines while meeting EPA 2004 emission standards (2.4 g/hp-hr NOx).

Materials Technology

(4) Materials Technology - By 2006, Transportation Materials Technologies R&D activities will reduce the production cost of carbon fiber from $12 per pound in 1998, to $3 per pound.

Performance Indicator

The cost of carbon fiber.

Annual Performance Results and Targets - Materials Technologies

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Fabricate a sport utility vehicle chassis component using carbon fiber, in a low cost molding process that is suitable for high volume production.	Complete R&D on technologies which, if implemented in high volume, could reduce the price of automotive-grade carbon fiber to less than $7/pound.	Complete R&D on technologies which, if implemented in high volume, could reduce the price of automotive-grade carbon fiber to less than $5/pound.

By 2004, identify and develop advanced Materials Technologies that can:

- Reduce the weight of an unloaded class 8 heavy vehicle from 23,000 pounds to 18,000 pounds through materials substitution and/or innovative design approaches.

By 2004, develop and validate advanced materials and processes that will:

- Enable reduction in the weight of body and chassis components by 50 percent and overall vehicle weight by 40 percent.
- Exhibit the performance, reliability, and safety characteristics comparable to those of conventional vehicle materials.
- Be cost competitive with life-cycle costs of conventional vehicle materials.

By 2005, develop and validate advanced Materials Technologies that will:

- Develop the technology to control the erosion and corrosion in heavy vehicle engines as a result of the use of EGR.

- Exhibit the performance, durability, reliability, safety, and cost effectiveness comparable to those of current heavy vehicle engines.

Fuels Technology

(5) Fuels Technology - By 2007, Fuel Utilization R&D activities will identify an advanced petroleum-based fuel formulation, incorporating the use of non-petroleum based feedstocks, that enables light duty CIDI engine/vehicle systems to meet regulated emissions levels with minimum effect on fuel economy, and perform in full compliance with specified durability requirements.

Performance Indicator

Durability of CIDI engine/emissions control systems.

Annual Performance Results and Targets - Fuels Technologies

FY 2002 Results	FY 2003 Targets	FY 2004 Targets
Downselect (3) near-term fuel/engine/emission control technologies and develop test plan for 1,000-hour durability evaluation of these systems against 2004 and 2007 emission standards.	Publish results of 1,000-hour durability test and begin 6000-hour durability test of (3) next-generation fuels/engine/emission control technologies against 2004 and 2007 emission standards.	Complete durability testing and publish results for peer review. This will identify the fuel characteristics to allow for full emissions compliance of light duty engine/emissions technologies with Tier 2 standards.

Significant Program Shifts

Vehicle Systems

- Identify synergies between light and heavy vehicle technologies to help reduce duplication and leverage existing funds. Extend target setting of light vehicle technologies to multiplatform for heavy vehicles.

Innovative Concepts

- CARAT and STICK efforts are terminated and DOE will work through SBIR and STTR to involve similar types of small businesses and pursue comparable technical innovation topic areas.

Hybrid and Electric Vehicles

- In the energy storage hybrid component area, program emphasis is increased in long term, high risk Exploratory Technology Research to advance lithium polymer batteries and more fundamental storage concepts.

Advanced Combustion Engine R&D

- Off-Highway Vehicles activity is terminated because other research opportunities have higher impact on energy savings. Federal support of industry R&D in this area is of relatively lower priority. Emphasis is decreased in Combustion and Emission Control R&D because initial success in some research areas indicates that increases in industry participation are warranted.

Materials Technologies

- Emphasis is increased on lightweight materials for light-duty vehicles.
- Propulsion Materials R&D specific only for fuel cells has been transferred to the Hydrogen, Fuel Cells, and Infrastructure Technologies Interior Budget. Propulsion materials R&D on elements and components applicable to both hybrid and fuel cell vehicles is increased.

Fuels Technology

- Advanced Petroleum Based Fuels activity for trucks is terminated because it is largely within the capabilities of industry.
- Environmental Impacts activity is terminated because the work is aligned with the mission of other agencies.

Funding Profile

(dollars in thousands)

	FY 2002 Comparable Appropriation	FY 2003 Amended Request	FY 2004 Request	$ Change	% Change
Vehicle Technologies					
Vehicle Systems	14,869	14,414	14,514	+100	+0.7%
Innovative Concepts	600	1,600	500	-1,100	-68.8%
Hybrid and Electric Propulsion	47,121	41,973	49,563	+7,590	+18.1%
Advanced Combustion Engine	47,160	40,156	37,085	-3,071	-7.6%
Materials Technology	39,158	29,400	39,640	+10,240	+34.8%
Fuels Technology	24,650	17,999	6,800	-11,199	-62.2%
Technology Introduction	3,450	5,900	5,900	0	0.0%
Technical/Program Mgmt. Support	2,385	2,121	2,121	0	0.0%
Biennial Peer Review of FreedomCAR	--	--	1,500	+1,500	NA
Energy Efficiency Science Initiative[a]	1,959	0	0	0	0.0%
Total, FreedomCAR and Vehicle Technologies Program[b]	181,352	153,563	157,623	+4,060	+2.6%
Summary					
Operating Expenses	181,352	153,563	157,623	+4,060	+2.6%
Capital Equipment	0	0	0	0	0.0%
Total, FreedomCAR and Vehicle Technologies Program	181,352	153,563	157,623	+4,060	+2.6%

Public Law Authorizations:

P.L. 95-91, "Department of Energy Organization Act" (1977).

[a] Reflects Congressional guidance to transfer 50% of funding to Fossil.

[b] SBIR/STTR funding in the amount of $3,646,000 was transferred to the Science appropriation in FY 2002. Estimates for SBIR/STTR budgeted in FY 2003 and FY 2004 are $3,808,761 and $3,909,459 respectively.

Vehicle Systems Subprogram

Mission Supporting Goals and Measures

The Vehicle Systems subprogram funds R&D on advanced vehicle technologies and auxiliary equipment that could achieve significant improvements in fuel economy for cars, light trucks, and heavy vehicles without sacrificing safety, the environment, performance, and affordability. This subprogram's funding contributes to both the FreedomCAR Partnership and the 21st Century Truck Partnership.

Within this subprogram, the Heavy Vehicle Systems R&D activity seeks to develop, in collaboration with heavy vehicle manufacturers and their suppliers, technologies that will reduce non-engine parasitic energy losses from aerodynamic drag, tire rolling resistance, friction and wear, under-hood thermal conditions, and accessory loads, as well as ensure power train and truck system integration to increase overall system energy utilization and efficiency. The Ancillary Systems activity seeks to reduce direct and indirect fuel consuming loads imposed on internal combustion engines or fuel cell powered vehicles. These loads include those that negatively impact the fuel efficiency of a vehicle but do not propel the vehicle directly; the primary load in this category is the air-conditioning system. The Simulation and Validation activity develops and validates models and simulation programs to predict the fuel economy and emissions of advanced vehicles. With industry input, these models are used to develop performance targets for the complete range of vehicle platforms and their components to facilitate prioritization of technology R&D activities that could significantly reduce petroleum usage for transportation. The models are also used, in conjunction with "hardware-in-the-loop," to verify in the laboratory the achievement of these targets in the context of a vehicle system operating environment.

Funding Schedule

	FY 2002	FY 2003	FY 2004	$ Change	%Change
Vehicle Systems					
Heavy Vehicle Systems	9,769	10,714	10,714	0	0.0%
Ancillary Systems	1,200	1,100	1,200	+100	+9.1%
Simulation and Validation	3,900	2,600	2,600	0	0.0%
Total, Vehicle Systems	14,869	14,414	14,514	+100	+0.7%

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	%Change
Vehicle Systems					
Albuquerque Operations Office					
Albuquerque Operations Office	3,008	3,200	1,500	-1,700	-53.1%
Golden Field Office	0	0	2,150	+2,150	NA
National Renewable Energy Laboratory	2,263	2,100	2,600	+500	+23.8%
Sandia National Laboratories	420	300	300	0	0.0%
Total, Albuquerque Operations Office	5,691	5,600	6,550	+950	+17.0%
Chicago Operations Office					
Ames Laboratory	0	400	0	-400	-100.0%
Argonne National Laboratory	5,794	5,000	5,000	0	0.0%
Total, Chicago Operations Office	5,794	5,400	5,000	-400	-7.4%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	100	100	0	-100	-100.0%
Total, Idaho Operations Office	100	100	0	-100	-100.0%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	643	800	800	0	0.0%
Office of Scientific and Technical Information	109	0	0	0	0.0%
ORISE	80	0	0	0	0.0%
Total, Oak Ridge Operations Office	832	800	800	0	0.0%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

	FY 2002	FY 2003	FY 2004	$ Change	%Change
Oakland Operations Office					
Lawrence Livermore National Laboratory .	540	600	600	0	0.0%
Oakland Operations Office	1,013	945	400	-545	-57.7%
Total, Oakland Operations Office	1,553	1,545	1,000	-545	-35.3%
Richland Operations Office					
Pacific Northwest National Laboratory	320	450	450	0	0.0%
Total, Richland Operations Office	320	450	450	0	0.0%
NASA	0	400	400	0	0.0%
Washington Headquarters	579	119	314	+195	+163.9%
Total, Vehicle Systems	14,869	14,414	14,514	+100	+0.7%

Site Description

Albuquerque Operations Office

Soliciting, awarding, and administering research and development contracts, cooperative agreements, and grants with industry, academia, and other Government organizations.

Golden Field Office

Soliciting, awarding, and administering support services and research and development contracts, cooperative agreements, and grants.

National Renewable Energy Laboratory

Provides analysis of performance targets for light and heavy vehicles. Develops system models and provides analysis and simulations of advanced hybrid and fuel cell configurations using the ADVISOR software developed at the lab. Provides CAD/CAE for optimized vehicle system solutions in support of FreedomCAR goals, and general engineering assessments of HEV and AFV technologies. Conducts research in reducing ancillary and climate control loads for light vehicles.

Sandia National Laboratories

Participates in the modeling and simulation for reduction of heavy vehicle aerodynamic drag.

Ames Laboratory

Conducts basic research on new materials with unique properties. Work for FCVT includes the development of low-cost power metallurgy manufacturing methods for particle reinforced aluminum (PRA) composite components. Materials efforts are developing to improve powder for permanent magnets.

Argonne National Laboratory

Provides simulation, analysis, and develops transient models for hybrid and fuel cell systems. Develops sophisticated software for hardware-in-the loop testing. Provides technical support and analysis for heavy hybrids and locomotive programs. Conducts research to reduce parasitic loads on heavy vehicles including reductions in idling losses, rolling resistance, aerodynamic drag, and under hood thermal management. Also, works to improve oil filtration, coolants, and regenerative shocks for trucks. Performs high-performance computing with particular focus on computational fluid dynamics (combustion, underhood cooling, HVAC, etc.). Utilizes the Advanced Photon Source facility to characterize fundamental mechanisms of friction, lubrication, and fuel spay from fuel injectors. Develops nano fluid technology and new designs for higher efficiency heavy vehicle cooling systems. Monitors R&D in industry for underhood electrification for heavy

vehicle components and new brake material developments.

Idaho National Engineering and Environmental Laboratory

Development and assessment of advanced oil by-pass filter concepts for heavy vehicles.

Oak Ridge National Laboratory

Develops models to estimate cost of advanced hybrid and fuel cell vehicles to perform trade-off studies, and also develops models to predict emissions from advanced after-treatment devices. Conducts research to develop high thermal conductivity carbon foams for high performance truck and automobile radiators.

Office of Scientific and Technical Information

Disseminated heavy vehicle technical reports and literature.

ORISE

Organizing, planning and conducting scientific workshops and peer reviews to engage industry with the scientific community in the national labs.

Lawrence Livermore National Laboratory

Provides leadership and coordination in the application of advanced methods of conventional fluid dynamics to aerodynamic drag of heavy vehicle for increased energy efficiency.

Oakland Operations Office

Soliciting, awarding, and administering research and development contracts, cooperative agreements, and grants with industry, academia, and other Government organizations.

Pacific Northwest National Laboratory

Conducts research on predictive cruise control for heavy vehicles to increase energy efficiency.

NASA

Provides research in full scale aerodynamic stability tests for heavy vehicles.

Washington Headquarters

Soliciting, awarding, and administering support services and research and development contracts, cooperative agreements, and grants.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Heavy Vehicle Systems R&D	**9,769**	**10,714**	**10,714**
P **Vehicle Systems Optimization**	**9,369**	**10,314**	**10,314**

FY 2002: Transferred from Vehicle Technologies R&D / Heavy Vehicle Systems. Distributed 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. Identified key R&D needs, prioritized potential project areas, and identified current and outyear funding requirements. Compared longer-term Computational Fluid 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. Validated and refined formulations with results to be obtained from full size trucks in NASA Ames large wind tunnel. Began aerodynamic redesign of over-the-road tractor-trailer combinations that meet: operational, freight-loading, and maintenance needs of the truck industry; dimensional and safety requirements of the Department of Transportation (DOT); and the DOE mission of enhanced efficiency and reduced exhaust emissions. Performed wind tunnel tests of 1/16th scale model truck to validate and refine mathematical models developed using Circulation Control theory for aerodynamic drag reduction, achieving greater vehicle stability and braking assist.

Designed and modified trailers for field-service road testing with industry partners. Determined energy efficiency, operational stability, sensor requirements, and maintenance issues for redesigned trailers. Completed study of near-term application of "off-the-shelf" technology to achieve 12 mile per gallon (mpg) heavy truck (current industry average: 6 mpg). With industry cost-share, designed this advanced vehicle. Initiated teaming and R&D efforts for building and testing this vehicle. Cooperated with industry, trade associations to reduce unnecessary idling of heavy truck engines. Continued R&D of heavy vehicle electrification, axle improvements, and improved braking materials, based on competitive awards for greater energy efficiency. Explored feasibility of reducing parasitic energy losses by using on-board Essential Power Systems to provide power-on-demand to electric water, fuel, and oil pumps of heavy duty truck engines. Issued competitive solicitation for Essential Power Systems, and made awards. Prepared peer-reviewed multi-year program plan for increased locomotive energy efficiency and reduction of emissions. Issued competitive solicitation in these areas and make awards. Conducted workshop on reduction of emissions of off-road vehicles. Utilized results to issue competitive solicitation and made awards.

Participants include: ANL, PNNL, ORNL, MIT, Cal Tech, NASA, USC, PSU, Tufts University,

(dollars in thousands)

FY 2002	FY 2003	FY 2004

GTRI, Caterpillar Corp., Navistar, LLNL, Sandia, Castrol, Norfolk and Southern Railroad, Burlington Northern-Santa Fe Railroad, CSX, and competitive solicitations.

FY 2003: Transfer from: Vehicle Technologies R&D/Heavy Vehicle Systems. Based on peer group and industry-reviewed Multi-Year Program Plans, which have identified key R&D needs, initiate priority projects in the parasitic energy loss categories of Aerodynamic Drag, Rolling Resistance, Friction and Wear, and Underhood Thermal Management. Complete the final runs in the 7'x10' wind tunnel to provide the data for the Computational Fluid Dynamics (CFD) analytical modeling. Design scale-up tests for the NASA Ames 12-foot wind tunnel. All tests use the generic truck model specifically designed for this project. Initiate instrumented full-size truck tests in the NASA Ames large wind tunnel. Plan and perform first phase verification of fuel economy improvements with active control of airflow around modified tractor-trailer combinations in full scale on-road tests. For increased heavy vehicle safety, trailer stability control and braking assist aspects of the Circulation Control method will be designed and preliminary validation tests will be performed. Detailed test plans will be formulated based on these scoping trials and an initial full-scale test will be conducted. Substantial industry operational participation and cost sharing is anticipated in these efforts. Expand tests of "off-the-shelf" technology to achieve 12 mpg heavy truck fuel economy. Investigate with industry and DOT the replacement of truck mirrors with electronic devices, to reduce aerodynamic drag.

Continue the competitively-awarded, industry cost-shared project on the More Electric Truck, decoupling mechanically-driven underhood components from the engine and utilizing electric drives to achieve a potential increase in efficiency of over 18 percent; the advanced axle project, designed to increase the efficiency of energy transfer in a heavy vehicle by over 2 percent; and the project for the transfer of highly effective aircraft brake technologies to improved braking materials for heavy vehicles. The braking project is a key enabling safety technology as a result of the success anticipated in substantially reducing heavy vehicle aerodynamic drag. Continue the projects to develop Essential Power Systems, methods for improving locomotive efficiencies and reducing their emissions, and projects aimed at reducing emissions from off-road vehicles and their auxiliary power requirements. With the Environmental Protection Agency (EPA), expand efforts with industry trade associations to reduce idling of heavy truck engines. Continue development of on-board Essential Power Systems (EPS) to provide power-on-demand for truck auxiliary electric power, such as water, fuel, and oil pumps, and heating, ventilating and air conditioning equipment. This comprehensive EPS approach will include the energy- and power-producing systems, the energy distribution system, and the energy- and power-utilizing components aboard the vehicle.

Participants include: American Trucking Associations, PACCAR, Freightliner, Kenworth, Peterbuilt, Honeywell, Caterpillar, ANL, PNNL, ORNL, MIT, NASA, USC, PSU, GTRI, LLNL, Tufts University, Sandia, Castrol, Navistar, EMP, TBD. (21CT $10,314,000)

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2004: Vehicle Systems Optimization. Parasitic energy losses that substantially reduce (by at least 50 percent) the energy efficiency of a heavy truck and concomitantly increase the exhaust emissions are apportioned among aerodynamic drag, rolling resistance, friction and wear, and thermal management. Key R&D needs to reduce these losses have been identified by: peer reviews; industry-reviewed Multi-Year Program Plans developed in workshops attended by industrial, academic, and national laboratory participants; and by NAS reviews. Enhance the aerodynamic data accumulation related to improved heavy vehicle energy efficiency utilizing realistic air (wind) velocities in tests in the NASA 12-foot pressure-wind tunnel. Using the DOE/Industry designed System Leveraged Improved Roadworthy Truck (SLIRT) model, performance parameters will be compared to state-of-the-art computer calculations using massively parallel processors and a variety of physical and mathematical modeling techniques. Results will be compared to commercial computational fluid dynamics (CFD) codes using various turbulence models. Use the developed and benchmarked techniques to investigate fuel savings achieved without optical truck mirrors, and with vehicle configuration changes. Design a trailer for demonstration of Air Circulation Control for truck dynamic stabilization. Determine required sensor arrays and accuracy of measurement needed. Plan full-scale validation tests in wind tunnel. Demonstrate/optimize the effect of Circulation Control to increase the braking capacity of the integral truck as a system. Prepare solicitation for cost shared contracts for the design, development, and test of improved rolling resistance tires for light and heavy vehicles.

Develop tractor without belt- or gear-driven equipment attached to the engine to increase fuel efficiency by 13-20 percent by reduction of required engine power and elimination of engine idling. Employ novel efficient energy sources such as fuel cells/and or thermoelectrics to accelerate transition to electric auxiliary power. Develop computer simulation and modeling to more rapidly identify components and/or substitute materials. Assess the developed technologies for their applicability to a wide range of heavy vehicles for efficiency improvement and emissions reduction. Reduce radiator size, which will reduce truck weight, aerodynamic drag and the energy needed to activate the cooling system, and allow filling of the void space with energy-absorbing materials for crash protection. Techniques to achieve an ultimate 40 percent reduction in the cooling system size include: cooling using increased thermal conductivity of nanofluids/nanotubes, evaporative cooling for peak loads, nucleated boiling, and higher-temperature coolants. Model and optimize the effect of nanofluids on increase of thermal conductivity. Use model CFD calculations to place critical heat-sensitive power electronics components in cooler areas to optimize cooling. Employ new computer designs of lightweight, more effective cooling fans to construct a prototype system for efficiency gain measurements and durability assessment. Optimization efforts will follow. Scuffing, a friction/wear phenomenon, produces catastrophic failure in lubricant-starved rotating component systems, including engine and shaft applications. Continue in-situ experiments to determine the mechanisms of scuffing and boundary-layer lubrication using the Advanced Photon Source. Develop scuffing models relating to fundamental materials properties to

(dollars in thousands)

predict/mitigate scuffing to avoid the costly, time-consuming large-scale testing. Conduct periodic tests to validate the models. Determine the effects of various surface treatments on friction and wear and measure the effects of non-petroleum based lubricants on engine friction. Propose strategies to decrease friction forces by 10 percent and increase service life by 10 percent.

Participants include: NREL, PNNL, LLNL, SNL, NASA, USC, Cal. Tech., GTRI, ANL, Volvo, Great Dane, DOT, ATA, PACCAR, Freightliner, Kenworth, Peterbuilt, International, Ricardo Engr., EMP, Cabot, MSU, Caterpillar, Tufts, General Electric, MIT, EPA, and others to be identified through competitive solicitations (21CT $10,314,000).

P	**Truck Safety Systems . . . . . .**	**400**	**400**	**400**

FY 2002: Transferred from Vehicle Technologies R&D / Heavy Vehicle Systems. Supported activities in key safety areas for heavy vehicles. Conducted planning activities with trucking industry/government agencies to identify specific R&D needs for future brake requirements, including materials, cost-effectiveness, and brake system lightweighting. Conducted risk assessment of high pressure gaseous fuel storage tanks.

Participants include: DOT, ATA, trailer manufacturers, Honeywell, Materials Performance Group.

FY 2003: Transfer from Vehicle Technologies R&D / Heavy Vehicle Systems. Continue to support activities in key safety areas for heavy vehicles, particularly in conjunction with DOT. Evaluate advanced monolithic composite materials for advanced heavy vehicle braking applications. Complete risk assessment of high pressure gaseous fuel storage tanks. Determine test protocols and initiate preliminary tank tests. Initiate material substitution studies for the crash-worthiness of heavy vehicle tractors and automobile under-ride protectors for trailers.

Participants include: DOT, ATA, trailer manufacturers, Honeywell (21CT $400,000).

FY 2004: Truck Safety Systems. Continue to develop a disc-air brake system using cost-effective ceramic composites. Tests will be performed on fully-loaded class 8 (over 32,000 pounds gross vehicle weight) tractor-trailers. Development of a fundamental, materials-based model of brakes will be instigated. The objective will be to determine the optimal pad and rotor properties such that the empirical approach currently used can be replaced by a knowledge-based model to optimize brake performance. Coordinate the materials expertise of DOE with the safety concerns and requirements of DOT.

Participants include: DOT, ORNL, GE, Knoor-Bremse, PACCAR, ATA, WVU (21CT $400,000).

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Ancillary Systems 1,200 1,100 1,200

FY 2002: Evaluated response of thermal comfort manikin to changes in temperature and humidity and correlated results with psychological model. Validated the transient air conditioning model with "real system" experimental data using an industry collaborative project.

Participants include: ANL, NREL, ORNL, USCAR, other contractors.

FY 2003: Complete development of thermal manikin and integrate with psychological, physiological, and vehicle cabin climate models. Begin assessment of manikin response to complete environment.

Participants include: ANL, NREL, ORNL, USCAR, other contractors (FreedomCAR $1,100,000).

FY 2004: Continue to develop and demonstrate advanced auxiliary load reduction technologies, and climate control systems, that reduce fuel use, tailpipe emissions, and improve driver comfort and safety. Using newly developed evaluation methods and instruments such as the thermal manikin, predict the fuel saving of the various light vehicles where the technologies would be applicable. Develop methods to utilize propulsion system waste heat and apply results to concepts for more efficient cabin cooling and heating, and to heat-generated electricity for accessories. Evaluate rollable photovoltaic (PV) shades, PV-powered ventilation and heat pipe cooling. Continue integration and optimization techniques for cabin thermal comfort using advanced climate control seats, direct body cooling/heating/ ventilation, and active occupant sensors for minimum climate control fuel use. Utilize thermal manikin and modeling to evaluate driver vigilance and safety to new concepts.

Participants include: NREL, Ford, DaimlerChrysler, Visteon, Johnson Controls (FreedomCAR $1,200,000).

Simulation and Validation 3,900 2,600 2,600

FY 2002: Transferred from Vehicle Technologies R&D / Hybrid Systems R&D / Light Vehicle Propulsion and Ancillary Systems. Shifted focus to setting performance targets and developing technologies applicable to a wide range of vehicle classes. A target setting process was developed, with the objective of ensuring that technology targets apply to multiple vehicle classes and are consistent with achieving out-year fuel reduction goals. Continued to develop cost models focusing on model calibration, facilitated by the development of a credible cost database, and a limited number of "cost roll-ups," for several generic vehicle configurations. Further quantified the energy savings associated with the application of the Digital Functional Vehicle. Investigated potential application of the Digital Functional Vehicle process to fuel cell systems design. Validated performance targets of an advanced lithium ion battery pack in a vehicle system environment using hardware-in-the-loop techniques. Validated the battery pack model in ADVISOR with a NiMH battery pack.

Participants include: NREL, ANL, ORNL, Ford, GM, DaimlerChrysler.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2003: Transfer from Vehicle Technologies R&D / Hybrid Systems R&D / Light Vehicle Propulsion and Ancillary Systems. Complete target setting process and make available to industry partners on the Web for purpose of managing and tracking programs. Use hardware-in-the-loop to validate, in a systems environment, performance targets for an advanced electric motor and power electronics modules being developed by industry partners. Continue developing emissions models to enable prediction of exhaust emissions for internal combustion engines. Perform trade-off studies using the cost model to determine optimal hybrid vehicle configurations which provide maximum fuel economy at the lowest vehicle cost.

Participants include: NREL, ANL, ORNL, Ford, GM, DaimlerChrysler (FreedomCAR $2,600,000).

FY 2004: Continue to develop and refine transient models for predicting fuel cell performance for different fuel cell configurations over various cold and hot drive cycles. Study impact of future fuel cell characteristics on vehicle performance. Analyze hydrogen-fueled IC engine-powered hybrid vehicles and compare to hydrogen-powered fuel cell hybrid vehicles. Continue to develop, validate and tailor simulation models for advanced electric motors, CIDI engine emissions, energy storage and energy storage thermal systems as needed to support hardware-in-the-loop testing and development. Initiate development of ultracapacitor and hydraulic energy storage models for vehicle applications to evaluate and/or prepare to test powertrain systems proposed by cooperating government agencies (e.g., EPA hydraulic hybrid). Initiate cost trade-offs studies for hydrogen fuel cell vehicles to determine hybrid configurations which provide the best trade-off between cost and fuel efficiency. Complete detailed trade-off studies for various vehicle classes using optimization techniques to better understand impacts of power train configurations on multiple platforms and on national petroleum consumption.

Participants include: NREL, ANL, ORNL (FreedomCAR $2,600,000).

Total, Vehicle Systems	**14,869**	**14,414**	**14,514**

Explanation of Funding Changes

		FY 2004 vs. FY 2003 ($000)
Vehicle Systems		
P	In ancillary systems, evaluate rollable photovoltaic (PV) shades, PV-powered ventilation, and heat pipe cooling	+100
Total Funding Change, Vehicle Systems		+100

Innovative Concepts Subprogram

Mission Supporting Goals and Measures

The Innovative Concepts subprogram supports activities of both the FreedomCAR and Vehicle Technologies and the Hydrogen, Fuel Cells, and Infrastructure Technologies Programs. This effort consists of three activities described below.

The Graduate Automotive Technology Education (GATE) activity aids in the development of interdisciplinary curricula to train the future workforce of automotive engineers. This is accomplished by setting up GATE Centers of Excellence at universities that have been competitively selected, establishing focused curriculum, and providing funds for research fellowships. The Cooperative Automotive Research for Advanced Technology (CARAT) activity aims to competitively fund the most promising ideas from small businesses and universities and then marry the concept with a manufacturer or supplier possessing the knowledge and resources to take the concept to market. Stimulate Truck Innovative Concepts and Knowledge (STICK) offers to small businesses and institutions of higher education the opportunity to develop concepts which have the potential to increase the fuel economy and reduce emissions from heavy vehicles, and to enhance productive working relationships among small businesses, institutions of higher education, manufacturers and suppliers.

CARAT and STICK were designed to help small businesses and universities. The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs also aim to help small businesses. Each year, the FCVT Program contributes a portion of its appropriated funding to the SBIR and STTR programs in accordance with existing law. Funding will not be requested for CARAT and STICK and DOE will work through SBIR and STTR to involve similar types of small businesses and pursue comparable technical innovation topic areas; universities will be involved in the program through other competitive means.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Innovative Concepts					
GATE	0	500	500	0	0.0%
CARAT	500	500	0	-500	-100.0%
STICK	100	600	0	-600	-100.0%
Total, Innovative Concepts	600	1,600	500	-1,100	-68.8%

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Innovative Concepts					
Albuquerque Operations Office					
Albuquerque Operations Office	100	600	0	-600	-100.0%
Golden Field Office	0	0	400	+400	NA
Total, Albuquerque Operations Office	100	600	400	-200	-33.3%
Chicago Operations Office					
Argonne National Laboratory	0	100	100	0	0.0%
Chicago Operations Office	500	900	0	-900	-100.0%
Total, Chicago Operations Office	500	1,000	100	-900	-90.0%
Total, Innovative Concepts	600	1,600	500	-1,100	-68.8%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

Site Description

Albuquerque Operations Office

Conducted STICK solicitations and made 3 awards in FY 2003. Close out award agreements in FY 2004**.**

Golden Field Office

Conduct FY 2004 GATE solicitation.

Argonne National Laboratory

Provide technical and analytical expertise to the CARAT and GATE activities.

Chicago Operations Office

Complete CARAT activities arising from FY 2002 CARAT awards.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
GATE	**0**	**500**	**500**

FY 2002: No activities.

FY 2003: Provide research fellowships for 25 students for research in advanced automotive technologies. Conduct GATE Forum with industry, universities, and government agencies to increase partnering opportunities.

Participants include: Michigan Technological University, Ohio State University, Pennsylvania State University, University of California, Davis, University of Maryland, University of Michigan-Dearborn, University of Tennessee, Virginia Tech, West Virginia University (FreedomCAR $500,000).

FY 2004: Provide research fellowships for 25 students for research in advanced automotive technologies. Initiate solicitation for new GATE Centers of Excellence.

Participants include: Michigan Technological University, Ohio State University, Pennsylvania State University, University of California, Davis, University of Maryland, University of Michigan-Dearborn, University of Tennessee, Virginia Tech, West Virginia University (FreedomCAR $500,000).

CARAT	**500**	**500**	**0**

FY 2002: Transferred from Vehicle Technologies R&D/Cooperative Automotive Research Advanced Technologies (CARAT). CARAT taps innovation and expertise that small businesses and universities offer for developing advanced automotive technologies.

Participants include: small businesses and universities.

FY 2003: Transfer from Vehicle Technologies R&D / Cooperative Automotive Research Advanced Technologies. Complete and evaluate the existing CARAT projects in the core advanced automotive technology topic areas. Disseminate results of research efforts.

Participants include: small businesses and universities. (FreedomCAR $500,000).

FY 2004: Terminate the CARAT, the program plans to accomplish the small business portion through SBIR/STTR (FreedomCAR $0).

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
STICK	**100**	**600**	**0**

FY 2002: Transferred from Vehicle Technologies R&D / Heavy Vehicle Systems. Established program to stimulate truck innovative concepts and knowledge developed by small businesses and universities to accelerate progress on technologies and inventions to increase efficiency of heavy vehicles. Released first solicitation for Phase I projects.

Participants include: small businesses and universities.

FY 2003: Transferred from Vehicle Technologies R&D / Heavy Vehicle Systems. Award and conduct nine Phase I projects that are geared toward innovative concepts to reduce parasitic energy losses in various heavy vehicle systems to enable the development of a 12-mpg heavy vehicle.

Participants include: small businesses and universities (21CT $600,000).

FY 2004: Terminate the STICK Program, the program plans to accomplish the small business portion through SBIR/STTR (21CT $0).

Total, Innovative Concepts	**600**	**1,600**	**500**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Innovative Concepts	
P CARAT efforts are terminated and DOE will work through SBIR and STTR to involve similar types of small businesses and pursue comparable technical innovation topic areas.	-500
P STICK efforts are terminated and DOE will work through SBIR and STTR to involve similar types of small businesses and pursue comparable technical innovation topic areas	-600
Total Funding Change, Innovative Concepts	-1,100

Hybrid and Electric Propulsion Subprogram

Mission Supporting Goals and Measures

The Hybrid and Electric Propulsion subprogram funds research and development activities for both light and heavy vehicles. Activities include research in energy storage systems, advanced power electronics and electric machines, and heavy hybrid system development and integration. The subprogram consists of three activities: Energy Storage, Advanced Power Electronics, and Subsystem Integration and Development.

Energy Storage activities support long-term research, applied research, and technology development for both light and heavy vehicles. Long-term research is focused on developing advanced energy storage technologies for hybrid and electric vehicle applications. Applied research is focused on the development and validation of low-cost and long-life batteries for hybrid vehicle applications. Technology development for all light vehicle energy storage is conducted with industry through the United States Advanced Battery Consortium (USABC). All of the cost-shared USABC subcontracts to develop advanced light vehicle batteries for hybrid and electric vehicles are awarded under a competitive process. Interagency coordination on advanced battery development is conducted through the government-sponsored Interagency Advanced Power Group.

The Power Electronics & Electric Machines activity develops low cost DC/DC converters and motor controllers, and motors that are needed for fuel cell and hybrid vehicles. Supporting R&D on capacitors, magnets and thermal management complements the motor and electronic technology development.

Subsystem Integration and Development supports work to validate achievement of technical targets for components and subsystems by emulating a vehicle operating environment for light and heavy vehicles using hardware-in-the-loop testing. This subprogram also benchmarks and characterizes advanced commercial vehicles and components to determine commercial progress against research performance goals. Data gathered is used to validate simulation models which are used to predict fuel economy and emissions using advanced controls and configurations for hybrid vehicles. Heavy hybrid efforts support development of advanced, cost effective components and systems to improve fuel economy by at least 100 percent while meeting 2007 emission standards.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Hybrid and Electric Propulsion					
Energy Storage	24,117	21,110	28,700	+7,590	+36.0%
Advanced Power Electronics	14,163	13,690	13,690	0	0.0%
Subsystem Integration and Development	8,841	7,173	7,173	0	0.0%
Total, Hybrid and Electric Propulsion	47,121	41,973	49,563	+7,590	+18.1%

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	%Change
Hybrid and Electric Propulsion					
Albuquerque Operations Office					
Albuquerque Operations Office	900	0	0	0	NA
Golden Field Office	0	0	9,700	+9,700	NA
National Renewable Energy Laboratory	4,907	4,808	3,990	-818	-17.0%
Sandia National Laboratories	2,060	1,800	1,670	-130	-7.2%
Total, Albuquerque Operations Office	7,867	6,608	15,360	+8,752	+132.4%
Chicago Operations Office					
Ames Laboratory	290	300	300	0	0.0%
Argonne National Laboratory	8,181	8,826	9,300	+474	+5.4%
Brookhaven National Laboratory	580	560	830	+270	+48.2%
Chicago Operations Office	15,549	10,315	8,000	-2,315	-22.4%
Total, Chicago Operations Office	24,600	20,001	18,430	-1,571	-7.9%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	2,567	2,250	3,000	+750	+33.3%
Idaho Operations Office	55	150	0	-150	-100.0%
Total, Idaho Operations Office	2,622	2,400	3,000	+600	+25.0%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

	FY 2002	FY 2003	FY 2004	$ Change	%Change
Nevada Operations Office					
Nevada Operations Office	1,881	1,708	0	-1,708	-100.0%
Total, Nevada Operations Office	1,881	1,708	0	-1,708	-100.0%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	3,845	4,115	6,000	+1,885	+45.8%
Total, Oakland Operations Office	3,845	4,115	6,000	+1,885	+45.8%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	5,211	5,138	4,175	-963	-18.7%
Total, Oak Ridge Operations Office	5,211	5,138	4,175	-963	-18.7%
Richland Operations Office					
Pacific Northwest National Laboratory	100	0	0	0	0.0%
Total, Richland Operations Office	100	0	0	0	0.0%
Washington Headquarters	995	2,003	2,598	+595	+29.7%
Total, Hybrid & Electric Propulsion	47,121	41,973	49,563	+7,590	+18.1%

Site Description

Albuquerque Operations Office

Soliciting, awarding, and administering research and development contracts, cooperative agreements, and grants with industry, academia, and other Government organizations.

Golden Field Office

Soliciting, awarding, and administering support services and research and development contracts, cooperative agreements, and grants.

National Renewable Energy Laboratory

Investigation and development of advanced battery thermal management for hybrid and fuel cell vehicles. Manages heavy hybrid subcontracts. Provides analysis, modeling, and technical support for power electronics and electric machines for heavy vehicles.

Sandia National Laboratories

Conducts research on new, rugged high temperature film capacitors for power electronics. Conducts and evaluates electrode materials that would improve abuse tolerance of lithium based battery technologies. Performs abuse tests of various battery technologies.

Ames Laboratory

Conducts basic research on new materials with unique properties. Work for FCVT includes the development of low-cost powder metallurgy manufacturing methods for particle reinforced aluminum (PRA) composite components. Materials efforts are developing to improve powder for permanent magnets.

Argonne National Laboratory

Conducts HEV component and subsystem performance and emissions tests in a state-of-the-art test facility. Validates components and subsystems performance targets for hybrid and fuel cell technology using hardware-in-the loop testing to simulate vehicle operating environment. Develops test procedures for advanced vehicle testing and control strategies to improve overall vehicle efficiency and reduce emissions. Conducts research in energy storage for EVs and HEVs and high performance capacitors. Provides battery technical support, and testing of advanced batteries.

Brookhaven National Laboratory

Performs analysis studies and conducts research in advanced materials that would improve the performance and abuse tolerance of lithium battery systems.

Chicago Operations Office

Soliciting, awarding, and administering research and development contracts, cooperative agreements, and grants with industry, academia, and other Government organizations.

Idaho National Engineering and Environmental Laboratory

Development and assessment of ultracapacitors for hybrid vehicles. Testing of high-power batteries and development of battery test procedures. Testing and simulation of hybrid vehicle performance. Developed energy storage models for electric and hybrid vehicles (SIMPLEV).

Idaho Operations Office

Soliciting, awarding, and administering research and development contracts, cooperative agreements, and grants with industry, academia, and other Government organizations.

Nevada Operations Office

Soliciting, awarding, and administering research and development contracts, cooperative agreements, and grants with industry, academia, and other Government organizations.

Lawrence Berkeley National Laboratory

Exploratory research in advanced battery technology, including development of new electrode and electrolyte materials and understanding of fundamental electrochemical phenomena.

Oak Ridge National Laboratory

Conducts analysis, technical support, testing and research on power electronic devices and electric machines.

Pacific Northwest National Laboratory

Evaluates advanced energy storage materials.

Washington Headquarters

Soliciting, awarding, and administering support services and research and development contracts, cooperative agreements, and grants.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Energy Storage	**24,117**	**21,110**	**28,700**
P **High Power Energy Storage**	**17,295**	**17,675**	**17,675**

FY 2002: Transferred from Vehicle Technologies R&D/Hybrid Systems R&D. Supported R&D on high power batteries with the U.S. Advanced Battery Consortium (USABC), with an industry cost share of 50 percent. Continued testing of nickel-metal hydride cells at a DOE laboratory, to assess the performance against energy storage requirements. Continued development of low-cost, liquid-cooled, high power nickel-metal hydride modules. Continued development of lithium ion cells and modules. Initiated validation testing of modules relative to technical performance targets. Completed validation of 276-volt lithium ion mini-battery pack at 30°C. Validated performance of 276-volt lithium ion mini-battery pack in hardware-in-the-loop test facility. Initiated the development of a low-cost lithium ion battery separator. Developed specifications and test procedures for 42-volt battery technology. Incorporated second generation lithium ion electrochemistry from the Advanced Technology Development Program into full-size cells. Continued transfer of technology improvements to industrial suppliers for validation in small cells prior to incorporation into full size, prototype, lithium-based cells. Assessed diagnostic tools and techniques and selected those that have the potential to identify lithium ion degradation/failure mechanisms that limit life and abuse-tolerance capabilities. Initiated an accelerated calendar life study to predict the life of lithium ion batteries. SBIR/STTR funding in the amount of $499,000 was transferred from this subprogram to the Science Appropriation.

Participants include: USABC, Saft America, PolyStor, Texaco Ovonic Battery Systems Incorporated, ANL, BNL, LBNL, INEEL, SNL.

FY 2003: Transferred from Vehicle Technologies R&D /Hybrid Systems R&D. Support R&D on high power batteries with the U.S. Advanced Battery Consortium, with an industry cost share of 50 percent. Complete first Phase 3 monoblock nickel-metal hydride module technology development efforts. Assess performance against energy storage requirements. Based on results, select baseline and accelerate development of nickel-metal hydride modules and/or battery packs for life verification and validation testing. Continue development of lithium ion full size cells and modules, which are abuse tolerant and have thermal and electrical controls, for use in hybrid electric vehicles. Validate module performance against energy storage technical targets and 15-year calendar life requirement. Develop and deliver full-current subsystems with enhanced life and abuse tolerance to a national laboratory for test, evaluation, and life demonstration. Initiate hardware cost reduction development efforts. Develop a plan for verification of candidate cost reduction measures. Incorporate low-cost, advanced lithium ion electrochemistry from the Advanced Technology Development Program into full-size cells.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Continue transfer of technology improvements to industrial suppliers for validation in small cells prior to incorporation into full size, prototype, lithium-based cells. Complete low-cost packaging efforts and transfer technology to battery developers. Complete accelerated calendar life study to predict the life of lithium ion batteries, and transfer to developers an accelerated method to evaluate calendar life.

Participants include: USABC, ANL, BNL, LBNL, INEEL, SNL, TBD (FreedomCAR $17,675,000).

FY 2004: Continue to develop full-sized, high performance lithium ion cells and modules that are abuse tolerant and evaluate their life and performance at the DOE national laboratories. Continue programs to develop lower cost production techniques and to develop low cost packaging. Validate low cost, stable, high performance cathode material based on abundant, low toxicity manganese oxide. Develop, validate, and publish accelerated life test procedures that allow developers to quickly and economically predict the performance and life of prototype hardware. Continue transfer of technology to developers and suppliers for validation in laboratory cells and incorporation into full-size prototype cells, modules, and batteries. Validate the performance of 42-volt batteries against FreedomCAR targets for start/stop hybrid applications. Define need and requirements for batteries to be used in fuel cell hybrid vehicles. Reassess the viability of ultracapacitors, flywheels, and thermoelectrics as energy storage/power devices in heavy-duty hybrid vehicle systems.

Participants include: USABC, ANL, ORNL, TBD (FreedomCAR $17,675,000).

P **Advanced Battery Development 4,447 1,500 1,500**

FY 2002: Continued R&D on long-term advanced batteries for electric vehicles under the United States Advanced Battery Consortium Phase III Cooperative Agreement with an average cost-share of 65 percent.

Environmental, health, and safety: Completed assessment of recycling issues, and shipping and abuse tolerance requirements, for lithium-based battery technology inelectric and hybrid vehicles, through the Advanced Battery Readiness Working Groups. Coordinated these activities with the National Highway Traffic Safety Administration and the Environmental Protection Agency.

Long-term Battery R&D: Characterized life limitations of lithium ion battery technology at high state of charge and temperature, and developed potential solutions. Reduced the severity of lithium ion thermal events by cell engineering redesign and developing abuse tolerance chemistries. Initiated assessment of lithium-sulfur electrochemical couples, including focus on anode dendrite formation and cycling performance. Focused technical efforts to solve the poor cycling efficiency of the lithium anode.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Assessed advanced battery technologies which have the potential to meet or exceed the USABC long-term battery goal. SBIR/STTR funding in the amount of $132,000 was transferred from this subprogram to the Science Appropriation.

Participants include: ANL, INEEL, SNL, SAFT, USABC.

FY 2003: Continue R&D on long-term advanced batteries for electric vehicles under the United States Advanced Battery Consortium Phase III Cooperative Agreement, with an industry average cost-share of 65 percent.

Long-term Battery R&D: Complete study of life limitations of lithium ion battery technology at high states of charge and extreme temperatures. Develop and validate, at the full-size cell level, solutions to life limitation. Based on progress to solve poor cycling efficiency, reassess the viability of the lithium-sulfur technology to meet the USABC long-term goals.

Participants include: ANL, USABC, TBD (FreedomCAR $1,500,000).

FY 2004: Continue R&D, in conjunction with industry, with focus on the high-energy lithium ion and lithium sulfur battery development by the U.S. Advanced Battery Consortium (USABC), with an industry cost share of 65 percent. Initiate development of lithium metal gel electrolyte batteries. Continue the cost reduction program for lithium ion batteries.

Long-term Battery R&D: Accelerate development of the lithium-sulfur technology. Demonstrate that this technology can meet USABC long-term goals and build prototype EV cells.

Participants include: ANL, USABC, TBD (FreedomCAR $1,500,000).

P **Exploratory Technology Research 2,375 1,935 9,525**

FY 2002: Transferred from Vehicle Technologies R&D /Electric Vehicles R&D

Continued research and development efforts to address the key barriers impeding the successful development of lithium ion and lithium polymer battery technologies. Developed and characterized novel anode, electrolytes and cathode materials that have higher capacity and are lower in cost. Continued research and development of advanced diagnostic methods to investigate life-limiting and performance-limiting processes in lithium batteries. Refined electrochemical models to understand the failure mechanisms and the mechanisms for thermal runaway of lithium ion and lithium polymer systems. Conducted 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.

Participants include: ANL, BNL, LANL, LBNL, SNL.

FY 2003: Transferred from Vehicle Technologies R&D / Electric Vehicles R&D

Continue research and development efforts to address 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 development of advanced diagnostic methods to investigate life-limiting and performance-limiting processes in lithium batteries. Continue to develop improved electrochemical models to understand the failure mechanisms and the mechanisms for thermal runaway of lithium ion and lithium polymer systems. Evaluate integrated electrochemical systems at the cell level to demonstrate that novel anodes, cathodes, and electrolytes are addressing the key electric vehicle battery barriers of performance, life, abuse tolerance, and cost.

Participants include: ANL, BNL, LANL, LBNL (FreedomCAR $1,935,000).

FY 2004: Continue research and development to addresses key barriers impeding the successful development of cost-effective, reliable, and durable energy storage systems for electric and hybrid vehicles. Continue the development and characterization of novel anode and cathode materials and electrolytes that have higher energy capability, longer and more stable cycling characteristics, and are lower in cost. Continue development of advanced diagnostic techniques to investigate and better understand life- and performance-limiting processes in lithium-based batteries. Develop electrochemical models to understand failure mechanisms and the mechanisms of thermal runaway in lithium batteries.

Accelerate the development of solid polymer electrolytes with high room temperature conductivity and good mechanical strength. Accelerate the development of low cost, abuse tolerant lithium sulfur battery technology. Investigate methods to protect the surface of the lithium electrodes and prevent dendrite formation in batteries with lithium metal anodes, including lithium metal polymer electrolyte and lithium sulfur systems. Investigate the use of nano-structured materials as cathodes in lithium batteries. Explore novel electrochemical energy storage technologies.

Participants include: LBNL, BNL, ANL, TBD (FreedomCAR $9,525,000).

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Advanced Power Electronics	**14,163**	**13,690**	**13,690**

FY 2002: Evaluated second generation Automotive Integrated Power Module (AIPM) and Automotive Electric Motor Drive (AEMD) production prototypes developed under 50 percent cost-shared agreements. Completed work with at-least one AIPM contractor. Validated AIPM and AEMD development efforts at the national laboratories.

Developed and explored improved materials and architectures for advanced automotive propulsion systems and flexible manufacturing. Evaluated prototype high temperature polymer capacitors and continue materials development to increase capacitor energy storage at high temperature. Studied advanced cooling methods with carbon foam. SBIR/STTR funding in the amount of $240,000 was transferred from this subprogram to the Science Appropriation.

Participants include: SatCon, SPCO, Semikron, ORNL, SNL, LLNL, ANL, Ames.

FY 2003: Perform baseline independent evaluation relative to the technical targets of the final Automotive Integrated Power Module (AIPM) and Automotive Electric Motor Drive (AEMD) production prototypes developed under 50 percent cost-shared agreements. Baseline evaluation performed by national laboratories.

Transfer production prototype high temperature polymer capacitor technology to industry. Continue materials development to increase capacitor energy storage at high temperature. Evaluate improved magnetic material. Start new effort to integrate developments from AIPM and AEMD. Start advanced energy study for long-range transportation solutions.

Participants include: SPCO, Semikron, Delphi, Delco-Remy, Lynx, ORNL, NREL SNL, LLNL, ANL, Ames, TBD (FreedomCAR $13,690,000).

FY 2004: Continue cooperative agreements with industry to develop advanced electronic components and electric machines, with potential application in light and heavy hybrid and fuel cell vehicles. Efforts are focused on advanced motors, DC/DC converters, and motor controllers. Test preliminary deliverables at a national laboratory for conformance to specifications. Maintain close collaboration among researchers, device manufacturers, and users of the technologies of light and heavy vehicles. Initiate research and development of advanced modules and systems to meet both light and heavy vehicle requirements.

Test thin film and ceramic capacitor deliverables for performance and temperature stability. Analyze performance data and re-focus capacitor development efforts to address technical barriers. Fabricate small batches of sintered and bonded permanent magnets for laboratory testing. Compare thermal limits and shape stability to commercial magnetic materials. Re-direct magnetic materials development efforts toward resolving

(dollars in thousands)

key technical hurdles to achieve low cost, near net shape permanent magnet materials.

Participants include: Ames, ANL ORNL, NREL, SNL, Freedom-CAR partners, Heavy Hybrid Partners, TBD (FreedomCAR $13,690,000).

Subsystem Integration and Development		**8,841**	**7,173**	**7,173**
P	**Light Vehicle Propulsion and Ancillary Subsystems . . . . . .**	**3,900**	**3,135**	**3,135**

FY 2002: Transferred from: Vehicle Technologies R&D / Hybrid Systems R&D

Developed neural network emissions predictors for advanced internal combustion engines, to accurately predict emissions during warm-up and transient conditions. Demonstrated advanced control techniques to improve fuel economy and reduce emissions of a parallel hybrid propulsion system in the laboratory, using a combination of components including a motor, engine, and transmission. Began testing battery thermal management system in a test vehicle. SBIR/STTR funding in the amount of $118,000 was transferred from this subprogram to the Science Appropriation.

Participants include ANL, NREL and industry.

FY 2003: Transferred from: Vehicle Technologies R&D/Hybrid Systems R&D

Complete testing of battery thermal management system for an advanced battery pack, and use results to develop hardware/software for self-heating for cold climates.

Participants include NREL and FreedomCAR Partners (FreedomCAR $3,135,000).

FY 2004: Demonstrate transient operation of a light vehicle fuel cell propulsion system over a federal drive cycle using hardware-in-the-loop facility. Demonstrate a hydrogen-fueled internal combustion engine-powered light hybrid powertrain and validate the analytical comparison to fuel cell-powered light hybrid vehicles. Complete testing of a thermal management system for a battery pack in fuel cell powered light vehicle.

Participants include ANL, NREL and FreedomCAR Partners (FreedomCAR $3,135,000).

(dollars in thousands)

FY 2002	FY 2003	FY 2004

P	**Heavy Vehicle Propulsion and Ancillary Subsystems**	**4,941**	**4,038**	**4,038**

FY 2002: Transferred from Vehicle Technologies R&D / Hybrid Systems R&D

Integrated the latest technologies for heavy hybrid vehicles. Finalized design and established preliminary manufacturing techniques for cost-effective mass production of hybrid components/subassemblies. Performed analytical modeling to confirm industry predictions of fuel economy improvement and emission reduction. Funded research and development of a new natural gas engine.

Participants include: Allison, NREL, DOT, DoD, ORNL, ANL.

FY 2003: Transferred from Vehicle Technologies R&D/Hybrid Systems R&D

Finalize integration of first generation heavy-duty hybrid propulsion systems into prototype heavy-duty vehicle designs targeted at specific performance goals, using powertrain characteristics consistent with market requirements. Apply advanced computer models for vehicle simulations to assist in component optimization and final confirmation of industry performance predictions. Maintain coordination with the Department of Transportation (DOT) and appropriate, related DOD technology development activities. Adopt current light-duty performance models to address heavy vehicles.

Participants include: Allison, NREL, DOT, DoD, ORNL, ANL, TBD Heavy Hybrid Partners (21CT $4,038,000).

FY 2004: In conjunction with industry teams selected in FY 02, continue development of efficient, cost-effective, next generation heavy hybrid components and system in support of the 21st Century Truck Partnership. The goal is to enable industry to introduce commercially viable heavy hybrid components and vehicle systems by 2007 and commercial vehicles by 2010. The R&D targets heavy hybrid components and systems developments for medium and heavy trucks with efficiency improvements, compared to conventional heavy vehicles, of up-to 100 percent at the vehicle systems level, while meeting 2007 emissions standards. Apply advanced computer modeling and analysis to assist in component optimization and continued confirmation of industry performance projections.

Participants include: NREL, ORNL, Heavy Hybrid partners (21CT $4,038,000).

Total, Hybrid and Electric Propulsions	**47,121**	**41,973**	**49,563**

Explanation of Funding Changes

		FY 2004 vs. FY 2003 ($000)
Hybrid and Electric Propulsion		
P	Accelerate research activities in the Exploratory Technology Research Program in support of long-term energy storage requirements for the FreedomCAR partnership. Broaden the scope of research and development activities that address the key barriers to the development of batteries for EVs and HEVs and expand the exploration of novel electrochemical energy storage systems	+7,590
Total Funding Change, Hybrid and Electric Propulsion		+7,590

Advanced Combustion Engines Subprogram

Mission Supporting Goals and Measures

The Advanced Combustion Engine R&D subprogram activities are focused on improving engine efficiency while meeting future Federal and State emissions regulations through a combination of combustion and exhaust aftertreatment technologies (e.g., NOx catalysts and particulate traps). This subprogram focuses R&D efforts on removing critical technical barriers to commercialization of higher efficiency, advanced internal combustion engines.

The subprogram consists of five activities: Combustion and Emission Control, Light Truck Engine, Heavy Truck Engine, Waste Heat Recovery and Health Impacts. The Combustion and Emission Control activity develops fundamental technologies to enable passenger cars and light trucks to utilize fuel efficient compression-ignition, direct-injection (CIDI) engines while meeting Federal and State emissions requirements. The Light Truck Engine activity develops diesel engine technologies for light trucks (pickups, vans, and sport utility vehicles) with the goal of enabling a 35 percent fuel efficiency increase while complying with Tier 2 emission standards. The Heavy Truck Engine activity develops technologies for diesel engines, such as optimized fuel injection, emissions control, waste heat recovery systems, and reduced friction and pumping losses, with the goal of improving the thermal efficiency to 50 percent (from the current 45 percent) while meeting Federal emissions standards. The Waste Heat Recovery activity develops technologies to convert waste heat from engines to electrical energy to improve overall thermal efficiency and reduce emissions. The Health Impacts activity evaluates the relative toxicity of emissions from new vehicle technologies developed to meet future emission standards.

The Off-Highway Vehicles activity assists industry in improving fuel efficiency while meeting future EPA emissions standards. Because other research opportunities have higher impact on energy savings and the air quality issues will be addressed by regulations, Federal support of industry R&D in this area is lower priority. This activity is terminated in the FY 2004 budget.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Advanced Combustion Engine R&D					
Combustion and Emission Control	19,515	17,571	15,000	-2,571	-14.6%
Light Truck Engine	15,778	13,106	13,106	0	0.0%
Heavy Truck Engine	9,396	6,979	6,979	0	0.0%
Waste Heat Recovery	500	500	500	0	0.0%
Off-Highway Vehicles	500	500	0	-500	-100.0%
Health Impacts	1,471	1,500	1,500	0	0.0%
Total Advanced Combustion Engine R&D	47,160	40,156	37,085	-3,071	-7.6%

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Advanced Combustion Engine R&D					
Albuquerque Operations Office					
Albuquerque Operations Office	3,757	1,389	600	-789	-56.8%
Golden Field Office	0	0	13,500	+13,500	NA
Los Alamos National Laboratory	1,000	1,100	600	-500	-45.5%
National Renewable Energy Laboratory	535	0	0	0	0.0%
Sandia National Laboratories	4,084	4,500	4,000	-500	-11.1%
Total, Albuquerque Operations Office	9,376	6,989	18,700	+11,711	+167.6%
Chicago Operations Office					
Argonne National Laboratory	2,110	50	1,300	+1,250	+2,500.0%
Brookhaven National Laboratory	380	315	380	+65	+20.6%
Chicago Operations Office	4,317	4,275	0	-4,275	-100.0%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Total, Chicago Operations Office	6,807	4,640	1,680	-2,960	-63.8%
National Energy Technology Laboratory	2,400	1,400	0	-1,400	-100.0%
Oakland Operations Office					
Lawrence Berkeley National Laboratory	250	0	0	0	NA
Lawrence Livermore National Laboratory	450	500	500	0	0.0%
Total, Oakland Operations Office	700	500	500	0	0.0%
Oak Ridge Operations Office					
ORISE	60	0	0	0	NA
Oak Ridge National Laboratory	4,490	3,650	2,300	-1,350	-37.0%
Oak Ridge Operations Office	20,962	20,210	11,705	-8,505	-42.1%
Total, Oak Ridge Operations Office	25,512	23,860	14,005	-9,855	-41.3%
Richland Operations Office					
Pacific Northwest National Laboratory	2,225	2,200	1,700	-500	-22.7%
Total, Richland Operations Office	2,225	2,200	1,700	-500	-22.7%
Washington Headquarters	140	567	500	-67	-11.8%
Total, Advanced Combustion Engine R&D	47,160	40,156	37,085	-3,071	-7.6%

Site Description

Albuquerque Operations Office

Provides contractual administration of the competitively awarded cooperative agreement for: projects on the development and demonstration of diesel engine emissions reduction technology; components suitable for light-duty and heavy truck application; comparative toxicology of gasoline and diesel emissions; and development of sensors to measure PM, O_2, and NOx for exhaust aftertreatment.

Golden Field Office

Award and administer Heavy Truck Engine and Emission Control cooperative agreements.

Los Alamos National Laboratory

Performs research on ICE combustion using simulation and modeling to reduce NOx in lean-burn engines and developing microwave regeneration components and design tools for emission controls. Los Alamos is also performing R&D to discover and develop next-generation emissions-control catalysts for lean burn engines and the development of technology for onboard generation of chemical reductants from diesel fuel.

National Renewable Energy Laboratory

Conduct engine/vehicle integration and platform studies.

Sandia National Laboratories

Conducts extensive fundamental research on piston engine combustion processes to reduce emissions formation while maintaining efficiency. R&D includes: the use of laser-based diagnostics to investigate advanced low-temperature, low-emission combustion regimes needed to develop high efficiency, low-emission diesel engines; and the study of engine and fuel parameters effects on fuel spray, combustion and emissions formation processes in diesel engines to determine the possible parameter ranges for sootless diesel combustion.

Investigations in optical and non-optical medium-duty HCCI engines and in an optically accessible light-duty gasoline engine are being conducted to provide the fundamental understanding of the combustion and emissions processes in HCCI engines needed to develop efficient, ultra-low emission engines for both heavy- and light-duty use. Laser diagnostics are also being developed to measure diesel particulate matter concentration, size, morphology, and metallic ash content, measurements vital to the successful development of robust diesel exhaust aftertreatment systems.

Argonne National Laboratory

Conducts research and development of in-cylinder emission control techniques for CIDI engines and the evaluation of innovative technologies to reduce emissions and improve fuel efficiencies in heavy-duty diesel engines. In addition, Argonne is using its Advanced Photon Source to perform fuel spray characterization for both light- and heavy-duty engines.

Brookhaven National Laboratory

Provides research support for genotoxicological analysis of internal combustion (IC) engine emissions.

Chicago Operations Office

Award and administer Emission Control cooperative agreements.

National Energy Technology Laboratory

Award and administer Emission Control cooperative agreements.

Lawrence Berkeley National Laboratory

Develop device to measure particulate matter from engines.

Lawrence Livermore National Laboratory

Performs studies of combustion under diesel and homogeneous charge compression ignition (HCCI) conditions using chemical kinetic modeling and other methods to determine means for increasing fuel efficiency, reducing emissions, and increasing peak output power.

ORISE

Plan technical meeting and conduct peer reviews.

Oak Ridge National Laboratory

Conducting research in internal combustion engine technologies, in-cylinder diagnostics (such as application of chaos theory and emission studies), and exhaust aftertreatment (including catalytic converter research, development, and testing). Develop an understanding of NOx adsorber processes affecting regeneration, desulfation, and degradation under real-world conditions. Providing detailed characterization and speciation of combustion and emission products.

Using primarily laboratory reactors and some engine experiments, kinetic data are being acquired for the development of computer models of aftertreatment devices. Efforts are also focused on improving lower temperature combustion by expanding the useful combustion regime and determining how to effectively integrate this type of combustion with emission controls.

Oak Ridge Operations Office

Performs contractual administration of competitively awarded cooperative agreement for projects to develop and demonstrate diesel engine emissions reduction technology and to develop components suitable for light truck engine development

Pacific Northwest National Laboratory

Developing experimental and analytical methods to measure and improve technologies to reduce exhaust emissions and studying materials for lean-burn, high-durability NOx sensors. Work includes the development of efficient and effective plasma assisted lean NOx reduction for both light- and heavy-duty diesel engines while

minimizing vehicle fuel economy penalty.

The lab is also conducting fundamental studies to determine the mechanisms of NOx adsorber deactivation due to sulfur poisoning and to develop improved sulfur trap capacities for use in exhaust aftertreatment systems. The lab is working to facilitate the scale-up process for depositing Si/SiGe superlattices, materials used in the development of thermoelectric devices for recovering waste heat in diesel engine thus improving fuel efficiency.

Washington Headquarters

Award and administer support services contract.

Detailed Program Justification

	FY 2002	FY 2003	FY 2004
Combustion and Emission Control	**19,515**	**17,571**	**15,000**

FY 2002: Transfer from: Vehicle Technologies R&D / Advanced Combustion R&D. Conducted R&D to 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: Conducted CIDI Combustion CRADA, focused on optical engine studies. This work was cost-shared (50-50) with industry. Investigated control systems for Homogeneous Charge Compression Ignition (HCCI) technologies to reduce engine-out emissions at SNL and several universities. The work at the universities was cost-shared at 20 percent. Performed laser diagnostic and high speed imaging work; used to visualize formation and oxidation of in-cylinder soot and evaluate various fuel injection strategies to minimize emission formation. Also conducted combustion, fuel injection, and emissions formation simulation projects.

Emission Controls: Conducted the lean NOx catalyst CRADA program, focusing on developing urea-based catalysts with improved activity and durability at the low exhaust temperatures characteristic of light duty compression ignition, direct injection (CIDI) engines. Ford, GM, and DaimlerChrysler were cost-sharing partners on this CRADA. Developed late-cycle injection and other strategies to generate reductants for lean NOx catalysts and adsorbers. Initiated program with GM using combinatorial chemistry to screen high volumes of NOx catalyst materials. Continued program with Ford to develop urea-based SCR catalyst system. Completed emission control development for small displacement- engines at Detroit Diesel and Cummins, moving to SUV-sized engines and emission control strategies to achieve stretch targets of 0.07 g/mi NOx and 0.01 g/mi PM for automotive and light truck applications by 2010. The contracts with Ford, GM, Detroit Diesel and Cummins included a 35 percent cost share. Continued non-thermal plasma CRADAs for light-duty vehicles between PNNL and GM, Ford, and Daimler-Chrysler, and for heavy-duty vehicles between PNNL and Caterpillar and Delphi. Continued programs to determine how engine parameters, such as Exhaust Gas Recirculation (EGR) level, could be adjusted to reduce NOx and particulate emissions. Completed programs to develop and test a state-of-the-art particulate measurement device.

Engine/Emission Controls Integration: Continued program to develop a PM sensor to provide feedback for optimizing control systems for combustion and emission control. This work was cost-shared by industry at 20 percent. Continued Engine Control System work for complex manipulation of EGR, timing multiple fuel injection events, making temperature adjustments, and other control strategies to enable proper emission control device operation and regeneration. SBIR/STTR funding in the amount of $342,000 was transferred from this subprogram to the Science Appropriation.

Participants include: SNL, LANL, ORNL, PNNL, LLNL, ANL, Ford, GM, DaimlerChrysler, Detroit Diesel, Cummins, Engelhard, Caterpillar, Delphi, Mack, ExxonMobil, Diesel engine and catalyst manufacturers,

suppliers, and universities.

FY 2003: Transfer from: Vehicle Technologies R&D / Advanced Combustion R&D. Continue R&D to 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: Continue CIDI Combustion work, focused on optical engine studies. This work is cost-shared (50-50) with industry. Continue investigations of control systems for HCCI technologies to reduce engine-out emissions. Continue laser diagnostic and high speed imaging work used to visualize formation and oxidation of in-cylinder soot, and evaluate various fuel injection strategies to minimize emission formation. Continue combustion, fuel injection, and emissions formation simulation projects. Evaluate membrane technologies to generate nitrogen to use as diluent instead of Exhaust Gas Recirculation (EGR). Develop strategies to reduce NOx with late cycle air/oxygen injection.

Emission Controls: Continue lean NOx catalyst CRADA program, focusing on developing urea-based catalysts with improved activity and durability at the low exhaust temperatures characteristic of light duty CIDI engines. Ford, GM, and DaimlerChrysler are cost-sharing partners on this CRADA. Develop late cycle injection and other strategies to generate reductants for lean NOx catalysts and adsorbers. Continue program at GM using combinatorial chemistry to screen high volumes of NOx catalyst materials. Continue program with Ford to develop and demonstrate a urea selective catalytic reduction (SCR) emission control system on a light-duty vehicle. Continue programs at Detroit Diesel and Cummins on emission control system technologies to achieve Tier 2 emissions standards of 0.07 g/mi NOx and 0.01 g/mi PM for automotive and light truck applications by 2010. The cooperative agreements with Ford, GM, Detroit Diesel and Cummins include a 35 percent cost-share. Continue non-thermal plasma CRADAs with industry partners, to reduce NOx and PM emissions. Continue testing of variable compression ratio (VCR) engine to verify ability to achieve emission and fuel economy goals.

Engine/Emission Controls Integration: Develop NOx, PM, and wide-range oxygen sensors through cost-shared CRADAs with automotive suppliers, to enable closed-loop control of fuel injection and emission control devices. Develop exhaust sulfur traps that enable catalyst-based emission control systems to meet Federal 120,000-mile durability requirements. Develop microwave-regenerative particulate traps that achieve 0.01 gram/mile. Benchmark performance and cost of available worldwide technology against program performance targets of 0.07 g/mile NOx and 0.01 g/mile PM.

Participants include: SNL, LANL, ORNL, PNNL, LLNL, ANL, Ford, GM, DaimlerChrysler, Detroit Diesel, Cummins, Engelhard, ExxonMobil, Caterpillar, Mack, International, Delphi, Honeywell, University of Michigan, University of Wisconsin, catalyst manufacturers, other suppliers, other universities (FreedomCAR $13,976,000; 21CT $3,595,000).

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2004: Continue fundamental R&D which will enable passenger cars and trucks to utilize fuel efficient compression-ignition, direct-injection (CIDI) engines while meeting Federal and State emissions requirements.

Combustion: Continue CIDI Combustion research, focused on optical engine studies. This cooperative research is cost-shared with industry. Continue investigations of control systems for HCCI (Homogeneous Charge Compression Ignition) technologies to reduce engine-out emissions at SNL and several universities. The research at the universities is cost-shared at 20 percent. Identify technology barriers to the use of hydrogen combustion engines and examine research options in coordination with Hydrogen, Fuel Cell, and Infrastructure Technologies Program. Continue laser diagnostic and high speed imaging work used to visualize formation and oxidation of in-cylinder soot, and evaluate various fuel injection strategies to minimize emission formation. Utilize X-rays to study near-fuel injection spray characteristics. Continue combustion, fuel injection, and emissions formation simulation projects

Emission Controls: Develop late cycle injection and other strategies to generate reductants for lean NOx catalysts and adsorbers. Through partnership with industry, develop a shared database of simulation codes for exhaust emission control systems. Continue program at GM using combinatorial chemistry to screen high volumes of catalyst materials for NOx adsorbers. Integrate and test at the vehicle level on program at Cummins using NOx adsorber/PM filter to achieve Tier 2 emissions standards of 0.07 g/mi NOx and 0.01 g/mi PM with projected 120,000 mile durability for automotive and light truck applications by 2006. The cooperative agreements with Ford, GM, and Cummins include a 35 percent cost-share. Continue to investigate new innovative technologies, in addition to non-thermal plasma, to reduce NOx and PM emissions.

Engine/Emission Controls Integration: Continue development of NOx, PM, and wide-range oxygen sensors through cost-shared CRADAs and cooperative agreements with automotive suppliers, to enable closed-loop control of fuel injection and emission control devices. Develop exhaust sulfur traps that enable catalyst-based emission control systems to meet Federal 120,000-mile durability requirements. Develop microwave-regenerative particulate traps that achieve 0.01 gram/mile.

Participants include: SNL, LANL, ORNL, PNNL, LLNL, ANL, Ford, GM, DaimlerChrysler, Detroit Diesel, Cummins, Engelhard, ExxonMobil, Caterpillar, Mack, International, Delphi, Honeywell, University of Michigan, University of Wisconsin, catalyst manufacturers, other suppliers, other universities (FreedomCAR $12,799,000; 21CT $2,201,000).

Light Truck Engine	**15,778**	**13,106**	**13,106**

FY 2002: Optimized production-ready prototype clean diesel engines for light trucks (pickups, vans, and sport utility vehicles). Incorporated emission reduction technology to achieve compliance with EPA emission standards. Initiated reliability testing of engine and emissions reduction technology. Continued development of promising NOx reducing (HCCI) combustion and fuel injection systems. Developed non-thermal plasma for

80 hp diesel engine. Scaled-up non-thermal plasma devices for both light and heavy trucks, utilizing solid state power systems compatible with vehicle installation. Designed, fabricated, and tested 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. SBIR/STTR funding in the amount of $990,000 was transferred from this subprogram to the Science Appropriation.

Participants include: Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp., Hi-Z, NoxTech, national laboratories.

FY 2003: Integrate in-cylinder and aftertreatment NOx and particulate reduction devices with the engine control microprocessor in a vehicle; conduct efficiency, emissions, reliability, and durability testing. Finalize iterative test and redesign of diesel engine and emission control system compliant with EPA Tier 2 emissions standards. Integrate in-cylinder and aftertreatment NOx and particulate reduction devices with the engine control microprocessor in a vehicle; conduct efficiency, emissions, reliability, and durability testing. Continue development of fuel injection system components and redesign of combustion chamber as necessary for homogeneous charge compression ignition (HCCI) system. Continue iterative single cylinder engine optimization. Initiate multi-cylinder evaluation of HCCI. Scale up non-thermal plasma for nominal 250 hp engine NOx and particulate reduction to achieve greater than 80 percent NOx reduction. Complete prototype solid state power supply development. Develop greater than 1 kW quantum-well thermoelectric generators that will convert exhaust waste heat into enough electricity to replace a conventional light truck alternator and supply power to electrical components. Develop quantum-well thermoelectric generators that are 5 times more efficient than current state-of-the-art bulk semiconductors.

Participants include: Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp., Hi-Z, NoxTech, national laboratories (21CT $13,106,000).

FY 2004: Complete integration of in-cylinder and aftertreatment NOx and particulate reduction devices, such as NOx adsorbers and PM filter, with the engine control microprocessor in a light truck and demonstrate program goals of 35 percent fuel efficiency improvement and while meeting EPA Tier 2 emission regulations. Complete development of fuel injection system components and design of combustion chamber for (HCCI) system. Complete iterative single cylinder and multi-cylinder engine optimization of HCCI. Complete scale up non-thermal plasma for nominal 250 hp engine NOx and particulate reduction to achieve greater than 80 percent NOx reduction. Complete development of greater than 1 kW quantum-well thermoelectric generators that will convert exhaust waste heat into enough electricity to supplement the conventional light truck alternator and supply power to electrical components. Transferred to Waste Heat Recovery: Future work transferred to waste heat recovery.

Participants include: Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp., Hi-Z, NoxTech, national laboratories (21CT $13,106,000).

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Heavy Truck Engine	**9,396**	**6,979**	**6,979**

FY 2002: Developed and tested laboratory diesel engines, through 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. Investigated technologies to optimize fuel injection, emissions control, and waste heat recovery systems, and reduce friction and pumping losses. Continued evaluating technologies developed in the Combustion and Emission Control R&D and Light Truck Engine programs to determine their applicability to the higher pressures and temperatures experienced in heavy duty engines. Developed a Multi-Year Program Plan for the Heavy Duty Diesel Engine Emissions Control Technology Program to address the recommendations from the 2000 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.

FY 2003: Shift focus to the development of technologies for diesel and emission control systems that will meet the very stringent EPA 2007 emission standards with a thermal efficiency of 50 percent. Continue investigating technologies to optimize emissions control, combustion, fuel injection and waste heat recovery systems, and reduce friction and pumping losses. Develop emission control technologies from the Combustion and Emission Control R&D and Light Truck Engine Component Development programs for the higher pressures, temperatures, and durability requirements of heavy duty diesel engines. Implement Multi-Year Program Plan for the Heavy Duty Diesel Engine Emissions Control Technology Program, to address the recommendations from the 2000 National Research Council (NRC) peer review of the Office of Heavy Vehicle Technologies (OHVT) Program to "place a high priority on integrated emissions-control technology (combustion and aftertreatment technologies) to meet future emissions requirements."

Participants include: Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp., suppliers, national labs (21CT $6,979,000).

FY 2004: Continue development of technologies for diesel engine and emission control systems that will improve the thermal efficiency from the current 45 percent to 50 percent, while meeting the very stringent Federal 2007 emission standards. Develop and integrate NOx adsorbers, SCR, sulfur traps and PM filters to meet the durability requirement of 435,000 miles for heavy vehicles. Investigate new combustion regimes to reduce engine out emissions. Continue to optimize fuel injection and waste heat recovery systems, and reduce friction and pumping losses. Continue to evaluate emission control technologies from the Combustion and Emission Control R&D and Light Truck Engine programs for the higher pressures, temperatures, and durability requirements of heavy duty diesel engines

Participants include: Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp., suppliers, national labs (21CT $6,979,000).

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Waste Heat Recovery (formerly Engine Boosting) 500 500 500

FY 2002: Continued work under cooperative agreements to develop electric turbocompounding combined with 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.

FY 2003: Complete laboratory tests of electric turbocompound units designed for heavy- and light-duty trucks that increase low-speed torque, improve engine transient response, and reduce particulate emissions. The unit will also provide 1.8 kW for electrically powered accessories (currently belt driven) and will be incorporated in the "More Electric Truck" initiative being developed by the Heavy Vehicle Systems R&D Program. The light truck design will be integrated into a vehicle for evaluation.

Participants include: Honeywell, Caterpillar, and International Truck and Engine Co. (21CT $500,000).

FY 2004: Continue vehicle tests of electric turbocompound units designed for heavy- and light-duty trucks that increase low-speed torque, improve engine transient response, and reduce particulate emissions. The unit will also provide 1.8 kW for electrically powered accessories. Combine turbocompounding with starter motor-alternator to improve vehicle fuel economy and performance. Previously funded under Light Truck Engine: Continue research of quantum-well thermoelectric generators that are 5 times more efficient than current state-of-the-art bulk semiconductors.

Participants include: Honeywell, Caterpillar, and International Truck and Engine Co. (21CT $500,000).

Off-Highway Engine R&D 500 500 0

FY 2002: Completed development of industry-government technology road map to identify research needs for off-highway vehicles, including locomotive. Awarded 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 future EPA regulations. Evaluated technologies developed in the Heavy Truck Engine Program, to determine their applicability to off-highway engines.

Participants include: Caterpillar, Cummins, John Deere, General Electric, and Michigan Tech.

FY 2003: Utilize the industry-government roadmap developed to identify off-highway vehicle and locomotive research needs. Develop technologies that will allow diesel engines used for off-highway applications to meet future EPA emissions standards without sacrificing efficiency. Evaluate technologies developed in the Heavy

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Truck Engine Program and determine their applicability to off-highway engines. Investigate areas for system efficiency improvements including advanced powerplants and thermal management.

Participants include: Caterpillar, Cummins, John Deere, General Electric, and Michigan Tech (21CT $500,000).

FY 2004: Industry must meet future EPA emissions standards. Because other research opportunities have higher impact on energy savings and the air quality issue will be addressed by regulations, Federal support of industry R&D in this area is lower priority. Therefore, this activity is terminated in FY 2004. (21CT $0).

Health Impacts	**1,471**	**1,500**	**1,500**

FY 2002: Transfer from: Vehicle Technologies R&D /Advanced Combustion Engine R&D. Continued comparison of toxicity of diesel and gasoline emissions by sub-chronic inhalation exposures. Completed exposures to diesel emissions and begin exposures to gasoline emissions. Performed short-term biological assays of new technology diesel emissions, including organic and solid nanoparticles, without emissions passing through trap and catalyst aftertreatments. SBIR/STTR funding in the amount of $29,000 was transferred from this subprogram to the Science Appropriation.

Participants include: Lovelace Respiratory Research Institute, NIOSH.

FY 2003: Transfer from: Vehicle Technologies R&D /Advanced Combustion Engine R&D. Extend application of validated rapid toxicity tests or inhalation studies to emissions from new engine, fuel, and aftertreatment technologies. Determine toxicity effect of exposing cells to airborne nanoparticles. Apply rapid toxicity tests to determine contribution of lube oil to toxicity.

Participants include: Lovelace Respiratory Research Institute, NIOSH (21CT $1,500,000).

FY 2004: Evaluate the relative toxicity of emission samples from new vehicle technologies developed to meet the 2004 Tier 2 emission standards. Evaluate the relative health hazards of emissions of nanoparticles from gasoline and diesel vehicle technologies. Perform short-term bioassays of emission samples from gasoline and diesel vehicles to determine relative toxicity.

Participants include: Lovelace Respiratory Research Institute, NIOSH (21CT $1,500,000).

Total, Advanced Combustion Engine R&D	**47,160**	**40,156**	**37,085**

Explanation of Funding Changes

		FY 2004 vs. FY 2003 ($000)
Advanced Combustion Engine R&D		
P	Combustion & Emissions Control: Terminate projects in the combustion and emissions control activity on Selective Catalytic Reduction for NOx reduction and reduce efforts on NOx adsorber/PM system development in order to focus more on longer-term activities within the FCVT Program	-2,571
P	Terminate off-highway vehicle activity in order to focus more on longer-term activities within the FCVT Program	-500
Total Funding Change, Advanced Combustion Engine R&D		**-3,071**

Materials Technologies Subprogram

Mission Supporting Goals and Measures

The Materials Technologies subprogram supports the development of cost-effective materials and materials manufacturing processes that can contribute to fuel-efficient transportation vehicles. This subprogram is a critical enabler for concepts developed in the FreedomCAR and 21st Century Truck Partnerships. The subprogram consists of three activities: Propulsion Materials Technology, Lightweight Materials Technology, and the High Temperature Materials Laboratory (HTML).

Propulsion Materials Technologies activities focus on technologies that are critical in removing barriers to the fuel cell, electric drive, hydrogen engine and emissions control research programs. Lightweight Materials Technology activities develop carbon fiber and metal composites to reduce vehicle weight while maintaining safety and performance, and reducing cost. The HTML is a user facility that assists industry, academia, and other government agencies in developing advanced materials. The HTML provides a skilled staff, numerous sophisticated one-of-a-kind material characterization tools, and a knowledge base for solving materials engineering problems.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Materials Technologies					
Propulsion Materials Technologies	8,670	6,850	8,850	+2,000	+29.2%
Lightweight Materials Technology	24,986	18,550	26,790	+8,240	+44.4%
High Temperature Materials Laboratory (HTML)	5,502	4,000	4,000	0	0.0%
Total, Materials Technologies	39,158	29,400	39,640	+10,240	+34.8%

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY2003	FY2004	$ Change	% Change
Materials Technologies					
Albuquerque Operations Office					
Albuquerque Operations Office	153	0	0	0	NA
Golden Field Office	0	0	3,446	+3,446	NA
Los Alamos National Laboratory	0	100	100	0	0.0%
Sandia National Laboratories	175	670	1,170	+500	+74.6%
Total, Albuquerque Operations Office	328	770	4,716	+3,946	+512.5%
Chicago Operations Office					
Ames Laboratory	65	0	0	0	NA
Argonne National Laboratory	1,754	1,375	3,875	+2,500	+181.8%
Chicago Operations Office	10	0	0	0	NA
Total, Chicago Operations Office	1,829	1,375	3,875	+2,500	+181.8%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	0	250	250	0	0.0%
Idaho Operations Office	325	0	0	0	NA
Total, Idaho Operations Office	325	250	250	0	0.0%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

	FY 2002	FY2003	FY2004	$ Change	% Change
Oakland Operations Office					
Lawrence Berkeley National Laboratory .	400	400	1,900	+1,500	+375.0%
Lawrence Livermore National	650	385	565	+180	+46.8%
Total, Oakland Operations Office	1,050	785	2,465	+1,680	+214.0%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	26,488	18,669	23,069	+4,400	+23.6%
ORISE	289	0	0	0	NA
Oak Ridge Operations Office	3,993	3,786	0	-3,786	-100.0%
Total, Oak Ridge Operations Office	30,770	22,455	23,069	+614	+2.7%
Richland Operations Office					
Pacific Northwest National Laboratory . . .	4,696	3,565	5,065	+1,500	+42.1%
Total, Richland Operations Office	4,696	3,565	5,065	+1,500	+42.1%
Washington Headquarters	160	200	200	0	0.0%
Total, Materials Technologies	39,158	29,400	39,640	+10,240	+34.8%

Site Description

Albuquerque Operations Office

Soliciting, awarding, and administering research and development contracts, cooperative agreements, and grants with industry, academia, and other Government organizations.

Golden Field Office

Provides technical project management and administrative support for new contracts, cooperative agreements, and grants. Focus will be in research and recycling of composites and light metals.

Los Alamos National Laboratory

Research is directed at materials development and advanced automotive manufacturing concepts, such as metal treatment using Plasma Surface Ion Implantation (PSII) and development of low-cost aluminum sheet.

Sandia National Laboratories

Materials R&D to improve the performance of tires, engines, and automotive body structures. Analysis and laboratory demonstration of improved manufacturing techniques and instrumentation for forging, heat treatment, coating, welding, and other factory processes.

Ames Laboratory

Conducts basic research on new materials with unique properties. Works to identify transportation applications for new materials that take best advantage of their special properties.

Argonne National Laboratory

Develops wide range of materials (both metals and ceramics), with particular expertise in nondestructive evaluation, rapid prototyping, sensors, and catalysts. Developing economic processes for automotive recycling. Develops permanent magnet materials for high performance motors. Characterizing the effect of microdimpling on reduction of surface friction and wear. Developing lower temperature, high strength bonding method for ceramics and dissimilar materials.

Chicago Operations Office

Soliciting, awarding, and administering research and development contracts, cooperative agreements, and grants with industry, academia, and other Government organizations.

Idaho National Engineering and Environmental Laboratory

Developed and demonstrated spray forming process for rapid production on net-shape molds, dies, and related tooling for automotive components. Modeling of slurry preforming for fiber reinforced composites, NDE for cylinder liners, intelligent welding, spray forming of aluminum. Characterize metallic structures produced by equal channel angular extrusion process.

Idaho Operations Office

Provided contract administration for grants and cooperative agreements for university research.

Lawrence Berkeley National Laboratory

Development of nondestructive testing techniques for evaluation of aluminum and composite structures in manufacturing environments.

Lawrence Livermore National Laboratory

Development of high-voltage, dielectric ultracapacitors based on nanostructure multilayer oxide materials. Aerogel-based NOx catalysts development for CIDI engines. Nondestructive evaluation and in-line sensors for the design and product optimization of cast light metals. Applying equal channel angular extrusion to the fabrication of amorphous metallic materials for magnet applications.

Oak Ridge National Laboratory

Conducts research and provides technical/project management support in propulsion and vehicle system materials. Materials development for light metals, composites, carbon foam, and material manufacturing techniques. Development of material analytical techniques and material related solutions for automotive and heavy vehicle systems. The HTML provides unique materials characterization and measurement capabilities for government and industry.

ORISE

Organizing, planning and conducting scientific workshops to engage industry with the scientific community in the national labs.

Oak Ridge Operations Office

Soliciting, awarding, and administering research and development contracts, cooperative agreements, and grants with industry, academia, and other Government organizations.

Pacific Northwest National Laboratory

Development of energy efficient production for magnesium, titanium, polymer composite and glass components for advanced automotive and heavy vehicle designs. Studying materials for lean-burn, high-durability spark plugs. Developing environmentally friendly processes for the manufacture of planar thin film ceramic sensors. Creation of a Northwest Alliance to develop lightweight materials processing technologies. Developing and testing a lightweight SUV frame prototype with performance equal to conventional steel components. Designing hybrid composite materials for weight critical heavy vehicle structures.

Washington Headquarters

Soliciting, awarding, and administering support services and research and development contracts, cooperative agreements, and grants.

Detailed Program Justification

	FY 2002	FY 2003	FY 2004
Propulsion Materials Technology	**8,670**	**6,850**	**8,850**
P Automotive Propulsion Materials	**2,914**	**1,000**	**3,000**

FY 2002: Developed in-cylinder application techniques for diesel engine aluminum block surface treatment technology, to improve durability in a light weight engine block. Optimized ceramic particulate filter system for diesel engines to remove 90 percent of particulates with 95 percent filter regeneration efficiency. Demonstrated full scale carbon foam heat sinks for power electronic modules. Transferred polymeric DC buss capacitor technology to industry supplier(s). Characterized relationship between processing parameters and structure of NdFeB permanent magnets. Developed highly sensitive NOx sensor. Developed techniques to fabricate small orifices for diesel fuel injectors. SBIR/STTR funding in the amount of $57,000 was transferred from this subprogram to the Science Appropriation.

Participants include: ORNL, LLNL, SNL, ANL, Industrial Ceramic Solutions.

FY 2003: Validate aluminum block surface treatment technology by testing Ford engine that incorporates two treated components. Demonstrate dielectric plates (catalyst substrate) in a non-thermal plasma reactor assembly in actual diesel exhaust. Transfer carbon foam heat sink technology for power electronic modules to industry suppliers. Continue to transfer polymeric DC buss capacitor technology to industry supplier(s). Optimize high dielectric ceramic bus capacitor fabrication techniques.

Participants include: ORNL, LLNL, SNL, ANL, Industrial Ceramic Solutions (FreedomCAR $1,000,000).

FY 2004: Reduce diesel particulate filter regeneration temperature and improve durability. Evaluate thermal stability of ceramic cermet seals in non-thermal plasma reactors. Continue to transfer carbon foam heat sink technology modules to industry suppliers. Optimize carbon foam properties for different applications. Continue to develop improved high-energy product permanent magnets. Develop materials and coatings for hydrogen engines and fuel cell subsystems.

Participants include: ORNL, LLNL, ANL, Industrial Ceramic Solutions (FreedomCAR $3,000,000).

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
P **Heavy Vehicle Propulsion Materials . . . . . .**	**5,756**	**5,850**	**5,850**

FY 2002: Distributed peer/industry-reviewed Multi-Year Program Plan for the Propulsion Systems Materials Program. Identified and assessed materials needs for design/ manufacture of components for high efficiency, low emission, high durability, high reliability heavy vehicle engines. Studied prototype thick thermal barrier coatings for pistons. Completed evaluation of test results. Developed catalyst and catalyst support systems for exhaust aftertreatment to significantly reduce engine emissions. Evaluated new formulations of NOx catalysts, plasma assisted catalysts, and catalyst systems, in the presence of exhaust gas recirculation (EGR). Assessed materials EGR-related degradation of engine components. Developed cermet materials for fuel systems and low-cost continuous sintering processes for cermets, ceramics, metallurgical and intermetallic compounds for engine components. Completed initial development, laboratory testing of "smart materials" in fuel injection applications. Planned proposed follow-on development project. Refined component durability evaluations and part-life prediction models. Validated code predictions of cost, performance parameters. Applied refined models to current R&D portfolio. Continued development of high reliability non-destructive evaluation technology for diesel engine components, advanced testing/characterization of new engine materials. Incorporated new Aberration Corrected Electron Microscope (ACEM) at the HTML in examination/characterization of heavy vehicle-related materials and components. Investigated breakthrough in titanium production for feasibility of cost-effective titanium alloy development for engine components. Collaborated with ASTM, SAE to develop domestic, international testing standards for advanced materials for higher efficiency diesel engines. With NIST, continued similar cooperation with International Energy Agency. Expanded assessment of the Femto-second laser technology for processing of component materials. SBIR/STTR funding in the amount of $140,000 was transferred from this subprogram to the Science Appropriation.

Participants include: Caterpillar, Cummins, Detroit Diesel Corp., ORNL, NIST, ANL, Ford, North Carolina A&T, Southern Illinois University.

FY 2003: Select and prioritize, based on peer/industry-reviewed Multi-Year Program Plan, potential projects on materials and/or manufacturing processes for components of high efficiency, low emission, high reliability, durable heavy vehicle engines. Explore new approaches for producing thick thermal barrier coatings for thermal control within the engine. Investigate laser surface microtexturing to increase surface bonding and enhance performance of components in shear applications. Evaluate electrodeposition, thermal and plasma spray, cold spray, chemical vapor deposition and physical vapor deposition coating methods. In conjunction with industry, continue to evaluate the performance of NOx catalysts, plasma assisted catalysts, and catalyst systems in the presence of EGR to achieve compliance with mandatory emission standards. Downselect from among materials currently being developed for

low emissions exhaust gas aftertreatment devices. Conduct detailed characterization and structure / performance optimization. Continue assessment of the degradation of engine components by re-circulated exhaust gases (EGR) to determine abatement strategies. Rig test "smart materials" on fuel injector actuators that have passed stringent laboratory tests. Apply life-prediction models to selected diesel engine components and verify performance. Use advanced high reliability non-destructive evaluations of diesel engine components and microstructural characterization of new engine materials to achieve material/component optimization.

Conduct, with industry partners, development and testing of advanced materials including intermetallic compounds, cermets, ceramics, and titanium alloys. Develop cost-effective manufacturing processes of components for high efficiency, low emission engines. Design and test prototype radiators constructed of very high conductivity carbon foams for down-sizing and possible relocation of heavy vehicle cooling systems. Continue collaboration with NIST, ASTM, and SAE in the development of domestic and international testing standards for advanced materials for high efficiency diesel engines. Assist the International Energy Agency in expanding the materials portfolio of the High Temperature Materials Annex from ceramic powders only, to include all light-weighting materials to achieve greater vehicular efficiency. Identify and develop new methods for joining dissimilar materials to be subjected to high stress, high velocity environments in air handling components of high efficiency, low emissions heavy duty engines. Apply Femto-second laser to automotive glasses and industrial ceramics, to modify the surface and possibly improve in-service material behavior and component performance. Extend advanced, high precision machining by a movable electric spark device to include intractable intermetallic compounds, precipitation hardenable alloys, ceramics, and cermets.

Participants include: Caterpillar, Cummins, Detroit Diesel Corp., Ford, ORNL, NIST, ANL, North Carolina A&T, Southern Illinois University, (21CT $5,850,000).

FY 2004: Issue a competitive solicitation for industry-led teams on the materials, fabrication, and life-extension technologies for significantly higher efficiency, ultra low emission, high performance heavy duty engines. Initiate research projects. Develop advanced coatings and surface modifications to improve friction couples in diesel engine hot-sections and materials for applications that are performance limited by excess wear and friction. Conduct experimental and computational R&D to formulate/develop advanced catalytic materials for emission reduction in diesel engines in concert with rig tests and engine dynamometer tests. Monitor corrosion and wear phenomena for component durability assessments of new materials in engines using exhaust gas recirculation (EGR) for reduction of NOx. Develop new materials for the next generation of fuel injector systems for ultra-clean diesel engines. Complete rig and engine testing of piezoelectric "smart materials" for fuel system actuators. Test performance predictions of materials in selected components by rig and engine tests. Develop advanced inspection, testing, and life prediction methods for new diesel-engine materials. Develop

(dollars in thousands)

FY 2002	FY 2003	FY 2004

low-cost titanium materials for advanced engines. Identify and assess cost-effective materials processing, component design, materials/component characterization, and testing.

Formulate advanced thermal management concepts with high-thermal conductivity carbon foam materials to improve truck efficiency via redesign of traditional cooling systems. Develop ASTM, SAE, and ISO standards through the voluntary consensus processes with technical exchanges and round-robin testing. Continue domestic and international collaboration on standard methods of testing advanced materials. Finalize the technical realignment of the IEA materials annex for selected materials development for high efficiency heavy vehicles. Continue development of joining technology for dissimilar material couples and of low-cost manufacturing processes for diesel engines. Evaluate precision and durability of components manufactured by new, cost-effective processes. Develop materials modeling and simulation approaches to enable more rapid materials development and experimentally validate the formulations. Apply the approaches to the design of new high efficiency, clean, cost-effective diesel engines. Evaluate the impact of low-sulfur and alternative fuels on the durability and performance of materials for advanced diesel engines and develop corrosion/wear-resistant materials for use with those fuels.

Participants include Caterpillar, Cummins, Detroit Diesel, Ford, ORNL, NIST, ANL, LLNL, North Carolina A&T, Southern Illinois University, N.C. State University, International, PACCAR, Freightliner, Volvo Trucks (21CT $5,850,000).

Lightweight Materials Technology	**24,986**	**18,550**	**26,790**

P	**Automotive Lightweight Materials . . . . . .**	**15,412**	**9,600**	**17,840**

FY 2002: Continued planning and coordination with the USAMP, ACC, A/SP and NRCan and planning with the APC, VRP, and others on new efforts in plastics and recycling.

Metals: Continued the warm forming and stamping binder projects on fabrication of components from aluminum sheet, and the aluminum extrusion hydroforming project. Concluded the project on extending the lives of steel dies used for casting aluminum components and the difficult-to-cast aluminum alloy, thus ending all program efforts on aluminum casting. Completed three of six metal-joining projects. These include one on non-destructive evaluation (NDE) of spot welds of aluminum, one on plasma-arc welding of aluminum and magnesium and one on NDE of laser-welded light metals. Continued projects on extending the lives of electrodes used for spot welding aluminum, the fundamentals of joining dissimilar aluminum alloys to each other and to steels and joining advanced high-

strength, high-ductility steels to each other. Continued a major project on optimizing casting of magnesium alloys into mainly cool-section (body and chassis) structural components, one on casting of more creep-resistant magnesium alloys into hot-section powertrain components, and one on lower cost production of raw magnesium. Tested product of the new approaches for producing titanium to see if R&D work on parts fabrication is justified. Concluded five of the nine projects on advanced high-strength, high-ductility steels.

Composites: Continued efforts on processing technologies critical for successfully conducting Focal Project 3 (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, was completed. Continued the FP3 preforming, molding and composite-metal joining projects, and the Carbon Fiber Reinforced Polymer Matrix Composites durability, crashworthiness and SUV skid plate projects. Concluded the thermoplastic molding project. Completed two carbon-fiber precursor projects, while continuing two others.

Other: Continued process development work on carbon fiber recovery and recycling, including re-use testing and evaluation of recovered fibers. Completed technical evaluation and testing of aluminum sorting technologies and process options, and the effort on lower weight automotive window glass. A unique device for testing materials at strain rates typical of automotive crashes was installed, tested and put into use in conjunction with projects included in the *Metals* and *Composites* activities. SBIR/STTR funding in the amount of $248,000 was transferred from this subprogram to the Science Appropriation.

Participants include: ANL, LBNL, LLNL, ORNL, PNNL, SNL, numerous companies and universities.

FY 2003: Conclude all residual efforts on aluminum, steel, and metal-matrix composites.

Metals: Continue research on titanium, creep resistant magnesium for structural applications, and joining dissimilar metals.

Composites: Focal Project 3 efforts will continue at FY 2002 levels, including those on molding and advanced joining. A final cost, weight, and performance analysis of the hybrid BIW will be completed. Post-down-select carbon fiber precursor projects will also continue.

Other: Continue the carbon fiber recovery and recycling efforts. Begin some new projects in the areas of plastics and recycling, identified in the FY 2002 planning with the APC and the VRP.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Participants include: ANL, LBNL, LLNL, ORNL, PNNL, SNL, numerous companies and universities (FreedomCAR $9,600,000).

FY 2004: An overall shift of emphasis, begun in FY 2003, toward manufacturing issues needed to achieve the cost neutrality of the 2011 goal, will continue.

Metals: Work to verify achievability of the FY 2004 goal of 40 percent vehicle weight reduction at cost neutrality via aluminum or advanced high strength steels will begin winding down in early- to mid- FY 2005. The initial, concept-feasibility phases of work on magnesium, capable of meeting the 2011 goal of 60 percent weight reduction in the body and chassis at cost neutrality, will also begin winding down in early FY 2005. Initial, concept-feasibility work on balance-of-vehicle structural materials, namely, titanium, glass and metal-matrix composites, will continue. Emphasis will shift toward the needs of fuel cell vehicles.

Composites: The initial, concept-feasibility phases of work on carbon-fiber-reinforced polymer-matrix composites (CFRPMC), capable of meeting the 2011 goal of 60 percent weight reduction in the body and chassis at cost neutrality, will begin winding down. Low cost carbon fiber will be produced through inexpensive precursors and efficient processing. As with metals, additional emphasis will be placed on composite applications for fuel cell vehicles.

Advanced Materials and Processes: Recycling and real-time, on-line nondestructive evaluation (NDE) will expand. Installation and checkout of initial recycling and NDE systems will be completed. Efforts to improve processes and costs for carbon fiber, glass, metal-matrix composites, and crash-worthiness prediction would be continued. Novel technologies developed for recycling and treating carbon fiber will help to reduce component cost. Innovative processing technology for advanced high strength steel, titanium, and magnesium will continue focused on hydrogen and fuel cell vehicles.

Participants include: ANL, LBNL, LLNL, ORNL, PNNL, SNL, numerous companies and universities (FreedomCAR $17,840,000).

P	**Heavy Vehicle High Strength Weight Reduction Materials . . . . . .**	**9,574**	**8,950**	**8,950**

FY 2002: Continued competitively selected multi-year cost-shared R&D on cost-effective materials improvement, substitution in lightweight truck systems, increased reliability and durability of components, and lower life cycle costs. Performed assessment of 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 (500-750 psi) storage vessel, initiated planning for an engine/gas storage system demonstration to evaluate system characteristics and performance. Achieved a ratio of at least 180 volume. Prepared samples of the carbon storage material for detailed characterization/analysis to study alternatives for optimizing storage capacity. Began study of applicability to other energetic gases, hydrogen in particular. Continued industry cost-shared projects designed to achieve a 30-40 percent reduction in the weight of an SUV frame, while cost-effectively satisfying all component performance requirements. Assessed manufacturability, durability, life-cycle costs, corrosion and crash worthiness; compared to current frame technology. Continued development of advanced processing technologies for materials applications in heavy vehicles. Initiated construction of full size prototype stainless steel bus frame with bus manufacturer to validate 50 percent reduction in weight based on modeling efforts. Evaluated manufacturability, cost, and performance parameters. Issued competitive solicitation on cost-effective, high performance carbon composite heavy vehicle components. Announced awards and initiated projects. Integrated heavy vehicle brake material and brake system energy loss activities in conjunction with Vehicle Systems Optimization tasks. SBIR/STTR funding in the amount of $146,000 was transferred from this subprogram to the Science Appropriation.

Participants include: American Trucking Associations, PACCAR, Freightliner, ALCOA, Cummins, Caterpillar, Ford, DaimlerChrysler, Autokinetics, ANL, LANL, INEEL, PNNL, ORNL, Tennessee Tooling and Engineering, Delphi.

FY 2003: Continue cost-shared R&D on materials development with validation testing. Prepare a competitive solicitation for multi-year, cost-shared R&D in high performance, lightweighting materials for the overall truck system to increase reliability of components and reduce life-cycle costs. Implement, on a trial basis, the proposed generic approach to identify, qualify and utilize cost-effective material substitutions in heavy vehicle components and structures. Perform in-lab tests of a full scale engine/natural gas carbon based storage system to characterize and evaluate system parameters, characteristics and performance. Achieve at least 180 volumes of natural gas storage per unit volume at pressures between 500-700 psi and demonstrate in a prototype. Identify, through high resolution electron microscopy, relationships between the density of local storage sites and precursor processing parameters, to optimize the stored and retrievable volume of natural gas. Evaluate cost feasibility of applying this technology to the storage of other energetic gases, emphasizing hydrogen. Experimentally verify predictions. Laboratory test prototypic lightweight (30-40 percent weight reduction) SUV frames to determine compliance with industry performance requirements. Prepare for on-road vehicle tests and performance evaluations. Refine analyses of manufacturability, durability, life-cycle costs, corrosion, and crash-worthiness behavior of the innovative structures.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Characterize advanced processing technologies for heavy vehicle materials applications. Complete construction of full size prototype stainless steel bus frame of novel design, to verify calculated 50 percent weight reduction and predicted compliance with all industry required performance parameters. Validate manufacturability and projected cost reduction in excess of 12 percent. Test and characterize rods of composition-modified magnesium-rare earth alloys formed by the Equal Channel Angular Extrusion process. Establish increase in plastic elongation (expected to be greater than 300 percent). Fabricate industry-designed prototype component for heavy vehicle performance tests, which has a potential 25 percent reduction in weight over comparable aluminum components. Evaluate near-net-shape casting and forming of new, lower cost, titanium alloys for high performance parts. Based on positive results of feasibility studies, formulate R&D effort to utilize new, lower cost titanium alloys in high performance, light-weight forged, rolled or stamped heavy vehicle components. Road test thin-wall iron and steel castings with higher fatigue resistance for motor mount brackets. Establish feasibility of utilization of new technology to other structural components of heavy trucks.

Participants include: American Trucking Associations, PACCAR, Freightliner, ALCOA, Caterpillar, DaimlerChrysler, Delphi, Volvo Autokinetics, ANL, LANL, INEEL, PNNL, MIT, ORNL (21CT $8,950,000).

FY 2004: Activities in this area focus on achieving ultimately a weight reduction of heavy vehicles (HV) by up to 7,000 lbs. This would result in an ultimate increase in fleet energy efficiency of 8-10 percent. Award contracts based on responses to the competitive solicitation to develop and evaluate lightweighting materials in high performance applications for Heavy Vehicles. Conduct R&D in materials and materials processing enabling material substitutions for HV components to achieve partial vehicle lightweighting and increased component performance for higher system efficiency. Complete vehicle durability test of road-worthy lightweight SUV frames and evaluate feasibility of technology transfer to Class 3-6 heavy vehicles. Initiate R&D to develop cost-competitive processing technology enabling new materials introductions. Apply concepts developed for the manufacture of a 50 percent lighter, 40 percent cheaper stainless steel bus to trailers for long haul freight transport and railroad rolling stock. Evaluate the use of carbon fiber reinforced polymer matrix composites and novel design concepts to obtain further weight reductions. Continue efforts to develop cost-effective high performance carbon fiber composite components for HVs and reliable, durable, cost-effective joining methods. Expand development of cost-effective wrought magnesium materials with improved performance and formability for lightweighting HV components. Collaborate with the HV Propulsion Materials and Automotive Lightweight Materials programs in evaluating titanium alloys for lightweight, high performance HV components. Initiate R&D to overcome technical barriers to cost-efficient manufacturability of aluminum components. Validate improvements in brake materials with lab scale tests. Prepare for full scale tests on vehicle brake dynometer.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Participants include: American Trucking Associations, PACCAR, Freightliner, ALCOA, Delphi DaimlerChrysler, Autokinetics, Volvo, ANL, LANL, INEEL, PNNL, ORNL (21CT $8,950,000).

High Temperature Materials Laboratory	**5,502**	**4,000**	**4,000**

FY 2002: Maintained world class, state-of-the-art technical, scientific level diagnostic/characterization capabilities for advanced materials. Developed advanced analytical techniques. Supported the material characterization requirements of EERE. Determined, as needed, microstructural, compositional, crystallographic conditions of structural metals, alloys, ceramics, novel materials under development for truck applications both from within DOE, and from other stakeholders through HTML's user centers. Developed protocols for obtaining, preparing prototypic nanosize samples for atomic-level characterization and analysis using the Aberration Corrected Electron Microscope (ACEM). Prepared test articles to scope application of ACEM to key materials issuer. Characterized fine exhaust particles from both spark ignition and diesel engines. Maintained support of 16 scientific staff for the user programs and managed the sophisticated experimentation in support of transportation materials R&D.
SBIR/STTR funding in the amount of $98,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: Maintain world class, state-of-the-art characterization capabilities for advanced materials. Develop cutting-edge analytical techniques in support identifying innovative materials for use in surface transportation applications. Conduct projects involving microstructural, compositional, crystallographic conditions of metals, alloys, ceramics, and novel materials under development for vehicle applications, generated by both DOE and outside stakeholders, and which benefit from HTML's user centers. Support 12 scientific staff for the user programs and manage the sophisticated experimentation in support of transportation materials R&D.

FY 2004: Maintain world class, state-of-the-art characterization capabilities for advanced materials. Develop cutting-edge analytical techniques in support of identifying innovative materials for use in surface transportation applications. Conduct projects involving microstructural, compositional, crystallographic conditions of metals, alloys, ceramics, and novel materials under development for vehicle applications, generated by both DOE and outside stakeholders, and which benefit from HTML's user centers. Demonstrate sub-angstrom level imaging and chemical analysis capability of ACEM. Utilize this capability to determine catalyst poisoning mechanism(s). Support 12 scientific staff for the user programs and manage the sophisticated experimentation in support of transportation materials R&D.

Total, Materials Technology	**39,158**	**29,400**	**39,640**

Explanation of Funding Changes

		FY 2004 vs. FY 2003 ($000)
Materials Technology R&D		
P	In propulsion materials technology, increase emphasis on thermal management materials and materials for fuel cell vehicles	+2,000
P	In lightweight materials technology, increase emphasis on recycling, non-destructive evaluating and crash worthiness prediction. Expand efforts to develop advanced high strength metals and processing technology for fuel cell and hydrogen vehicles. Enhance the competitiveness of carbon fiber by making it more recyclable	+8,240
Total Funding Change, Materials Technology R&D		+10,240

Fuels Technology Subprogram

Mission Supporting Goals and Measures

The Fuels Technology subprogram supports R&D that will provide vehicle users with fuel options that are cost competitive, achieve high fuel economy, and deliver low emissions. The subprogram consists of two activities: Advanced Petroleum Based Fuels (APBF) and Non-Petroleum Fuels and Lubricants (NPBFL).

The APBF activity develops petroleum-based fuels and lubricants that may allow high efficiency diesel engines for light duty vehicle applications to achieve low emissions with minimal efficiency penalties while employing advanced aftertreatment technologies. This effort employs the expertise and shared funding of the government, energy companies, and emission control and engine manufacturers. The goal is to identify fuel properties that can enable the engines to operated in the highest efficiency mode while meeting the emissions standards. Advanced Petroleum Based Fuels for heavy-duty vehicle applications is terminated because it is largely within the capabilities of industry, which must meet future EPA emissions standards.

The NPBFL activity aims to determine an appropriate specification for a fuel which can be made from domestic sources, including renewable (biomass) and non-petroleum fossil-based feedstocks (coal and natural gas).

Funding Schedule

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Fuels Technology					
Advanced Petroleum Based Fuels	11,326	13,324	4,000	-9,324	-70.0%
Non-Petroleum Based Fuels and Lubricants	10,535	2,300	2,800	+500	+21.7%
Environmental Impacts	2,789	2,375	0	-2,375	-100.0%
Total, Fuels Technology	24,650	17,999	6,800	-11,199	-62.2%

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Fuels Technologies					
Albuquerque Operations Office					
Albuquerque Operations Office	994	0	0	0	NA
Los Alamos National Laboratory	250	0	0	0	NA
National Renewable Energy Laboratory	11,760	9,314	3,100	-6,214	-66.7%
Sandia National Laboratories	736	560	0	-560	-100.0%
Total, Albuquerque Operations Office	13,740	9,874	3,100	-6,774	-68.6%
Chicago Operations Office					
Argonne National Laboratory	460	450	300	-150	-33.3%
Brookhaven National Laboratory	2,490	1,700	0	-1,700	-100.0%
Chicago Operations Office	2,500	1,600	0	-1,600	-100.0%
Total, Chicago Operations Office	5,450	3,750	300	-3,450	-92.0%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	650	100	0	-100	-100.0%
Total, Idaho Operations Office	650	100	0	-100	-100.0%
National Energy Technology Laboratory	190	300	0	-300	-100.0%
Oakland Operations Office					
Lawrence Livermore National Laboratory	850	350	0	-350	-100.0%
Total, Oakland Operations Office	850	350	0	-350	-100.0%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Oak Ridge Operations Office					
Oak Ridge National Laboratory	3,481	3,350	3,050	-300	-9.0%
Office of Scientific and Technical Information	0	50	50	0	0.0%
Oak Ridge Operations Office	249	0	0	0	0.0%
Total, Oak Ridge Operations Office	3,730	3,400	3,100	-300	-8.8%
Washington Headquarters	40	225	300	+75	+33.3%
Total, Fuels Technology	24,650	17,999	6,800	-11,199	-62.2%

Site Description

Albuquerque Operations Office

Provide support to the solicitation, award, and administration of contracts supporting the Environmental Impacts project.

Los Alamos National Laboratory

Conducted fuels related research for fuel processors.

National Renewable Energy Laboratory

Develop component models of engine/aftertreatment systems to allow for quick and inexpensive evaluations of proposed combinations of fuel/engine/emissions control combinations. Lead an effort to identify the effects of sulfur levels of diesel fuels on near term emissions control devises. Lead an effort to determine the lube oil effects on exhaust aftertreatment devices. Conduct tests of bio-based diesel fuel blending agents to determine their ability to act as reductants in the exhaust stream of diesel engines.

Sandia National Laboratories

Study the in-cylinder combustion processes of fuel born oxygen in diesel fuels using laser induced incandescence observations

Argonne National Laboratory

Conducts technology analysis (energy, environmental, and economic) as well as vehicle system and subsystem modeling.

Brookhaven National Laboratory

Developing a real time particle sensor that will enable the determination of particle size distribution in exhaust streams. Responsible for the monitoring of the collection and analysis of exhaust gas particulate matter from various engines operating in the DOE engine development programs. Technical monitoring of subcontract on conformable storage tank technologies for CNG vehicles.

Chicago Operations Office

Provide procurement support on the grant to West Virginia University.

Idaho National Engineering and Environmental Laboratory

Complete the development of a small scale liquified natural gas fueling facility.

National Energy Technology Laboratory

Lead an effort to develop a mechanism to remove sulfur from diesel fuel on board the vehicle and effectively reduce sulfur levels from 15 ppm to essentially zero.

Lawrence Livermore National Laboratory

Chemical kinetic modeling of in-cylinder combustion process of advanced HCCI engine technology as it applies to natural gas engines.

Oak Ridge National Laboratory

Evaluate the toxicity of unregulated emissions that are present in the exhaust streams of engines operating on advanced fuels. Lead an effort to evaluate the fuel effects on selective catalytic reduction systems on diesel engines. Evaluate the critical fuel properties that effect near term emissions control devices for diesel engines. Determine the effects and the mechanism of lube oil suspended phosphorous on the poisoning of exhaust catalysts in diesel engines. Evaluate the benefits of the use of e-diesel fuels in combination with high exhaust gas re-circulation rates in diesel engines.

Office of Scientific and Technical Information

Assisted in conducting industry/Government workshops in support of Multi-Year Program Planning efforts.

Oak Ridge Operations Office

Provide procurement support for the award and administration of the cooperative agreement with the Gas Research Institute.

Washington Headquarters

Assisted in the contract awards and administration of general support service contracts.

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Advanced Petroleum Based Fuels	**11,326**	**13,324**	**4,000**
P **Automobile/Light Truck and Heavy Truck . .**	**11,326**	**13,324**	**4,000**

FY 2002: Continued testing of advanced petroleum based fuels and blending additives. Evaluated new fuel formulations in the context of a complete engine emission control and fuel system which is optimized for emissions and fuel economy. Evaluated new fuels and blend options for safety during refueling and on-board storage. Conducted combustion modeling and environmental assessment efforts focused on oxygenated diesel fuel. Conducted single cylinder combustion studies of oxygenates. Developed sulfur trap to remove sulfur from fuel on-board vehicle. Continued national laboratory activities to determine fuel impurity (e.g., sulfur) effects on fuel cell system durability. Conducted limited testing and development of lube oils for use in diesel engines that operate on advanced petroleum based fuels and do not pose any deleterious emissions effects. SBIR/STTR funding in the amount of $106,000 was transferred from this subprogram to the Science Appropriation.

Participants include: NREL, ORNL, ANL, Southwest Research Institute.

FY 2003: Investigate combustion of reformulated diesel fuels, to optimize the particulate matter emissions reduction benefit of the fuel. Continue to evaluate the performance, emissions, and durability effects of advanced petroleum based fuels and additives on fuel system, power train, and emission control components. Complete initial durability testing of desulfurization and regeneration strategies for emission control devices which can achieve very low emissions levels and minimize fuel economy impacts. Characterize sulfur effects on emission control devices, and develop engine control strategies to reduce fuel economy impact associated with the regeneration of these devices for automotive, SUV and heavy duty application engines. Continue development and utilization of models to identify the optimum concentration and type of blending component for diesel fuel, consistent with minimizing emissions. Evaluate the impacts of lubricants on the long-term durability and conversion efficiency of advanced emission control devices. Complete refueling and on-board storage safety assessment of new fuels and blend options.

Participants include: NREL, ORNL, SNL, ANL, LLNL, LANL, Southwest Research Institute, FEV (FreedomCAR $5,100,000; 21CT $8,224,000).

(dollars in thousands)

FY 2002	FY 2003	FY 2004

FY 2004: Terminate all activities associated with advanced petroleum based fuels for heavy duty vehicle applications because it is largely within the capabilities of industry participation. Complete evaluation of near-term NOx adsorber aftertreatment systems of light duty platforms to determine fuel effects on the durability of these systems. Evaluate the use of diesel fuel blending agents as a means of enhancing emission control device efficiency and regeneration capabilities. Perform full up testing of prototype inline fuel sulfur removal technology to determine its ability to remove sulfur from diesel fuel in the fuel line just upstream of the engine (FreedomCAR $4,000,000; 21CT $0).

	Non-Petroleum Based Fuels & Lubricants	**10,535**	**2,300**	**2,800**
P	**Alternative Fuels / Automobile / Light Truck**	**971**	**0**	**0**

FY 2002: In cooperation with the HFCIT Program, developed critical technologies such as hydride-based on-board storage and related refueling infrastructure technology areas, such as purification and compression. Demonstrated fuel cell vehicle performance when fueled with gaseous hydrogen, including road testing and refueling. Analyzed and tested, in conjunction with fuel cell vehicle industry programs, vehicle performance measurements and resolve barriers for alternative fuels, including hydrogen and methanol. SBIR/STTR funding in the amount of $19,000 was transferred from this subprogram to the Science Appropriation.

Participants include: States, fuel providers, auto manufacturers, NREL, ANL, California Fuel Cell Partnership members.

FY 2003: No activities.

FY 2004: No activities.

P	**Medium Trucks . . . . . .**	**3,903**	**1,000**	**800**

FY 2002: Initiated activities to explore the use of alternative fuels other than natural gas in medium trucks. Completed design/market study for conformable CNG fuel storage tanks for class 3-6 trucks. Initiated 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.

(dollars in thousands)

FY 2002	FY 2003	FY 2004

Participants included: NREL, ORNL, BNL, ANL, West Virginia University.

FY 2003: Select one engine for completion, from among current natural gas engine projects, which has the greatest potential to meet 2004 emissions standards while improving efficiency by 15 percent.

Participants include: NREL, TBD (21CT $1,000,000).

FY 2004: Partner with industry to design/engineer at least two additional medium-duty vehicle platforms with fully integrated NG engine and fuel systems to serve critical niche market applications. Improve understanding and acceptance of NGV technologies among fire, safety, and code officials. Organize and facilitate NG vehicle infrastructure user groups to address safety and technology issues for specialized niche market applications (e.g., transit buses, refuse haulers, school buses).

Participants include: NREL,West Virginia University, TBD (21CT $800,000).

P Heavy Trucks 3,695 1,000 800

FY 2002: Completed full-scale laboratory testing of advanced liquified natural gas storage and fuel delivery systems. Initiated 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. Initiated a competitive request for proposals to develop a next generation heavy duty natural gas engine. SBIR/STTR funding in the amount of $208,000 was transferred from this subprogram to the Science Appropriation.

Participants include: NREL, ORNL, BNL, ANL.

FY 2003: Select one engine for completion from among current natural gas engine projects which has the greatest potential to meet 2004 emissions standards while improving efficiency by 15 percent.

Participants include: NREL, TBD (21CT $1,000,000).

FY 2004: Develop heavy duty engines to operate on natural gas feedstocks fuels utilized either as neat fuels or blendstocks with conventional diesel fuels.

Participants include: NREL, ORNL (21CT $800,000).

(dollars in thousands)

FY 2002	FY 2003	FY 2004

P **Fueling Infrastructure 1,966 300 400**

FY 2002: Completed field installation and began field testing of small scale natural gas liquefier and gas clean up technologies. In coordination with the Infrastructure Working Group, supported activities, through a competitive solicitation, that were focused on reducing the cost and improving the use of natural gas fueling stations.

Participants include: INEEL, SNL, BNL.

FY 2003: Conduct total fuel cycle analysis for Non-Petroleum Based Fuels and Lubricants, considering terms of economic, energy, and environmental factors in order to determine the feasibility of introducing a blending strategy for the introduction of non-petroleum based fuels.

Participants include: AD Little, and ANL (FreedomCAR $300,000; 21CT $0).

FY 2004: Conduct a study to determine the feasibility of introducing fuel cell fuels through the existing fueling infrastructure utilizing the concept of one fuel dispenser for internal combustion and fuel cell powered vehicles that could accommodate either on-board or off-board reforming.

Participants include: NREL, ORNL (FreedomCAR $300,000; 21CT $100).

P **Renewable and Synthetic Fuels Utilization . . 0 0 800**

FY 2002: No activities.

FY 2003: No activities.

FY 2004: Develop a Multi-Year Program Plan (MYPP) for Non-Petroleum Based Fuels & Lubricants incorporating input of stakeholders. Hold MYPP development workshop(s) to solicit input from stakeholders and identify independent reviewers of draft Plan. Write draft of Plan and circulate it for comment among stakeholders/reviewers. Develop baseline data on the relationships between molecular structure and bulk fuel properties for diesel fuels. Begin testing of high hydrogen to carbon ratio diesel fuel blending agent that is made from non-petroleum based feedstocks, which include biomass, natural gas and coal (21CT $800,000).

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Environmental Impacts	**2,789**	**2,375**	**0**

FY 2002: Assessed field studies of on-road contribution of mobile sources to emissions inventories and contribution of heavy vehicle emissions. Continued collection of on-road vehicle exhaust from new technology vehicles for health effect studies. SBIR/STTR funding in the amount of $183,000 was transferred from this subprogram to the Science Appropriation.

Participants include: NREL, CRC, other industry groups.

FY 2003: Evaluate contribution of emissions from new technology heavy-duty vehicles to ambient air quality. Evaluate the results from field studies to quantify the regulated emissions contributions from existing heavy vehicles. Continue characterization of natural gas emissions using various aftertreatment devices, and ascertain toxicity of resulting emissions. Evaluate toxicity of cold start gasoline emissions. Continue real-world studies to assess the relative importance of mobile source air toxic emissions from light-duty and heavy-duty new and in-use vehicles.

Participants include: NREL, BNL, CRC, other industry groups (21CT $2,375,000).

FY 2004: The Environmental Impacts activity is terminated because the work is aligned with the mission of other agencies.

Total, Fuels Technology	**24,650**	**17,999**	**6,800**

Explanation of Funding Changes

		FY 2004 vs. FY 2003 ($000)
Fuels Technology		
P	In Medium Trucks shift emphasis from natural gas engine R&D to vehicle platform design.	-200
P	In Heavy Trucks shift emphasis to focus on engine R&D to utilize natural gas feedstock fuels and blending agents.	-200
P	Terminate activities in Advanced Petroleum Based Fuels for heavy duty truck applications because it is largely within the capabilities of industry. Reduce sulfur testing of near-term aftertreatment technologies on light-duty systems to one platform.	-9,324
P	In fueling infrastructure study the feasibility of introducing fuel cell fuels through the existing petroleum fuel infrastructure.	+100
P	Develop Multi-Year Program Plan for non-petroleum based fuels and lubricants. Begin testing of high hydrogen to carbon ratio diesel fuel blending agents.	+800
P	Terminate activities that study the effects of regulated and unregulated emissions because the work is aligned with the mission of other agencies.	-2,375
Total Funding Change, Fuels Technology		-11,199

Technology Introduction Subprogram

Mission Supporting Goals and Measures

The Technology Introduction subprogram accelerates the adoption and use of alternative fuel and advanced technology vehicles to help meet national energy and environmental goals. This subprogram's efforts logically follow and complement successful technology development by industry and government. As identified in the National Energy Policy, consumer education and demonstration activities are critical to accelerating the use of energy technologies.

Legislative and Rulemaking consists of the State and Alternative Fuel Provider Regulatory Program, Fuel Petitions, Private and Local Government Fleet Regulatory Program, the normal implementation of other EPACT requirements including reports and rulemaking, the analysis of the impact of other regulatory and pending legislative activities, and the implementation of legislative changes to EPACT as they occur. The fleet programs require selected covered fleets to procure light-duty alternative fuel vehicles annually. The Department also reviews and processes petitions to designate new alternative fuels under EPACT.

Testing and Evaluation in partnership with industry, performance and emissions of near market-ready advance technology vehicles are validated and made available to engineers, government agencies, manufacturers, fleets, and consumers. The Department's testing program is recognized nationally and internationally for its objective testing and evaluation programs for alternative fuel vehicles, including electric vehicles. This activity also includes the Department's compliance with the Federal Fleet requirements of EPACT as well as providing support and guidance to other Federal agencies.

Advanced Vehicle Competitions provide educational opportunities for university students, while demonstrating the performance of critical vehicle technologies identified by the Department of Energy and its partners. Students who graduate from these vehicle competitions go on to take jobs in the auto industry, where they bring with them an unprecedented appreciation and understanding of advanced automotive technologies.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Technology Introduction					
Legislative and Rulemaking	900	1,900	1,900	0	0.0%
Testing and Evaluation	1,750	3,000	3,000	0	0.0%
Advanced Vehicle Competitions	800	1,000	1,000	0	0.0%
Total, Technology Introduction	3,450	5,900	5,900	0	0.0%

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Technology Introduction					
Albuquerque Operations Office					
National Renewable Energy Laboratory	1,350	2,800	2,800	0	0.0%
Total, Albuquerque Operations Office	1,350	2,800	2,800	0	0.0%
Chicago Operations Office					
Argonne National Laboratory	900	1,050	1,050	0	0.0%
Total, Chicago Operations Office	900	1,050	1,050	0	0.0%
Idaho Operations Office					
Idaho National Engineering and Environmental Laboratory	450	500	500	0	0.0%
Idaho Operations Office	750	1,400	1,400	0	0.0%
Total, Idaho Operations Office	1,200	1,900	1,900	0	0.0%
Oak Ridge Operations Office					
Oak Ridge National Laboratory	0	50	50	0	0.0%
Total, Oak Ridge Operations Office	0	50	50	0	0.0%
Washington Headquarters	0	100	100	0	0.0%
Total, Technology Introduction	3,450	5,900	5,900	0	0.0%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

Site Description

National Renewable Energy Laboratory

Support of EPACT regulatory programs including Federal Fleet, State and Fuel Provider, Private and Local, and Fuel petitions. Testing and evaluation of heavy-duty, medium duty and transit alternative and advanced technology vehicles.

Argonne National Laboratory

Alternative-fueled vehicle research, including emissions testing and evaluation of the largest fleet in the DOE system. Transportation technology evaluation capabilities (energy, environmental, and economic analysis) as well as vehicle system and subsystem modeling.

Idaho National Engineering and Environmental Laboratory

Field testing and evaluation of electric, hybrid and hydrogen light duty vehicles and infrastructure. Supports Federal Fleet acquisition reporting as required.

Idaho Operations Office

Manage, collect data, and report on field activities of the DOE sponsored fleet testing of electric and hybrid vehicles.

Oak Ridge National Laboratory

Conducts analysis, technical support, testing and research on power electronic devices and electric machines.

Washington Headquarters

Assist in the award and contract administration of general support services contracts.

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Legislative and Rulemaking (formerly Energy Policy Act Replacement Fuels)	**900**	**1,900**	**1,900**
P **State & Fuel Provider Fleet . . . . . .**	**650**	**1,000**	**1,000**

FY 2002: In support of EPACT Sections 501, 502, 504, 506, 507 and 508 continued EPACT compliance efforts for State and fuel provider fleet programs. (NREL)

FY 2003: In support of EPACT Sections 501, 502, 504, 506, 507 and 508, continue EPACT compliance efforts for State and fuel provider fleet programs. Promote alternative fuel use in State fleets, increase compliance activities including increased fleet monitoring. Reduce exemption request turnaround time. (NREL)

FY 2004: In support of EPACT Sections 501, 502, 506, 507 and 508, continue EPACT compliance efforts for State and fuel provider fleet programs. Continue to promote alternative fuel use in State fleets and begin fleet field monitoring activities. Reduce exemption turnaround time and seek out fleets that have never reported to DOE. (NREL)

P **Private & Local Fleet . . . . . .**	**150**	**500**	**500**

FY 2002: Transfer from Transportation Technologies Regulatory Support Activity. In support of EPACT Sections 501, 502, 504, 507, and 509, continued EPACT compliance efforts for private and local government rulemaking. Initiated a preliminary determination on whether or not to proceed with a private and local government fleet mandate that would require these fleets to purchase light-duty alternative fuel vehicles. (NREL)

FY 2003: Transfer from Transportation Technologies Regulatory Support Activity. In support of EPACT Sections 501, 502, 504, 507, and 509, continue EPACT compliance efforts for private and local government rulemaking. Develop and issue a notice of proposed rule on the private and local government fleet mandate determination. (NREL)

FY 2004: In support of EPACT Sections 502, 504, 507, and 509 issue a final rule on the private and local government fleet mandate determination. (NREL)

P	**Fuel Petitions . . . . . .**	**50**	**300**	**300**

FY 2002: In support of EPACT Section 301 continued efforts to review and process petitions to designate new alternative fuels under EPACT. (NREL, ANL, ORNL)

FY 2003: In support of EPACT Section 301, continued efforts to review and process petitions to designate new alternative fuels under EPACT. Enhance website and documents to create better guidance for petitioners to make for more efficient processing. (NREL, ANL, ORNL)

FY 2004: In support of EPACT Section 301 continued efforts to review and process petitions to designate new alternative fuels under EPACT. Continue process efficiency enhancement to web site and issue new guidance. (NREL, ANL, ORNL)

P	**Regulatory Support . . . . . .**	**50**	**100**	**100**

FY 2002: In support of EPAct Sections 502, 504, 506, 507 and 509, evaluated replacement fuel goals to determine if the goals are practical and achievable. (NREL, ANL, ORNL)

FY 2003: In support of EPACT Sections 502, 504, 506, 507 and 509, complete the evaluation of the replacement fuel goals and submit for stakeholder and congressional review. Issue Federal Register notice of the proposed revised replacement fuel goals. Analysis and review of proposed new energy legislation. (NREL, ANL, ORNL)

FY 2004: In support of EPACT Sections 502, 504, 506, 507 and 509, develop report to the Congress on recommendations for achieving the revised replacement fuel goals. (NREL, ANL, ORNL)

Testing and Evaluation	**1,750**	**3,000**	**3,000**

In FY 2002, SBIR/STTR funding in the amount of $50,000 was transferred from this subprogram to the Science Appropriation.

P	**Federal Fleets . . . . . .**	**250**	**513**	**513**

FY 2002: In support of EPACT Sections 303 and 502, assisted Federal agencies in acquiring 12,000 AFVs and increased the amount of alternative fuel consumed by Federal alternative fuel vehicles. (INEEL, NREL, GSA)

FY 2003: In support of EPACT Sections 303 and 502, assist Federal agencies in acquiring 12,000 AFVs and increase the amount of alternative fuel consumed by Federal alternative fuel vehicles. (INEEL, NREL, GSA)

FY 2004: In support of EPACT Sections 303 and 502, assist Federal agencies in acquiring 12,000 AFVs and increase the amount of alternative fuel consumed by Federal alternative fuel vehicles. Provide assistance in helping other agencies comply with E.O. 13149. (INEEL, NREL, GSA)

P	**Vehicle Evaluation . . . . . .**	**1,450**	**2,387**	**2,387**

FY 2002: In support of EPACT sections 502, and 601, conducted baseline performance testing and accelerated reliability testing of selected light-duty hybrid-electric vehicle models. Conducted baseline performance testing of one additional urban electric vehicle. Completed baseline performance testing of ten neighborhood electric vehicles. Discontinued development of hybrid-electric medium and heavy-duty vehicle testing procedures. Completed collecting data from advanced technology transit bus demonstration project. (INEEL, NREL, ANL, FTA, APTA)

FY 2003: In support of EPACT sections 502, and 601, continue baseline performance and reliability testing of selected light-duty hybrid-electric vehicle models. Continue fleet demonstration/reliability testing of new model urban and neighborhood electric vehicles. Complete evaluation of data from advanced technology transit bus demonstration projects and issue final report. Initiate procedure development for testing medium duty hybrid electric delivery truck and light-duty fuel cell vehicles. Conduct testing and evaluation of idling reduction technologies to support public information activities. (INEEL, NREL, ANL, ORNL, FTA, APTA, DOT, EPA)

FY 2004: In support of EPACT sections 502, and 601, conduct baseline performance and accelerated reliability testing of selected hybrid-electric light-duty vehicle models. Complete testing of urban electric vehicles and neighborhood electric vehicles. Complete initial data collection on one fuel cell transit bus and issue preliminary report. Initiate testing of a hybrid electric medium delivery truck. Initiate baseline performance testing of advanced technology, including fuel cell light-duty vehicles. Continue limited testing and evaluation of one idling reduction technology to support public information activities. (INEEL, NREL, ANL, FTA, APTA, DOT ORNL, EPA)

P	**Infrastructure Testing . . . . . .**	**50**	**100**	**100**

FY 2002: In support of EPACT Sections 303 and 502, continued leading interagency effort to assist industry in developing procedures for accurately tracking sales of alternative fuels. (INEEL, other Federal Agencies)

FY 2003: In support of EPACT Sections 303 and 502, continue efforts to assist industry in developing procedures for accurately tracking sales of alternative fuels.

FY 2004: In support of EPACT Sections 303 and 502, provide limited assistance to industry in developing procedures for accurately tracking sales of alternative fuels. Continue data collection and dissemination on hydrogen/hythane refueling procedures. (INEEL, Other Federal Agencies)

Advanced Vehicle Competitions	**800**	**1,000**	**1,000**

FY 2002: Conducted third year of Future Truck Challenge with a new automotive partner. (ASEE, ANL, Ford, California Polytechnic State University San Luis Obispo, Cornell University, Georgia Institute of Technology, Michigan Technological University, Ohio State University, Pennsylvania State University, Texas Tech University, University of Alberta, University of California-Davis, University of Idaho, University of Maryland, University of Tennessee, Knoxville, University of Wisconsin, Madison, Virginia Tech, West Virginia University).

FY 2003: Conduct fourth year of Future Truck Challenge, which is aimed at improving the fuel economy of light-duty vehicles (cars and light trucks), and increasing use of fuel cell propulsion systems in student designed vehicles. Initiate planning for new vehicle competition. (ASEE, ANL, Ford, California Polytechnic State University San Luis Obispo, Cornell University, Georgia Institute of Technology, Michigan Technological University, Ohio State University, Pennsylvania State University, Texas Tech University, University of Alberta, University of California-Davis, University of Idaho, University of Maryland, University of Tennessee, Knoxville, University of Wisconsin, Madison, Virginia Tech, West Virginia University). (FreedomCAR, $1,000,000; 21CT $0)

FY 2004: Conduct fifth year of Future Truck Challenge which is aimed at improving the fuel economy of light-duty vehicles (cars and light trucks). Initiate planning for new hydrogen-based vehicle competition in FY 2004. Finalize sponsorship and initiate competitive selection of participating colleges and universities (California Polytechnic State University San Luis Obispo, Cornell University, Georgia Institute of Technology, Michigan Technological University, Ohio State University, Pennsylvania State University, Texas Tech University, University of Alberta, University of California-Davis, University of Idaho, University of Maryland, University of Tennessee, Knoxville, University of Wisconsin, Madison, Virginia Tech, West Virginia University). (FreedomCAR, $1,000,000; 21CT $0)

Total, Technology Introduction	**3,450**	**5,900**	**5,900**

Explanation of Funding Changes

		FY 2004 vs. FY 2003 ($000)
Technology Introduction		
P	No changes.	0
Total Funding Change, Technology Introduction		0

Technical/Program Management Support Subprogram

Mission Supporting Goals and Measures

Consistent with other DOE programs under the jurisdiction of the Interior and Related Agencies Appropriations Committees, the Energy Conservation programs provide funding for Technical/Program Management Support. This includes activities such as research and development (R&D) feasibility studies; R&D option development and trade-off analyses; and technical, economic, market evaluations of research. These activities provide important benefits directly to the FreedomCAR and Vehicle Technologies Program described above and are therefore an integral part of the R&D program.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Technical/Program Management Support					
Total, Technical/Program Management Support	2,385	2,121	2,121	0	0.0%

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Technical/Program Management Support					
Chicago Operations Office					
Chicago Operations Office	1,027	809	0	-809	-100.0%
Total, Chicago Operations Office	1,027	809	0	-809	-100.0%
Washington Headquarters	1,358	1,312	2,121	+809	+61.7%

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

Total, Technical/Program Management Support . . .	2,385	2,121	2,121	0	0.0%

Site Description

Chicago Operations Office

Assisted in the contract awards and administration of general support service contracts.

Washington Headquarters

Assisted in the contract awards and administration of general support service contracts.

Detailed Program Justification

	(dollars in thousands)		
	FY 2002	FY 2003	FY 2004
Technical/Program Management Support	**2,385**	**2,121**	**2,121**

FY 2002: Provided technical and program management support services.

Participants: Sentech, Antares, QSS.

FY 2003: Provide technical and program management support services.

Participants: Sentech, Antares, QSS. (FreedomCAR $865,000; 21CT $1,156,000)

FY 2004: Representative activities will include preparation of program strategic plan, and operating plans; R&D feasibility studies and trade-off analysis; evaluation of the impact of new legislation on R&D programs; analysis of energy issues pertinent to the R&D program; identification of performance methodologies (including GPRA); data collection to assess program and project performance, efficiency and impacts; and development of performance agreements with management.

Participants: Sentech, Antares, QSS. (FreedomCAR $865,000; 21CT $1,156,000)

Total, Technical/Program Management Support . . .	**2,385**	**2,121**	**2,121**

Explanation of Funding Changes

	FY 2004 vs. FY 2003 ($000)
Technology Program/Management Support	
P No changes.	0
Total Funding Change, Technology Program/Management Support	0

Biennial FreedomCAR Peer Review Subprogram

Mission Supporting Goals and Measures

A biennial review of the FreedomCAR Partnership will be conducted by an independent party such as the National Academy of Sciences/National Academy of Engineering, to evaluate progress and program direction. The review will include evaluation of progress toward achieving the Partnership's 2010 technical goals and program direction. Based on these evaluations, resource availability, and other factors, the FreedomCAR partners will consider new opportunities, make adjustments to program targets, and set goals as appropriate.

Funding Schedule

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Biennial Peer Review of FreedomCAR					
Total, Biennial Peer Review of FreedomCAR	-	-	1,500	+1,500	NA

Funding by Site[a]

(dollars in thousands)

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Biennial Peer Review of FreedomCAR					
Washington Headquarters	-	-	1,500	+1,500	NA
Total, Biennial Peer Review of FreedomCAR	-	-	1,500	+1,500	NA

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

Site Description

Washington Headquarters

Assisted in the contract awards and administration of general support service contracts.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Biennial Peer Review of FreedomCAR	**-**	**-**	**1,500**

FY 2002: No activities.

FY 2003: No activities

FY 2004: Issue RFP for the first biennial peer review of the FreedomCAR Partnership. Initiate a peer review of the FreedomCAR Partnership.

Total, Biennial Peer Review of FreedomCAR	**-**	**-**	**1,500**

Explanation of Funding Changes

		FY 2004 vs. FY 2003 ($000)
Biennial Peer Review of FreedomCAR		
P	Issue RFP for the first biennial peer review of the FreedomCAR Partnership. Initiate a peer review of the FreedomCAR Partnership.	+1,500
Total Funding Change, Biennial Peer Review of FreedomCAR		+1,500

Energy Efficiency Science Initiative (EESI) Subprogram

Mission Supporting Goals and Measures

The Energy Efficiency Science Initiative (EESI) 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 and the Office of Science. The awards are generally small, and universities, small businesses, national labs (not as the lead), and industry (as appropriate) are all eligible to participate in this initiative.

Projects funded to date have been performed in collaboration with academia in partnership with the National Laboratories, as well as with the Office of Fossil Energy through the National Energy Technology Laboratory (NETL). Due to the need to accommodate higher priority activities, no additional funds will be requested in FY 2004.

Funding Schedule

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Energy Efficiency Science Initiative	1,959	0	0	0	NA
Total, Energy Efficiency Science Initiative	1,959	0	0	0	NA

Funding By Site[a]

	FY 2002	FY 2003	FY 2004	$ Change	% Change
Washington Headquarters	1,959	0	0	0	NA
Total, Energy Efficiency Science Initiative	1,959	0	0	0	NA

Site Description

Washington Headquarters

Assisted in the contract awards and administration of broad-based energy efficiency contracts.

Detailed Program Justification

(dollars in thousands)

	FY 2002	FY 2003	FY 2004
Energy Efficiency Science Initiative	**1,959**	**0**	**0**

FY 2002: In collaboration with the DOE Office of Fossil Energy, a single award solicitation was issued to address technology gaps between exploratory science and pre-commercial applied R&D. SBIR/STTR funding in the amount of $41,000 was transferred from this subprogram to the Science Appropriation.

FY 2003: No Activities.

FY 2004: No Activities.

Total, Energy Efficiency Science Initiative	**1,959**	**0**	**0**

[a] "On December 20, 2002, the National Nuclear Security Administration (NNSA) disestablished the Albuquerque, Oakland, and Nevada Operations Offices, renamed existing area offices as site offices, established a new Nevada Site Office, and established a single NNSA Service Center to be located in Albuquerque. Other aspects of the NNSA organizational changes will be phased in and consolidation of the Service Center in Albuquerque will be completed by September 30, 2004. For budget display purposes, DOE is displaying non-NNSA budgets by site in the traditional pre-NNSA organizational format."

Explanation of Funding Changes

		FY 2004 vs. FY 2003 ($000)
Energy Efficiency Science Initiative		
P	No changes	0
Total Funding Change, Energy Efficiency Science Initiative		0