Vehicle Technologies

Funding Profile by Subprogram[a]

	FY 2003 Comparable Appropriation	FY 2004 Comparable Appropriation[b]	FY 2005 Base	FY 2005 Request	FY 2005 Request vs Base	
					$ Change	% Change
Vehicle Technologies						
Vehicle Systems	13,485	14,335	14,335	13,883	-452	-3.2%
Innovative Concepts ..	1,590	494	494	500	+6	+1.2%
Hybrid and Electric Propulsion	41,996	45,002	45,002	51,821	+6,819	+15.2%
Advanced Combustion R&D	55,267	54,405	54,405	35,936	-18,469	-33.9%
Materials Technology	36,094	39,744	39,744	39,799	+55	+0.1%
Fuels Technology.....	19,164	16,494	16,494	6,800	-9,694	-58.8%
Technology Introduction	4,570	4,939	4,939	6,014	+1,075	+21.8%
Technical Program Mgmt Supt.....	2,005	2,095	2,095	1,903	-192	-9.2%
Biennial FreedomCAR Peer Review	0	494	494	0	-494	-100.0%
Total, Vehicle Technologies	174,171	178,002	178,002	156,656	-21,346	-12.0%

Public Law Authorizations:

P.L. 95-91, "U.S. Department of Energy Organization Act" (1977)
P.L. 102-486, “Energy Policy Act” (1992)

Mission

The mission of the Vehicle Technologies Program managed by the Office of FreedomCAR and Vehicle Technologies (FCVT) is to develop more energy efficient and environmentally friendly highway transportation technologies (for both cars and trucks) that will enable America to use significantly less petroleum. The long-term aim is to develop “leapfrog” technologies that through improvements in

[a] SBIR/STTR funding in the amount of $3,132,449 was transferred to the Science appropriation in FY 2003. Estimates for SBIR/STTR budgeted in FY 2004 and FY 2005 are $4,534,635 and $3,956,457 respectively.

[b] Programs in the Energy Conservation appropriation were reduced by .59 percent as required by the Omnibus Appropriation Bill.

vehicle energy efficiency will provide Americans with continuing freedom of mobility and greater energy security, at lower costs and with lower impacts on the environment than current high efficiency vehicles. The program focuses its research and development investments specifically on potential technology improvements that have uncertain or long-term outcomes, yet have significant public benefit. The high risks associated with these projects make it unlikely that they would be pursued by industry alone.

Benefits

The Vehicle Technologies Program mission and activities contribute directly to EERE's and DOE's mission of improving National Energy and Economic Security by addressing the President's National Energy Policy call 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 highway vehicles alone account for 54 percent of total U.S. oil use, more consumption than U.S. domestic production. Cost competitive and 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 make the Nation more secure and more prosperous while protecting the environment.

More detailed, integrated and comprehensive economic, energy and energy security benefits estimates are provided in the Expected Program Outcomes section at the end of the program level budget narrative.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Vehicle Technologies Program supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Vehicle Technologies Program has one program goal which contributes to General Goal 4 in the "goal cascade". This goal is:

Program Goal 04.02.00.00: Vehicle Technologies. The Vehicle Technologies Program goal is to develop technologies that enable cars and trucks to become highly efficient, through improved power technologies and cleaner domestic fuels, and to be cost and performance competitive. Manufacturers and consumers can then use these technologies to help the Nation reduce both energy use and greenhouse gas emissions thus improving energy security by dramatically reducing dependence on oil.

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

Contribution to Program Goal 04.02.00.00 (Vehicle Technologies)

The program contributes to General Goal 4, Energy Security, by developing technologies that can enable cars and trucks to become highly efficient by means of R&D that provides clean power technologies and improved domestic fuel specifications that work in concert with advanced power systems. In addition, the program R&D will focus on reducing the cost and improving other attributes of advanced vehicle technologies so that they will be both performance and cost competitive. The program activities presented below demonstrate key technology pathways that contribute to achievement of this goal.

- Vehicle Systems Subprogram and Materials Technologies Subprogram: Reduce heavy truck parasitic losses (e.g. aerodynamics, ancillary systems) from 39% of engine output in 1998 to 24% in 2006 and reduce the weight of a tractor-trailer from 23,000 pounds in 2003 to 18,000 pounds in 2010 (a 22% reduction), thereby increasing heavy truck fuel efficiency.
- Hybrid and Electric Propulsion Subprogram: 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.
- Advanced Combustion Engine R&D Subprogram and Fuel Technology Subprogram: Improve the efficiency of internal combustion engines from 30 percent (2002 baseline) to 43 percent by 2010 for light-duty and from 40 percent (2002 baseline) to 55 percent by 2012 for heavy-duty applications while utilizing an advanced fuel formulation that incorporates a non-petroleum based blending agent to reduce petroleum dependence and enhance combustion efficiency.
- Materials Technology Subprogram: By 2006, Transportation Materials Technologies R&D activities will reduce the projected production volume cost of carbon fiber from $12 per pound in 1998 to $3 per pound.

Annual Performance Results and Targets

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Targets	FY 2005 Targets
Program Goal 04.02.00.00 (Vehicle Technologies)					
Vehicle Systems (Heavy Vehicle Systems R&D Activity) and Materials Technologies (Lightweight Materials Technology Activity)					
Complete testing of baseline prototype, 50-volt high power lithium-ion battery modules for use in hybrid vehicles. (MET GOAL)	Complete testing of the 276-volt battery aimed at demonstrating an integrated system having thermal and electrical controls. (MET GOAL)	Reduced parasitic losses of heavy vehicle systems to 36 percent. (MET GOAL)	Reduced parasitic losses of heavy vehicle systems to 30 percent of total engine output and benchmark additional reductions through heavy truck electrification. (EXCEEDED GOAL)	Reduce parasitic loses to 27 percent of total engine output in a laboratory test.	Reduce parasitic energy loss to 25 percent of total engine output and reduce unloaded tractor-trailer weight to 22,000 pounds.
Hybrid and Electric Propulsion (Energy Storage Activity)					
N/A	Completed explorations of lithium-polymer and lithium ion battery technologies; lithium ion was selected as the most promising approach for continued development.	Completed development of second generation Lithium ion electrochemistry for hybrid vehicle power. (MET GOAL)	Reduced high power 25 kW estimated lithium ion battery cost to $1,180 per battery system. (EXCEEDED GOAL)	Reduce high power 25 kW light vehicle estimated lithium ion battery cost to $1,000 per battery system.	Reduce high power, 25kW, light vehicle, lithium ion battery cost to $900 per battery system.
Advanced Combustion Engine R&D (Combustion & Emission Control and Heavy Truck Engine activities) and Fuels Technology					
N/A	N/A	N/A	Demonstrated optimized emission control system that achieves 0.07 g/mile NO_x and 0.01 g/mile PM short-term performance in light duty vehicles. (MET GOAL)	Complete Light Truck activity with 35 percent fuel efficiency improvement over a gasoline powered light truck and Tier 2 emissions levels (0.07g/mile NO_x). Demonstrate 45 percent thermal efficiency for heavy-duty diesel engines while meeting EPA 2007 emission standards (1.2g/hp-hr NO_x).	Light vehicle combustion will reach 39 percent brake thermal efficiency and heavy vehicle combustion engines will be greater than 45 percent efficiency while meeting EPA 2007 emission standards (1.2 g/hp-hr NO_x).
Materials Technology (Lightweight Materials Technology activity)					
N/A	N/A	Fabricated a sport utility vehicle chassis component using carbon fiber in a low cost molding process that is suitable for high volume production. (NOT MET) Completion of their target was delayed due to an equipment failure requiring significant repairs. The target was rescheduled for completion in FY 2003.	Completed R&D on technologies, which, if implemented in high volume, could reduce the price of automotive-grade carbon fiber to less than $7/pound. (EXCEEDED GOAL)	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.	Complete R&D on technologies, which, if implemented in high volume, could reduce the price of automotive-grade carbon fiber to less than $4.50/pound.
Management of Funds					
				Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a	Contribute proportionately to EERE's corporate goal of reducing corporate and program uncosteds to a

FY 2000 Results	FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Targets	FY 2005 Targets
				range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2004 relative to the program uncosted baseline (in 2003).	range of 20-25 percent by reducing program annual uncosteds by 10 percent in 2005 relative to the program uncosted baseline (2004).

Means and Strategies

The Vehicle Technologies Program will use various means and strategies to achieve its program goals as described below. "Means" include operational processes, resources, information, and the development of technologies, and "strategies" include program, policy, management and legislative initiatives and approaches. Various external factors, as listed below, may impact the ability to achieve the program's goals. Collaborations are integral to the planned investments, means and strategies, and to addressing external factors.

The Department will implement the program through the following means:

- The program focuses its technology research and 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 produced domestically in a clean and cost-competitive manner.
- Fuel efficiency gains will be achieved through the introduction of more efficient technologies and lightweight materials. The use of advanced technologies will be more economically attractive through DOE research and development efforts that reduce their costs.
- Vehicles with advanced technologies include advanced combustion engines, hybrid internal combustion vehicles, and hybrid fuel cell vehicles. The penetration of these vehicles in the marketplace will be enhanced by DOE research and development that, for example, reduces high power battery costs and extends battery calendar life for hybrid vehicles, improves diesel and other combustion engines by making them more efficient and cleaner, and improves the power electronics and the electric motors needed for fuel cell and combustion hybrid vehicles.
- The 21st Century Truck Partnership has identified desirable technology goals in five general areas: engine systems, heavy-duty hybrids, parasitic losses, truck safety, and idling reduction. The partners are jointly developing technical roadmaps that outline the pathways for achieving long-range technology-specific R&D goals (including cost targets) and the milestones required to demonstrate progress. Each partner will consider these goals in implementing its respective R&D programs.

The Department will implement the program through the following strategies:

- For light vehicles the long-term strategy is clearly to perfect the technologies that will enable a timely transition to a transportation hydrogen economy. There are, however, significant gains in oil reduction possible from R&D to improve highway transportation technologies in the interim. Taking advantage of these interim opportunities to significantly reduce oil use (thus benefiting both our economy and our energy security) is a key outcome sought by both the FreedomCAR and 21st Century Truck Partnerships.
- The truck 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 helping enhance America's global competitiveness.
- These mission strategies are accomplished by targeted Federal investments in technology research and development in strategic partnerships with auto manufacturers, heavy vehicle manufacturers, equipment suppliers, energy companies, other Federal agencies, State government agencies,

universities, national laboratories, and other stakeholders. These strategic partnerships facilitate the technical coordination of activities and attract cost sharing to provide leveraged benefits for the American taxpayer. Two partnerships represent the major crosscutting elements of the program, the FreedomCAR Partnership and the 21st Century Truck Partnership.

- In addition, the program invests in technical program and market analysis and performance assessments in order to direct effective strategic planning.

These strategies will result in significant cost savings and a significant reduction in the consumption of gasoline and diesel fuels, thus cost effectively reducing America's demand for petroleum, lowering carbon emissions, and decreasing energy expenditures.

The following external factors could affect the ability of the Vehicle Technologies Program to achieve its strategic goal:

- Cleaner and more energy efficient highway transportation technologies face several market barriers in gaining consumer acceptance and private investment from manufacturers. For example, most new vehicle buyers do not place a high value on fuel economy, a statistic that has not varied much for many years.[a] Surveys show that the average new vehicle buyer wants about a three year payback for making an incremental expenditure for more fuel efficient technologies. As a result, manufacturers have been reluctant to assume the risk required for the production and distribution of advanced vehicle technologies.
- For each vehicle type and class and for each region, a number of 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. Factors such as the cumulative sales over time of the various technologies in the market for each type of light vehicle, vehicle and fuel prices, and consumer preferences will all affect results.
- Estimates for energy savings, oil savings, carbon emission reductions, and energy expenditure savings reflect EIA reference case assumptions about future energy markets. 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 purchase more efficient vehicles, the goals and benefits could be affected.
- Results are sensitive to the assumptions about consumer preferences made in the model, especially with regard to vehicle purchase price. The potential for hybrid and other efficient vehicle sales to respond to local market conditions, such as State and local vehicle preferences (e.g., use on carpool lanes) will effect results.
- Timing of market entry of fuel cell vehicles.

In carrying out the program's mission, the Vehicle Technologies Program performs the following collaborative activities:

- The FreedomCAR Partnership is a collaboration with the U.S. Council for Automotive Research (USCAR). The USCAR member companies are Ford, General Motors and DaimlerChrysler corporations. The USCAR aim is to strengthen the technology base of the U.S. domestic automotive industry through cooperative, pre-competitive research. The "CAR" in FreedomCAR stands for Cooperative Automotive Research.

[a] Surveys by JD Power for 1980, 1983, 1985, and 1987 and by Opinion Research Corporation for 1996, 1998, and 2000.

- Since fuel cell technologies are a common element of both, the FreedomCAR Partnership is closely linked to the President's Hydrogen Fuel Initiative. The Secretary of Energy and senior executives of DaimlerChrysler, Ford, and General Motors announced the FreedomCAR Partnership on January 9, 2002, to develop the vehicle component technologies necessary to free the Nation's personal transportation system from petroleum dependence and from harmful vehicle emissions, without sacrificing freedom of mobility and freedom of vehicle choice. In early 2003, the President announced the Hydrogen Fuel Initiative which, along with the FreedomCAR Partnership, can help direct the Nation towards a hydrogen transportation economy and a secure, emissions-free energy future. Together these address the key technology and infrastructure barriers of hydrogen fuel cell vehicles. The initiatives aim to facilitate an industry decision to commercialize hydrogen-powered fuel cell vehicles by the year 2015. The Vehicle Technologies Program develops the vehicle component technologies (lightweight materials, energy storage, advanced internal combustion engines, electronic components, and hybrid electric drivetrains) needed for both hybrid electric fuel cell vehicles and more efficient hybrid combustion engine vehicles. Many of the technologies under consideration by the FreedomCAR Partners provide opportunity for the achievement of significant energy savings in the interim period.

FreedomCAR Partnership Budget

(dollars in millions)

	FY 2003 Appropriation	FY 2004 Appropriation	FY 2005 Request
Vehicle Technologies Portion	84,081	89,736	91,400
Fuel Cell Portion	46,638	65,187	77,500
Hydrogen Portion[b]	20,870	0	0
Total, FreedomCAR Partnership	151,589	154,923	168,900

- The FreedomCAR Partnership is being jointly developed and implemented by the FreedomCAR and Vehicle Technologies (FCVT) Program Office and the Hydrogen, Fuel Cells, and Infrastructure Technologies (HFCIT) Program Office. Funding for the FreedomCAR Partnership comes from both Programs. For example, the FVCT Program funds all of FreedomCAR's planned activities dealing with R&D on hybrid technologies, advanced combustion engines, light weighting materials and vehicle systems, as well as Partnership direction and support. Fuel cell related R&D such as polymer electrolyte fuel cells are funded by the HFCIT Program. 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 called the Hydrogen Fuel Initiative which involves partnering with energy companies. (See the HFCIT section.)
- 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, independent 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

[b] After FY 2003, the Hydrogen Technology funding is reflected in the Hydrogen Fuel Intiative.

vehicle manufacturers, equipment suppliers, energy companies, other Federal agencies, State agencies, consumers, and other stakeholders.

- The FreedomCAR Partners have identified nine 2010 specific technology goals (one of which is jointly shared between FCVT and HFCIT) 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 light vehicles. This request fully supports FreedomCAR Partnership goals for Electric Propulsion Systems, Electric Drivetrain Energy Storage, and Material and Manufacturing Technologies. With regard to the two Internal Combustion Powertrain Systems goals, the request is commensurate with achievement of an estimated 43 percent efficiency in 2010.

FreedomCAR Partnership Goals

The Office of FreedomCAR and Vehicle Technologies has responsibility for these goals:

- 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 percent, 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 percent 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 cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards. *(shared responsibility with HFCIT)*

The Office of Hydrogen, Fuel Cells, and Infrastructure Technologies has responsibility for these goals:

- 60 percent peak energy-efficient, durable direct hydrogen 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 an on-board fuel processor) having a peak brake engine efficiency of 45 percent, 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 percent energy efficiency well-to-pump; cost of energy from hydrogen equivalent to gasoline at market price, assumed to be $1.50 per gallon (2001 dollars).
- Hydrogen Storage Systems demonstrating an available capacity of 6 weight percent hydrogen, specific energy of 2.0 kWh/kg and energy density of 1.5 kWh/l at a cost of $4/kWh.
- Internal Combustion Engine Powertrain Systems operating on hydrogen with cost target of $45/kW by 2010 and $30/kW in 2015, having a peak brake engine efficiency of 45 percent, and that meet or exceed emissions standards. *(shared responsibility with FCVT)*

- The 21st Century Truck Partnership, Vehicle Technologies' other major crosscutting effort, has similar aims, but is focused on improving technologies for heavy vehicles. In November 2002, the Secretary of Energy announced the "New Vision for the 21st Century Truck Partnership" that focuses on improving the energy efficiency and safety of trucks and buses. The truck partnership involves key members of the heavy vehicle industry, truck original equipment manufacturers, hybrid propulsion developers, and engine manufacturers as well as other Federal agencies. Primarily due to hydrogen's low energy density when compared to diesel fuel, hydrogen fuel cells are not seen as a viable option for heavy commercial vehicles. They would not provide adequate driving range and would limit cargo carrying capacity. Therefore, the effort centers on research and development to:
  - improve engine systems
  - improve heavy-duty, hybrids, and truck safety
  - reduce parasitic and idling losses
  - validate and demonstrate these technologies.
- The 21st Century Truck Partnership will fund a cooperative effort between the heavy vehicle (trucks and buses) industry and major Federal agencies to develop technologies that will make our Nation's heavy vehicles more efficient, cleaner, and safer. The government agency participants are the Departments of Energy, Defense (represented by the U.S. Army), Transportation, and the Environmental Protection Agency. Industry partners are Allison Transmission, BAE Systems Controls, Caterpillar, Cummins, DaimlerChrysler, Detroit Diesel, Eaton Corporation, Freightliner, Honeywell International, International Truck and Engine, Mack Trucks, NovaBUS, Oshkosh Truck, PACCAR, and Volvo Trucks North America.

21st Century Truck Partnership Budget

(dollars in millions)

	FY 2003 Appropriation	FY 2004 Appropriation	FY 2005 Request
21st Century Truck Partnership	80.9	78.6	56.1

Validation and Verification

The Vehicle Technologies Program uses several program performance management methods to validate and verify its performance during the course of the program on an annual and ongoing basis, including: management standards; incorporation of goals; measurement and reporting from program contracts; peer reviewed roadmaps and activities; performance modeling and estimation; prototype testing; site visits; and annual program reviews.

Data Sources: Program Reviews, Peer Reviews, Laboratory Tests, On-Road Tests, and Peer-Reviewed Model Baselines.

Baseline: Parasitic losses for heavy trucks in 1998 (39 percent), weight of heavy trucks in 2003 (23,000 pounds), cost of hybrid batteries in 1998 ($3,000 for a high power 25kW battery), combustion efficiency in 2002 (30 percent for light vehicles and

40 percent for heavy vehicles), and carbon fiber costs in 1998 ($12 per pound).

Frequency: Biennial reviews for the FreedomCAR and the 21st Century Truck partnerships.

Data Storage: EE Strategic Management System.

Verification: Conduct a biennial review of the FreedomCAR Partnership by an independent third 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 direction. Based on this evaluation, resource availability, and other factors, the FreedomCAR partners will consider new opportunities, make adjustments to technology specific targets, and set goals as appropriate.

Run vehicle simulation tests, conduct bench tests, run laboratory tests on the engine and vehicle dynamometers, run wind tunnel tests, and conduct on-road and track tests to evaluate the technology. Conduct fleets tests and undertake target performance review.

Funding by General and Program Goal

(dollars in thousands)

	FY 2003 Comparable Appropriation	FY 2004 Request	FY 2005 Request	$ Change	% Change
General Goal 4, Energy Security					
Program Goal 04.02.00.00, Vehicle Technologies					
Vehicle Systems	13,485	14,335	13,883	-452	-3.2%
Innovative Concepts	1,590	494	500	+6	+1.2%
Hybrid and Electric Propulsion	41,996	45,002	51,821	+6,819	+15.2%
Advanced Combustion Engines	55,267	54,405	35,936	-18,469	-33.9%
Materials Technologies	36,094	39,744	39,799	+55	+0.1%
Fuels Technology	19,164	16,494	6,800	-9,694	-58.8%
Technology Introduction	4,570	4,939	6,014	+1,075	+21.8%
Technical/Program Management Support	2,005	2,095	1,903	-192	-9.2%
Biennial FreedomCAR Peer Review	0	494	0	-494	-100.0%
Total, Program Goal 04.02.00.00, Vehicle Technologies	174,171	178,002	156,656	-21,346	-12.0%
Total, Vehicle Technologies	174,171	178,002	156,656	-21,346	-12.0%

The Vehicle Technologies (VT) Program is organized into subprograms that are described in the following sections. Nearly all of the subprograms are coordinated with the U.S. auto or trucking industries under the FreedomCAR or 21st Century Truck Partnerships, respectively.

Expected Program Outcomes

The Vehicle Technologies Program pursues its mission through integrated activities designed to improve the energy efficiency and productivity of our economy. We expect these improvements to reduce susceptibility to energy price fluctuations and potentially lower energy bills; reduce EPA criteria and other pollutants; enhance energy security by increasing the diversity of domestic fuel use; and provide greater energy security and reliability by reducing reliance on imported oil. In addition to these "EERE business-as-usual" benefits, realizing the Vehicle Technologies Program goals would provide the technical potential to reduce conventional energy use even further if warranted by future energy needs.

Estimates of annual non-renewable energy savings, energy expenditure savings, carbon emission reductions, oil savings, and natural gas savings that result from the realization of Vehicle Technologies Program goals are shown in the table below through 2050. These benefits are achieved by targeted Federal investments in technology research and 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. Two partnerships represent the major crosscutting elements of the program, the FreedomCAR Partnership and the 21st Century Truck Partnership (21CT).

The assumptions and methods underlying the modeling efforts have significant impact on the estimated benefits, and results could vary significantly if external factors, such as future oil prices and consumer attitudes towards the fuel economy of their vehicles, differ from the baseline case assumed for this analysis. A summary of the methods, assumptions, and models used in developing these benefit estimates that are important for understanding these results are provided at www.eere.energy.gov/office_eere/budget_gpra.html. Final documentation estimated to be completed and posted by March 15, 2004. Uncertainties are larger for longer term estimates. The results shown in the long term benefits tables are preliminary estimates based on initial modeling of some of the possible program production technologies; nonetheless, they provide a useful picture of growing national benefits over time.

GPRA Benefits Estimates for the Vehicle Technology Program[a]

Mid-term benefits[b]

	2010	2015	2020	2025
Primary Non-Renewable Energy Savings (Quads)	0.2	0.6	1.4	2.9
Carbon Emission Reductions (MMTCE)	4	13	27	53
Oil Savings (MBPD)	0.08	0.27	0.67	1.39
Energy Expenditure Savings (Billion 2001$)	6	8	26	55

[a] Benefits reported are annual, not cumulative, for the year given. Estimates reflect the benefits associated with program activities from FY 2005 to the benefit year or to program completion (whichever is nearer), and are based on program goals developed in alignment with assumptions in the President's Budget.

[b] Mid-term program benefits were estimated utilizing the GPRA05-NEMS model, based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) and utilizing the EIA's Annual Energy Outlook (AEO) 2003 Reference Case.

Long-term benefits[a]

	2030	2040	2050
Primary Non-Renewable Energy Savings (Quads)	5.9	12.4	16.2
Carbon Emission Reductions (MMTCE)	117	241	317
Oil Savings (MBPD)	2.8	5.8	7.6
Energy System Cost Savings (Billion 2001$)	25	83	150

The vehicles in the model increase their market share over time as their incremental cost relative to conventional vehicles declines and as their efficiency relative to conventional vehicles increases. Some of the efficiency gains are attained by using lightweight materials while maintaining the safety of the vehicles. By 2025, about 1.4 million barrels per day (mbpd) of oil is projected to be saved as compared with the reference projection without these technologies. This accounts for about 6% of projected transportation oil use in 2025. By 2050, the projected oil savings grows to 7.6 mbpd, which is about 35% of the amount of oil use projected for transportation in that year. The primary non-renewable energy savings are expressed in quads of energy and they are nearly equal to the oil savings since oil is a non-renewable energy source. The energy expenditure savings (in the mid-term benefits) are the savings in fuel costs by vehicle users due to the increased efficiency of their advanced vehicles. The energy system cost savings (in the long-term benefits) includes the fuel cost savings by vehicle users and the incremental expenditures the vehicle users made to purchase their advanced vehicles. Carbon savings are based on the amount of carbon that the petroleum products saved would have released if they had been used.

[a] Long-term benefits were estimated utilizing the GPRA05 - MARKAL developed by Brookhaven National Laboratory (BNL). Results can differ among models due to differences in their structure. In particular, the two models estimate economic benefits in different ways, with the MARKAL model reflecting the cost of additional investments required to achieve reductions in energy bills.

Vehicle Systems

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Vehicle Systems					
Heavy Vehicle Systems R&D					
Vehicle Systems Optimization	9,555	10,188	8,983	-1,205	-11.8%
Truck Safety Systems	397	394	100	-294	-74.6%
Total, Heavy Vehicle Systems R&D	9,952	10,582	9,083	-1,499	-14.2%
Ancillary Systems	1,100	1,185	1,300	+115	+9.7%
Simulation and Validation	2,433	2,568	3,500	+932	+36.3%
Total, Vehicle Systems	13,485	14,335	13,883	-452	-3.2%

Description

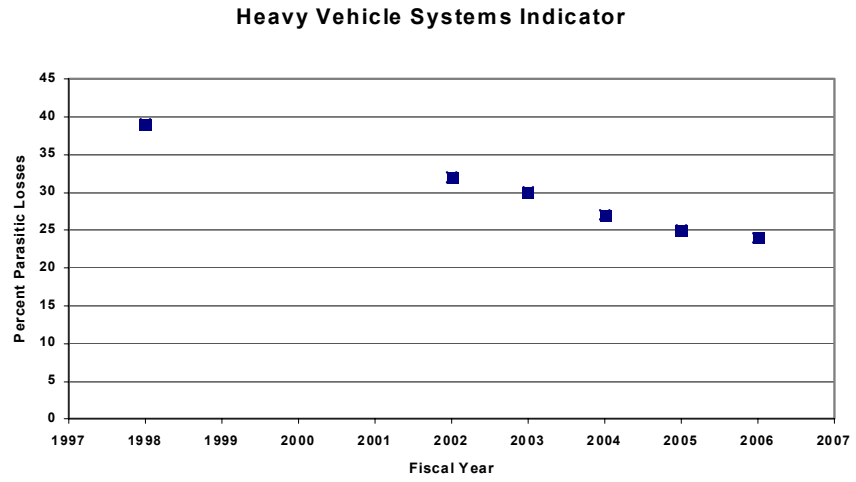
The Vehicle Systems subprogram funds R&D on advanced vehicle technologies and auxiliary equipment that could achieve significant improvements in fuel economy for light and heavy vehicles without sacrificing safety, the environment, performance, and affordability. This subprogram's funding contributes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

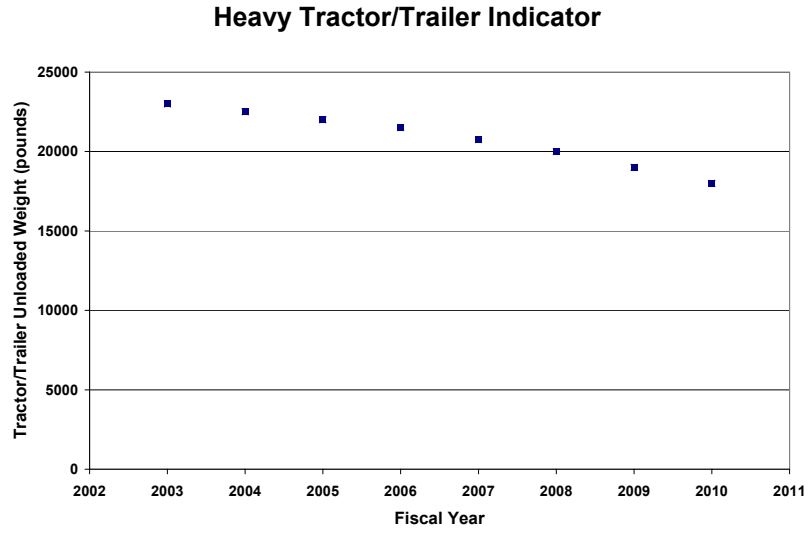
Benefits

The Vehicle Systems subprogram contributes to the VT program goal by addressing those system elements that, when resolved and adequately integrated into a vehicle's design, will accomplish improved system efficiency. For example, parasitic losses and vehicle weight in heavy trucks contribute to overall system inefficiencies. When appropriately addressed, improvements in these areas will add to the improvements that are achieved in the other activities.

A key objective for heavy trucks is to demonstrate a reduction in parasitic losses (e.g. aerodynamics, ancillary systems) from 39% of engine output in 1998 to 24% in 2006 and demonstrate the technical feasibility of reducing the weight of a tractor-trailer from 23,000 pounds in 2003 to 18,000 pounds in 2010 (a 22% reduction), thereby increasing heavy truck fuel efficiency.

Progress is indicated by measured parasitic losses (aerodynamics, cooling, compressed air) and truck weight. Actual and projected parameters for these two factors are shown graphically below:





Related milestones that will also contribute to meeting the VT program goal are:

- By 2005, demonstrate that a 14 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 system.
- By 2005, complete technology requirements for a range of vehicle platforms to facilitate VT 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 the National Renewable Energy Laboratory's Digital Functional Vehicle (DFV) modeling program, that developed light vehicle technologies will achieve vehicle-level performance and component cost objectives.

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Heavy Vehicle Systems R&D	**9,952**	**10,582**	**9,083**

The Heavy Vehicle Systems R&D activity develops, 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 powertrain and truck system integration to increase overall system energy utilization and efficiency. These objectives will be accomplished through two efforts, vehicle systems optimization and truck safety systems.

▪ **Vehicle Systems Optimization**	**9,555**	**10,188**	**8,983**

In FY 2005, negotiate contracts, initiate R&D on awards to competitive solicitations on Parasitic Energy Losses II (PEL-II) and on the Essential Power System for heavy vehicles (HV). Complete major phase of the system electrification project (from PEL-I, replacing belt and gear-driven devices with electrification of underhood components) with road tests of revenue bearing prototype vehicles. Complete test/evaluation of advanced filtration system for higher efficiency HV thermal management systems. With industry participation, equip a portion of five separately selected HV fleets with promising, off-the-shelf aero drag reduction devices, data log their fuel consumption in revenue bearing service, and provide all of the HV industry with validated data for the implementation of near term fuel saving technologies (up to 5 percent efficiency increase is projected). Validate commercial computational fluid dynamics codes for rapid, accurate prediction of aero drag coefficients to lessen the dependence on costly wind tunnel and on-road testing of new HV designs and components. Complete modeling of HV predictive cruise control energy saving methodology (up to 5 percent) and publicly present and publish results for broad dissemination to HV industry. (21CT, $8,983,000).

In FY 2003, funding for this effort was reduced by $194,153 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: NREL, PNNL, LLNL, SNL, NASA, USC, Cal. Tech., GTRI, ANL, Volvo, Great Dane, DOT, ATA, PACCAR, Freightliner, Kenworth, Mack, Peterbilt, International, Ricardo Engr., EMP, Cabot, MSU, Caterpillar, Tufts, General Electric, MIT, EPA, and others to be identified through competitive solicitations.*

▪ **Truck Safety Systems**	**397**	**394**	**100**

In FY 2005, complete the testing and characterization of lighter, more effective prototype size experimental brake components for heavy vehicles (PEL-I); with industry, assess potential for commercialization of the product (21 CT, $100,000). *Participants include: DOT, ORNL, Brunswick, GE, Knoor-Bremse, PACCAR, ATA, West Virginia University (WVU).*

Ancillary Systems	**1,100**	**1,185**	**1,300**

The Ancillary Systems activity seeks to reduce direct and indirect fuel consuming loads imposed on

(dollars in thousands)

FY 2003	FY 2004	FY 2005

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.

In FY 2005, develop and demonstrate advanced ancillary load reduction technologies in a prototype system that if implemented fleet wide would reduce the 0.463 mbpd of gasoline used annually for mobile air-conditioning while reducing tailpipe emissions, and improving driver comfort and safety. Initiate planned effort to develop technologies for fuel cell vehicles, hybrid electric vehicles, and conventional vehicles that use propulsion system waste heat to provide vehicle cabin cooling – eliminating the need for fuel currently required for mobile air conditioners. Initiate industry collaborative testing to evaluate energy-efficient mobile air-conditioning systems with the validated thermal manikin, physiological model, and local and global thermal comfort psychological model. Work with industry and other government agencies to refine estimates of national fuel consumption for vehicle air-conditioning to include advanced mobile air conditioning compressors, expansion devices, heat exchangers, and other energy loss devices contributing to reduction in fuel economy or emissions levels. (FreedomCAR, $1,300,000). *Participants include: NREL, USCAR, other contractors.*

Simulation and Validation	**2,433**	**2,568**	**3,500**

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.

In FY 2005 apply vehicle systems analysis tools and methods to predict and optimize vehicle performance, set technical targets, and link the VT Program objectives of reduced fuel consumption with the technology-specific goals at the component level. Develop flexible, user-friendly tools to analyze and optimize sets of technical targets relative to their potential impact on U.S. transportation sector oil use. Develop technical targets to guide light and heavy vehicle R&D for a range of vehicle platforms found in the marketplace to help achieve VT's year-2030 vision of significantly reducing petroleum usage for transportation. Enable and accelerate new fuel-efficient automotive technologies (e.g., hybrid electric vehicles, fuel cells, and lightweight designs) by analyzing and possibly eliminating barriers through the use of advanced Computer Aided Engineering (CAE) modeling techniques and innovative design processes. Analyze heavy vehicle performance in terms of system and component technical targets and market performance expectations. (FreedomCAR, $3,500,000).

In FY 2003, funding for this effort was reduced by $122,728 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: NREL, ANL, ORNL.*

Total, Vehicle Systems	**13,485**	**14,335**	**13,883**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Heavy Vehicle Systems	
▪ **Vehicle Systems Optimization**	
Major segments of the aerodynamic drag reduction, essential power systems, energy efficient oil filtration, and underhood thermal management efforts will be reduced to focus on core activities for the reduction of parasitic energy losses in heavy vehicles that have more near-term potential.	-1,205
▪ **Truck Safety Systems**	
Funding request will complete prototype of experimental brake components.	-294
Total, Heavy Vehicle Systems	**-1,499**
Ancillary Systems	
In Ancillary Systems, determine candidate technologies for capturing waste heat and assess performance utilizing fuel cell waste heat to provide passenger climate comfort	+115
Simulation and Validation	
In Simulation and Validation, accelerate system optimization and target-setting process for heavy and medium trucks and refine fuel cell models to include extreme temperature operation	+932
Total Funding Change, Vehicle Systems	**-452**

Innovative Concepts

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Innovative Concepts					
Graduate Automotive Technology Education	500	494	500	+6	+1.2%
Cooperative Automotive Research for Advanced Technology	494	0	0	0	0.0%
Stimulate Truck Innovative Concepts and Knowledge	596	0	0	0	0.0%
Total, Innovative Concepts	1,590	494	500	+6	+1.2%

Description

The Innovative Concepts subprogram supports activities of both the VT and the HFCIT Programs. The Cooperative Automotive Research for Advanced Technology (CARAT) and the Stimulate Truck Innovative Concepts and Knowledge (STICK) activities, 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 VT Program contributes a portion of its appropriated funding to the SBIR and STTR programs in accordance with existing law.

Benefits

The Graduate Automotive Technology Education activity contributes to meeting the VT program mission by supporting the development of students with technical skills important to the technology pathways chosen to advance the improvement of vehicle efficiency and petroleum fuel displacement. Improving the resource base in this area will help assure the timeliness of R&D success as well as the efficient transfer of new technologies into the market.

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Graduate Automotive Technology Education (GATE)	**500**	**494**	**500**

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.

In FY 2005, competitively select new GATE Centers of Excellence and provide research fellowships for approximately 25 students for research in advanced automotive technologies, including fuel cell vehicles. Conduct GATE Forum with industry, universities, and government agencies to increase partnering opportunities. (FreedomCAR, $500,000). *Current 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.*

Cooperative Automotive Research for Advanced Technology (CARAT)	**494**	**0**	**0**

The Cooperative Automotive Research for Advanced Technology (CARAT) activity was designed to help small businesses and universities.

Instead of CARAT, VT 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.

No activities are planned during FY 2005.

Stimulate Truck Innovative Concepts and Knowledge (STICK)	**596**	**0**	**0**

The Stimulate Truck Innovative Concepts and Knowledge (STICK) activity was designed to help small businesses and universities.

Instead of STICK, VT 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.

No activities are planned during FY 2005.

Total, Innovative Concepts	**1,590**	**494**	**500**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Graduate Automotive Technology Education	
Minimum change.	+6
Total Funding Change, Innovative Concepts	**+6**

Hybrid and Electric Propulsion

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Hybrid and Electric Propulsion					
Energy Storage					
High Power Energy Storage	17,241	17,457	17,675	+218	+1.2%
Advanced Battery Development	2,403	1,481	1,500	+19	+1.3%
Exploratory Technology Research	1,923	4,469	9,525	+5,056	+113.1%
Total, Energy Storage	21,567	23,407	28,700	+5,293	+22.6%
Advanced Power Electronics	13,355	13,522	13,900	+378	+2.8%
Subsystem Integration and Development					
Light Vehicle Propulsion and Ancillary Subsystems	3,135	3,097	3,735	+638	+20.6%
Heavy Vehicle Propulsion and Ancillary Subsystems	3,939	4,976	5,486	+510	+10.2%
Total, Subsystem Integration and Development	7,074	8,073	9,221	+1,148	+14.2%
Total, Hybrid and Electric Propulsion	41,996	45,002	51,821	+6,819	+15.2%

Description

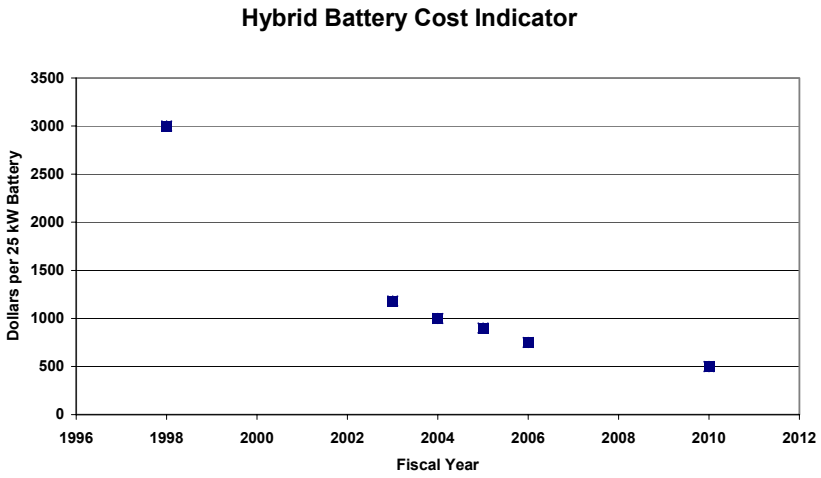
The Hybrid and Electric Propulsion subprogram funds research and development for both light and heavy vehicles. R&D efforts include research in energy storage systems, advanced power electronics and electric machines, and heavy hybrid system development and integration. There are three activities: Energy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

Benefits

The Hybrid and Electric Propulsion subprogram supports achieving the VT program goal by addressing those technology elements important to the utilization of electric energy storage, electric drives, and energy recovery in new, more efficient vehicle designs.

A key objective of the Hybrid and Electric Propulsion R&D subprogram is to reduce, by 2010, 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.

Progress is indicated by cost per 25kW battery system estimated for a production level of 100,000 battery systems per year. Actual and projected progress for this factor is shown graphically below:



A related milestone that will also contribute to meeting the VT program goal is:

- By 2005, define component requirements for heavy vehicle hybrid systems to guide component/system research efforts.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Energy Storage..... **21,567** **23,407** **28,700**

The Energy Storage activity supports 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 research and 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.

(dollars in thousands)

FY 2003	FY 2004	FY 2005

The Interagency Advanced Power Group (IAPG) brings together representatives from the Department of Energy, NASA, the Army, the Navy, and the Air Force to exchange information about government agency programs related to energy storage, generation, and conversion. The IAPG is managed by a Steering Committee of senior agency staff. Discussions are carried out through meetings of working groups that bring together technical experts on a regular basis. The Chemical Working Group covers batteries, fuel cells, and capacitors.

- **High Power Energy Storage** **17,241** **17,457** **17,675**

  In FY 2005, develop full-sized lithium ion cells using low cost, stable, high performance cathode materials based on abundant, low toxicity manganese oxide. Complete activities to develop low cost separator materials. Transfer technology to developers and suppliers for validation in laboratory cells and incorporation into full-size prototype cells, modules, and batteries. Initiate development of an advanced battery for use in fuel cell hybrid vehicles. Conduct benchmark testing and assessments of non-battery energy storage devices, such as ultracapacitors, flywheels, and thermoelectrics that might be applicable in hybrid vehicle systems. (FreedomCAR, $17,675,000).

  In FY 2003, funding for this effort was reduced by $317,334 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: USABC, ANL, BNL, INEEL, LBNL, SNL, Industrial contractors*.

- **Advanced Battery Development** **2,403** **1,481** **1,500**

  In FY 2005, conclude the initial development of high-energy lithium ion and lithium sulfur battery technologies by the USABC. Phase out effort to reduce cost of lithium ion batteries for EVs. Benchmark and assess emerging battery technologies. In FY 2003, funding for this effort was reduced by $79,625 for SBIR/STTR and transferred to the Science Appropriation. (FreedomCAR, $1,500,000). *Participants include: ANL, USABC, Industrial contractors.*

- **Exploratory Technology Research** **1,923** **4,469** **9,525**

  In FY 2005, explore energy storage systems that exhibit significant improvements over existing technologies for use in hybrid vehicles, including fuel cell hybrid vehicles. Develop and characterize novel anode and cathode materials and electrolytes that have higher energy capability, longer and more stable cycling characteristics, and are lower in cost. In particular, investigate multivalent and alloy based electrodes (such as Sn-based intermetallic alloys of Cu, Sb, and Mg), and anodes fabricated from higher purity metals, including pure Li metal. Develop diagnostic techniques to investigate and better understand life- and performance-limiting processes in lithium-based batteries. Develop and apply electrochemical models to understand failure mechanisms and the mechanisms of thermal runaway in lithium batteries.

  Re-evaluate, investigate, and develop solid polymer electrolytes with high room temperature conductivity and good mechanical strength and improved safety. Accelerate the development of low cost, abuse tolerant lithium sulfur battery technology. Explore novel electrochemical energy

storage technologies, specifically non-lithium based battery technologies such as Ca-based and Al-based chemistries. (FreedomCAR, $9,525,000). *Participants include: LBNL, BNL, ANL.*

Advanced Power Electronics **13,355** **13,522** **13,900**

The Advanced Power Electronics activity, which includes R&D on electric machines, develops low cost DC/DC converters and motor controllers, and motors that are needed for fuel cell and hybrid combustion vehicles. Supporting R&D on capacitors, magnets and thermal management complements the motor and electronics technology research and development.

In FY 2005, efforts are focused on advanced motors, DC/DC converters, low-cost permanent magnet materials, advanced thermal management systems, and motor controller systems to meet both light and heavy vehicle requirements. Initiate expanded thermal management R&D efforts in power electronics thermal management system. Test preliminary deliverables at national laboratories for conformance to specifications. Maintain close collaboration among researchers, device manufacturers, and users of the technologies of light and heavy vehicles. Initiate R&D for integrated inverter, motor, and thermal management system and transfer production prototype high temperature capacitor technology to industry. (FreedomCAR, $13,900,000).

In FY 2003, funding for this effort was reduced by $245,815 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: Ames, ANL ORNL, NREL, SNL, Freedom-CAR partners, Heavy Hybrid Partners.*

Subsystem Integration and Development **7,074** **8,073** **9,221**

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 activity also benchmarks and characterizes advanced commercial vehicles and components to determine commercial progress against research performance goals. Data gathered are 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.

- **Light Vehicle Propulsion and Ancillary Subsystems** **3,135** **3,097** **3,735**

  In FY 2005, use hardware-in-the-loop (HIL) techniques to emulate fuel cell propulsion systems to determine systems interactions required for vehicle system integration (e.g., energy storage requirements for different fuel cell subsystem technologies and configurations). Enhance engine emission models to analyze the impact of emissions control on fuel economy. Conduct hardware studies using HIL to determine the impact of expected emission control requirements on fuel economy of advanced light duty hybrid systems. Validate, in a systems environment, performance targets for deliverables from the power electronics and energy storage technology research and development activities. (FreedomCAR, $3,735,000). *Participants include ANL and FreedomCAR*

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Partners.

- **Heavy Vehicle Propulsion and Ancillary Subsystems** **3,939** **4,976** **5,486**

  In FY 2005, in conjunction with industry teams selected in FY 2002 and FY 2003, develop efficient, cost-effective, next generation heavy hybrid components and systems in support of the 21CT. Research in advanced heavy hybrid systems will be directed at developing specific components (especially electric motors, system level energy management, energy storage systems, power electronics, and control systems), advanced powertrain systems, advanced system modeling, system level prototype development, and vehicle level prototypes. Apply advanced computer modeling and analysis to assist in component optimization and continued confirmation of industry performance projections. R&D activities in heavy hybrid vehicle test, protocols, procedures and equipment development, and power electronics for heavy hybrid vehicles will be increased. This effort will coordinate with other DOE programs where synergy exists, e.g. fuel cells, batteries, power electronics, and parasitic energy losses. (21CT, $5,486,000).

  In FY 2003, funding for this effort was reduced by $72,498 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: NREL; Eaton Corporation-Truck Components and its team of International Truck and Engine Corporation, Ricardo, Hitachi, Oshkosh Truck Corporation and its team of Rockwell Automation, Ohio State University, GM –Allison Transmission, ElectraStor and JME; Other Heavy Hybrid Partners.*

Total, Hybrid and Electric Propulsion	**41,996**	**45,002**	**51,821**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Energy Storage	
▪ **High Power Energy Storage**	
Funds will be used to conduct more benchmark testing of promising battery technologies	+218
▪ **Advanced Battery Development**	+19
▪ **Exploratory Technology Research**	
Conduct increased long term, high risk Exploratory Technology Research to advance lithium polymer batteries, lithium sulfur batteries and more fundamental storage concepts	+5,056
Total, Energy Storage	+5,293
Advanced Power Electronics	
In Advanced Power Electronics, investigate thermal management technologies for power inverters for HEV applications under the Power Electronics Project	+ 378
Subsystem Integration and Development	
▪ **Light Vehicle Propulsion and Ancillary Systems**	
In Light Vehicle Propulsion & Ancillary Systems, initiate testing of various fuel cell vehicles provided by the Office of Hydrogen, Fuel Cells and Infrastructure Technologies utilizing existing FCVT testing capabilities and resources to establish baseline performance figures for fuel cell vehicle overall and fuel efficiency	+ 638
▪ **Heavy Vehicle Propulsion and Ancillary Subsystems**	
In Heavy Vehicle Propulsion and Ancillary Subsystems, accelerate advanced heavy hybrid technologies R&D to include power electronics technologies R&D and vehicle test protocols, procedures and equipment. These additional activities will advance progress towards demonstrating fuel economy and petroleum savings in advanced heavy hybrid vehicles.	+510
Total, Subsystem Integration and Development	+1,148
Total Funding Change, Hybrid and Electric Propulsion	**+6,819**

Advanced Combustion Engine R&D

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Advanced Combustion Engine R&D					
Combustion and Emission Control	22,994	22,716	22,000	-716	-3.2%
Light Truck Engine	14,734	12,944	0	-12,944	-100.0%
Heavy Truck Engine	12,174	11,832	10,436	-1,396	-11.8%
Waste Heat Recovery	488	2,469	1,500	-969	-39.2%
Off-Highway Engine R&D	3,414	3,456	0	-3,456	-100.0%
Health Impacts	1,463	988	2,000	+1,012	+102.4%
Total, Advanced Combustion Engine R&D	55,267	54,405	35,936	-18,469	-33.9%

Description

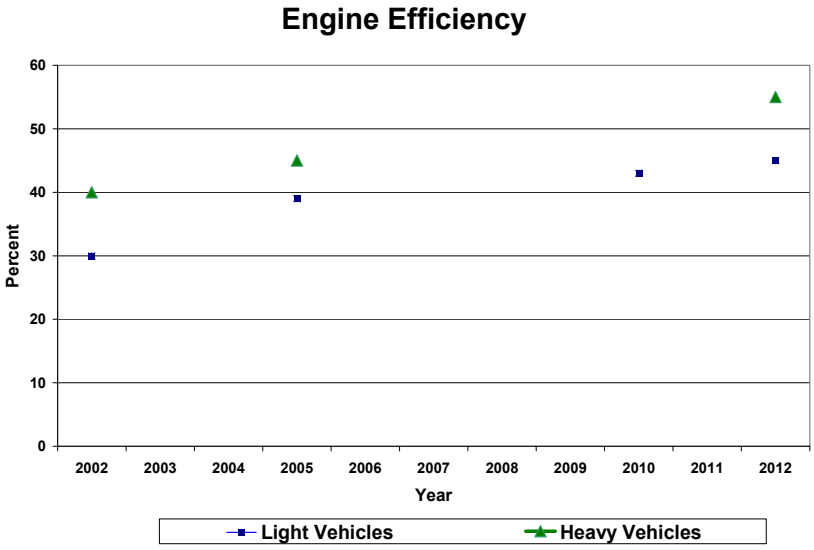
The Advanced Combustion Engine R&D subprogram focuses on removing critical technical barriers to commercialization of higher efficiency, advanced internal combustion engines in light-duty, medium-duty, and heavy-duty vehicles. The goals are to improve the efficiency of internal combustion engines for light-duty applications from to 45 percent by 2012, and for heavy-duty applications, to 55 percent by 2012, while meeting cost, durability, and emissions constraints. Research is conducted in collaboration with industry, national laboratories and universities, and in conjunction with the FreedomCAR and 21CT Partnerships. The Advanced Combustion Engine R&D subprogram includes Combustion and Emission Control R&D, Heavy Truck Engine R&D, Waste Heat Recovery R&D, and Health Impacts Research.

Benefits

The Advanced Combustion Engine R&D subprogram and Fuel Technology subprogram will contribute to the VT program goal by improving the drivetrain efficiency through development of more efficient combustion engines and through identification of fuel properties and components that make improved fuels possible that either make a more efficient system possible or that can displace petroleum based fuels. Improved efficiency and petroleum displacement both can directly reduce petroleum consumption.

The key objective is to improve the efficiency of internal combustion engines from 30 percent (2002 baseline) to an estimated 43 percent by 2010 and to 45 percent by 2012 for light-duty and from 40 percent (2002 baseline) to 55 percent by 2012 for heavy-duty applications while utilizing an advanced fuel formulation that incorporates a non-petroleum based blending agent to reduce petroleum dependence and enhance combustion efficiency.

Progress is indicated by efficiency of light- and heavy-duty internal combustion engines.



Detailed Justification

(dollars in thousands)

FY 2003	FY 2003	FY 2003
Combustion and Emission Control	**22,994**	**22,716**	**22,000**

The Combustion and Emission Control R&D activity supports the VT Program goal to enable energy-efficient, clean vehicles powered by advanced internal combustion engines using clean, hydrocarbon- and non-petroleum-based, and hydrogen fuels. Work focuses on developing technologies for light-, medium-, and heavy-duty Compression Ignition Direct Injection (CIDI) engines and is being transitioned to developing technologies for advanced engines operating in advanced combustion regimes that will further increase efficiency and reduce emissions to near-zero levels.

In FY 2005, increase emphasis on research in advanced combustion regimes that achieve efficiency goals for cars and trucks while maintaining cost and high durability with near-zero emissions.

Conduct optical laser diagnostics of in-cylinder combustion process for HCCI (Homogeneous Charge Compression Ignition), Low Temperature Combustion (LTC) and mixed-mode regimes. Release competitive solicitation and award competitive cooperative agreements for innovative component technologies to enable HCCI, LTC and mixed-mode regimes with high efficiency and near-zero emissions. Through simulation and experimentation, conduct R&D on advanced thermodynamic strategies that will enable engines to approach 60% thermal efficiency. Utilize laser-based, optical

diagnostics to conduct in-cylinder engine research focused on overcoming barriers to the development of high-efficiency, hydrogen-fueled IC engine technology in coordination with the HFCIT Program. Perform detailed chemical kinetic modeling of LTC and emissions processes, including fuel composition effects, to aid the development of advanced, high-efficiency IC engines using LTC and mixed-mode combustion regimes. Utilize X-rays from Advanced Photon Source to study near-fuel injection spray characteristics.

Terminate vehicle level testing and development at Cummins to reduce the fuel efficiency penalty of the NO_x adsorber and particulate matter (PM) filter emission control system from the current 5 to 7 percent to less than 2 percent. Develop efficient on-board reformers for generation of reductant needed to periodically restore catalyst function. This may enable the use of lean NO_x catalysts that require no additional energy input. Shift focus of GM cooperative agreement from high-volume screening of catalyst materials to engine-scale testing of most promising candidate materials. Terminate cooperative agreement with Ford for the development and vehicle integration of a Selective Catalytic Reduction system to achieve a less than one percent fuel economy penalty as compared to the current 3 to 5 percent. Through partnership with industry, develop a shared database of simulation codes for exhaust emissions control systems.

Engine/Emission Controls Integration: Shift focus of effort to reduce cost and improve durability of NO_x and PM sensors through cost shared CRADAs and cooperative agreements with automotive suppliers and universities, to enable closed loop control of fuel injection and emission control devices so that 120,000 mile goal can be achieved. (FreedomCAR, $13,500,000; 21CT, $8,500,000).

In FY 2003, funding for this effort was reduced by $423,224 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: SNL, LANL, ORNL, PNNL, LLNL, ANL, Ford, GM, DaimlerChrysler, Detroit Diesel, Cummins, Engelhard, ExxonMobil, Caterpillar, Mack, International, John Deere, GE, EMD, Delphi, Honeywell, University of Michigan, University of Wisconsin, catalyst manufacturers, other suppliers, other universities.*

Light Truck Engine **14,734** **12,944** **0**

No activities are planned during FY 2005. Light truck engine R&D activities completed with FY 2004 funding.

In FY 2003, funding for this effort was reduced by $271,191 for SBIR/STTR and transferred to the Science Appropriation.

Heavy Truck Engine **12,174** **11,832** **10,436**

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 55 percent by 2012, (from the current 40 percent) while meeting Federal emissions standards.

In FY 2005, place more emphasis on improving engine efficiency to greater than 45 percent through the

(dollars in thousands)

FY 2003	FY 2003	FY 2003

utilization of advanced combustion regimes (HCCI, LTC and mixed-mode), which are capable of reducing engine-out emissions to near-zero levels. This approach will result in a reduced need for emission control equipment, which has a negative impact on fuel economy, cost and durability. Develop and integrate NO_x adsorbers, Selective Catalytic Reduction (SCR), sulfur traps and PM filters to reduce fuel economy penalty and the potential to meet the durability requirement of 435,000 miles for heavy vehicles while meeting EPA 2007 standards. 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 subprogram for the higher pressures, temperatures, and durability requirements of heavy duty diesel engines. (21CT, $10,436,000).

In FY 2003, funding for this effort was reduced by $224,071 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: Caterpillar Inc., Cummins Engine Co., Detroit Diesel Corp., suppliers, national labs.*

Waste Heat Recovery (formerly Engine Boosting) **488** **2,469** **1,500**

The Waste Heat Recovery activity develops technologies to convert waste heat from engines to electrical energy to improve overall thermal efficiency and reduce emissions.

In FY 2005, integrate electric turbocompound unit with engine control system to produce 3 to 5 kilowatts (kW) for light-duty and up to 20kW for heavy-duty applications from engine waste heat. Combine turbocompounding with starter motor-alternator to improve vehicle fuel economy, increase low-speed torque, improve engine transient response, and reduce particulate emissions. Develop a Quantum Well thermoelectric generator to recovery up to 5 kilowatts of energy from engine waste heat. Identify innovative energy recovery technologies that can improve overall efficiency and conduct R&D towards feasibility demonstration. (21CT, $1,500,000).

In FY 2003, funding for this effort was reduced by $8,978 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: Honeywell, Caterpillar, Hi-Z, PNNL.*

Off-Highway Engine R&D **3,414** **3,456** **0**

No activities are planned during FY 2005 so as to focus on other research opportunities having higher potential for energy savings.

In FY 2003, funding for this effort was reduced by $62,845 for SBIR/STTR and transferred to the Science Appropriation.

Health Impacts **1,463** **988** **2,000**

The Health Impacts activity evaluates the relative toxicity of emissions from new vehicle technologies developed to meet energy efficiency goals.

In FY 2005, initiate toxicity testing of metallic compounds in fuels and lubricants (man-made additives and trace metals in non-petroleum-based feedstocks) to provide feedback on new technologies, and complete comparative toxicity testing of emissions from natural gas fueled vehicles. (21CT,

(dollars in thousands)

FY 2003	FY 2003	FY 2003

$2,000,000). In FY 2003, funding for this effort was reduced by $26,934 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: Lovelace Respiratory Research Institute, NIOSH.*

Total, Advanced Combustion Engine R&D	**55,267**	**54,405**	**35,936**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Combustion and Emissions Control	
In Combustion & Emissions Control, focus on the most promising avenues to advance HCCI, low temperature combustion and mixed-mode combustion regimes with high efficiency and near-zero emissions.....	-716
Light Truck Engine	
In Light Truck Engine, completed activity in FY 2004 and transitioned to private sector	- 12,944
Heavy Truck Engine	
In Heavy Truck Engine, consolidate research effort on improving engine efficiency to 50 percent through the utilization of advanced combustion regimes (HCCI, LTC, and mixed-mode) which are capable of reducing engine-out emission to near-zero levels	-1,396
Waste Heat Recovery	
In Waste Heat Recovery, consolidate development of turbocharger devices to recover waste heat from the engine and identify other innovative energy recovery devices to improve engine efficiency.....	-969
Off-Highway Engine R&D	
The Off-Highway Engine R&D activity is terminated to focus on other research opportunities having higher potential for energy savings..	-3,456
Health Impacts	
In Health Impacts, complete initial toxicology screening of heavy metals in emissions from combustion engines. Conduct research contributing to the Advanced	+1,012

	FY 2005 vs. FY 2004 ($000)
Collaborative Emissions Study (ACES) designed to elucidate deleterious health impacts emanating from proposed 2010 Energy Efficiency enhancing combustion engine emissions control technologies.....	
Total Funding Change, Advanced Combustion Engine R&D.....	**-18,469**

Materials Technology

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Materials Technology					
Propulsion Materials Technology					
Automotive Propulsion Materials	1,952	2,964	2,000	-964	-32.5%
Heavy Vehicle Propulsion Materials	5,705	5,778	5,000	-778	-13.5%
Total, Propulsion Materials Technology	7,657	8,742	7,000	-1,742	-19.9%
Lightweight Materials Technology					
Automotive Lightweight Materials	14,242	16,632	21,000	+4,368	+26.3%
Heavy Vehicle High Strength Weight Reduction Materials	8,731	8,839	7,799	-1,040	-11.8%
Total, Lightweight Materials Technology	22,973	25,471	28,799	+3,328	+13.1%
High Temperature Materials Laboratory	5,464	5,531	4,000	-1,531	-27.7%
Total, Materials Technology	36,094	39,744	39,799	+55	+0.1%

Description

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

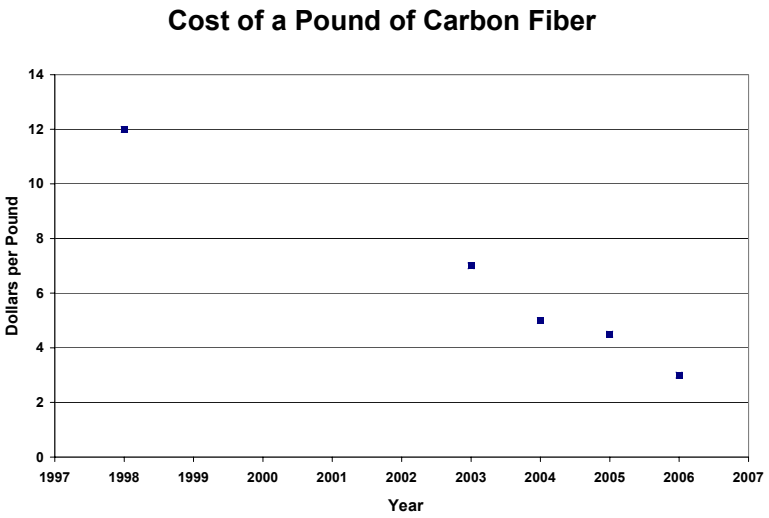
Benefits

The Materials Technology subprogram will contribute to the VT program goal by developing better, cost effective materials that will make lighter vehicle structures and more efficient power systems possible. Lighter vehicles (that provide comparable safety) require less energy to operate and thus

reduce the consumption of fuel. Likewise, better propulsion materials can make more efficient power systems possible thus also contributing to a vehicle's reduced energy consumption.

A key subprogram goal for the Transportation Materials Technologies R&D activity is to reduce the projected production volume cost of carbon fiber from $12 per pound in 1998 to $3 per pound by 2006.

Progress is indicated by cost of carbon fiber. Actual and projected progress for this factor is shown graphically below:



Related milestones that will contribute to the VT program goal are:

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 Exhaust Gas Recirculation (EGR).
- Exhibit the performance, durability, reliability, safety, and cost effectiveness comparable to those of current heavy vehicle engines.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Propulsion Materials Technology **7,657** **8,742** **7,000**

The Propulsion Materials Technology activity focuses on technologies that are critical in removing

(dollars in thousands)

FY 2003	FY 2004	FY 2005

barriers to electric drive, advanced combustion, and emissions control research activities.

- **Automotive Propulsion Materials**..... **1,952** **2,964** **2,000**

  In FY 2005, evaluate sensitivity, response time, and stability of prototype NO_x sensor and invite industrial partner to participate in further development. Make improvements to carbon foam production processes for improved cooling of electronics. Complete development of diesel fuel injectors with 50-micron orifices. (FreedomCAR, $2,000,000).

  In FY 2003, funding for this effort was reduced by $34,956 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: ORNL, LLNL, ANL, Industrial Ceramic Solutions.*

- **Heavy Vehicle Propulsion Materials**..... **5,705** **5,778** **5,000**

  In FY 2005, assess the viability of using titanium in engine components for higher efficiencies and lighter weight.

  Initiate characterization of new surface modification techniques to reduce friction/wear in engine component materials and increase engine efficiency. Assess viability of current concepts to enhance fracture toughness and/or to ductilize ceramics for advanced engine applications. Evaluate engine material substitution strategies for lighter weight, cost-effective, higher efficiency engines. Assess the capability of new analytic and simulation methods to characterize, formulate, and stabilize nano-size atomic clusters to achieve high potency, durable, cost-effective catalysts for controlling exhaust gas emissions. Characterize high strength, lightweight, wear resistant metal and ceramic matrix composites, and Cermets for applications in components of advanced high performance, efficient engines. Within the IEA Annex on Materials for Transportation, establish multilateral collaborative research on characterization of rolling contact fatigue, integrated surface modification of materials, and new applications of magnesium. (21CT, $5,000,000).

  In FY 2003, funding for this effort was reduced by $105,979 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: ORNL, LLNL, SNL, ANL, Industrial Ceramic Solutions.*

Lightweight Materials Technology..... **22,973** **25,471** **28,799**

Lightweight Materials Technology activity develops carbon fiber and metal composites to reduce vehicle weight while maintaining safety, performance, and reducing cost.

- **Automotive Lightweight Materials** **14,242** **16,632** **21,000**

  In FY 2005, conclude a major thrust that began in FY 2001, on aluminum alloys and carbon-fiber-reinforced polymer-matrix composites (CFRPMC), and enable new manufacturing-focused thrusts initiated in FY 2003 and FY 2004 respectively to reach mid-stream of their roughly five-year course.

  Metals: Complete development of a binder control system for stamping of aluminum sheet

components. Conclude initial development of corrosion/wear coatings for completed magnesium components. Design knowledge and product capabilities for cast magnesium structural components will be validated by full size component tests.
Composites: Conclude validation work on carbon-fiber rapid preforming technology and make a decision on future work. Part fabrication and cost, weight, and performance analysis for a CFRPMC-intensive body-in-white will be completed and a decision made on the course of future work.

Advanced Materials and Processes: Develop predictive models for dimensional control of welded assemblies and an understanding of the effect of strain-rate dependent materials on crash energy absorption capabilities. Complete evaluation of energy-absorption capabilities of prototype bonded and mechanically fastened structures. (FreedomCAR, $21,000,000).

In FY 2003, funding for this effort was reduced by $262,131 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: ANL, LBNL, LLNL, ORNL, PNNL, SNL, numerous companies and universities.*

- **Heavy Vehicle High Strength Weight Reduction Materials** **8,731** **8,839** **7,799**

In FY 2005, complete assembly of ultra-light 40 ft. stainless steel transit bus, insert drive train, and assess improvement of prototype vehicle performance parameters. Complete scale-up and evaluation of new magnesium casting process. Evaluate potential to produce wrought magnesium alloy sheet components to meet HV requirements, LWM and cost targets. Identify, characterize innovative, reliable, cost effective joining techniques for high performance LWM and dissimilar material joints. Emphasize joining of carbon composites to like and dissimilar structural materials. Determine impact of lower cost virgin titanium on its potential use in LWM structural applications on HVs.

Phase down Equal Channel Angular Extrusion efforts to focus only on fabricability of amorphous materials and metal matrix composites. Quantify/characterize effects of highway ice-clearing chemicals on corrosion of HV materials and components. (21CT, $7,799,000).

In FY 2003, funding for this effort was reduced by $160,699 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: American Trucking Associations, PACCAR, Freightliner, ALCOA, Caterpillar, DaimlerChrysler, Delphi, Volvo Autokinetics, ANL, LANL, INEEL, PNNL, MIT, ORNL.*

High Temperature Materials Laboratory **5,464** **5,531** **4,000**

The High Temperature Materials Laboratory (HTML) activity is an advanced materials R&D industrial user center located at the Oak Ridge National Laboratory. The HTML strives to maintain world class, state-of-the-art advanced materials characterization capabilities not available elsewhere and makes them available to U.S. industries for use in solving their materials problems. It develops cutting-edge analytical techniques to identify innovative materials for use in surface transportation applications. Projects include investigation of compositional crystallographic conditions of metals,

(dollars in thousands)

FY 2003	FY 2004	FY 2005

alloys, ceramics, and novel materials under development for vehicle applications.

The Nation's first Aberration Corrected Electron Microscope (ACEM) that has both sub-angstrom level clear imaging and chemical analysis capabilities will be delivered and become fully operational in FY 2005. ACEM will be used to study and characterize advanced materials such as lean NO_x catalytic materials which will enable higher efficiency clean diesel engines to replace lower efficiency spark ignition engines in most automobiles, light trucks and SUVs.

In FY 2003, funding for this effort was reduced by $100,553 for SBIR/STTR and transferred to the Science Appropriation.

Total, Materials Technologies	**36,094**	**39,744**	**39,799**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Propulsion Materials Technology	
▪ **Automotive Propulsion Materials**	
Concentrate research efforts on the development of electric drive system materials and combustion and aftertreatment materials	-964
▪ **Heavy Vehicle Propulsion Materials**	
Curtail the R&D on reduction of engine friction by innovative surface modifications and in ductilization of ceramics for engine applications in order to focus R&D on conventional technologies that have more near-term potential.	-778
Total, Propulsion Materials Technology	-1,742
Lightweight Materials Technology	
▪ **Automotive Lightweight Materials**	
Increase emphasis on recycling, non-destructive evaluation and crash worthiness prediction. Expand efforts to develop advanced high-strength metals and processing technology. Enhance the competitiveness of carbon fiber by making it more recyclable	+4,368
▪ **Heavy Vehicle High Strength Weight Reduction Materials**	
Continue development of lightweight metallic and alloy components for energy efficient heavy vehicles that have better near-term applicability and phase down lightweight carbon composite technology and equal channel angular extrusion	-1,040

Total, Lightweight Materials Technology	+3,328
High-Temperature Materials Laboratory	
Complete final preparations for installation of the Aberration Corrected Electron Microscope. Support 20 full-time staff members.	-1,531
Total Funding Change, Materials Technology	**+55**

Fuels Technology

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Fuels Technology					
Advanced Petroleum Based Fuels	12,955	10,272	4,000	-6,272	-61.1%
Non-Petroleum Based Fuels & Lubricants					
Medium Trucks	1,314	1,284	0	-1,284	-100.0%
Heavy Trucks	1,409	1,383	0	-1,383	-100.0%
Fueling Infrastructure	1,204	1,185	0	-1,185	-100.0%
Renewable and Synthetic Fuels Utilization	0	395	2,800	+2,405	+608.9%
Total, Non-Petroleum Based Fuels & Lubricants	3,927	4,247	2,800	-1,447	-34.1%
Environmental Impacts	2,282	1,975	0	-1,975	-100.0%
Total, Fuels Technology	19,164	16,494	6,800	-9,694	-58.8%

Description

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

Benefits

The Fuels Technology subprogram will contribute to the accomplishment of the VT program goal by developing advanced fuel formulations that enable the development of advanced power systems that will operate at significantly higher efficiencies. It will also contribute to the displacement of petroleum fuels by non-petroleum based fuels. Non-petroleum based components can be introduced through a blending strategy.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Advanced Petroleum Based Fuels (APBF) **12,955** **10,272** **4,000**

The APBF activity develops petroleum-based fuels and lubricants that will enable extremely high efficiency engines for heavy vehicle applications. 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 engines to operate in the highest efficiency mode while meeting the emissions standards.

In FY 2005, initiate efforts to determine base-fuel properties of most significance in advanced combustion regime engines through a competitively awarded teamed cooperative agreement with engine manufacturers and energy companies. This effort is in conjunction with the Advanced Combustion Engine's subprogram. Initiate development of predictive tools that relate molecular structure to ignition behavior and heat release of fuels in advanced combustion engines. This initial effort, to be conducted through experimentation and modeling, will support the development of fuels optimized for advanced combustion regimes and will contribute to the fundamental understanding of fuel effects on combustion. Terminate activities with West Virginia University's mobile emissions laboratory and activities associated with ReFuel Laboratory at NREL. (21CT, $4,000,000).

In FY 2003, funding for this effort was reduced by $280,709 for SBIR/STTR and transferred to the Science Appropriation. *Participants include: NREL, ORNL, SNL, LLNL, NETL.*

Non-Petroleum Based Fuels & Lubricants (NPBFL) ... **3,927** **4,247** **2,800**

The NPBFL activity formulates and evaluates biomass based and synthetic fuels for their effects on petroleum based fuels when used as blending agents. Specific areas being investigated include molecular make-up, effect on bulk fuel properties, and effect on engine performance, storage, handling, toxicity, and volatility.

- **Medium Trucks** **1,314** **1,284** **0**

  In FY 2005, no efforts are planned. Work in this area has supported natural gas engine/vehicle systems development and the technology is considered mature and ready for commercialization. In FY 2003, funding for this effort was reduced by $30,155 for SBIR/STTR and transferred to the Science Appropriation.

- **Heavy Trucks** **1,409** **1,383** **0**

  In FY 2005, no efforts are planned. Work in this area has supported natural gas engine/vehicle systems development and the technology is considered mature and ready for commercial development. In FY 2003, funding for this effort was reduced by $31,845 for SBIR/STTR and transferred to the Science Appropriation.

- **Fueling Infrastructure** **1,204** **1,185** **0**

  In FY 2005, no efforts are planned. Work in this area has supported natural gas fueling infrastructure R&D and is considered mature and ready for commercialization.

(dollars in thousands)

FY 2003	FY 2004	FY 2005

In FY 2003, funding for this effort was reduced by $28,090 for SBIR/STTR and transferred to the Science Appropriation.

- **Renewable and Synthetic Fuels Utilization**..... **0** **395** **2,800**

  In FY 2005, evaluate the variance between commercially available biomass-based fuels in terms of molecular make-up, effect on engine performance, and effect on overall fuel when blended with petroleum based fuels. Initiate development of a specification for biomass-based fuels with enough detail to ensure that such fuels, when blended with petroleum-based feedstocks, will not impose any adverse effects on engine performance. (21CT, $2,800). *Participants include: NREL, ORNL, SNL.*

Environmental Impacts **2,282** **1,975** **0**

In FY 2005, no efforts are planned as work in this area is not considered to be within the mission of DOE.

In FY 2003, funding for this effort was reduced by $47,936 for SBIR/STTR and transferred to the Science Appropriation.

Total, Fuels Technology..... **19,164** **16,494** **6,800**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Advanced Petroleum Based Fuels	
In Advanced Petroleum Based Fuels, research into the sensitivity of emission control after treatment to sulfur will be completed. Further development in this area is within the capabilities of industry to complete without government assistance. Additionally, terminate all activities related to fuels for light duty vehicles, focusing instead on heavy-duty vehicles not expected to be operated on hydrogen. Terminate activities associated with the West Virginia University transportable emissions laboratory and activities associated with the ReFuel Laboratory at NREL.....	-6,272
Non-Petroleum Based Fuels and Lubricants	
▪ **Medium Trucks**	
No activity is planned. Work in this area has supported natural gas engine/vehicle systems development and the technology is considered mature and ready for commercialization	-1,284

- **Heavy Trucks**

  No activity is planned. Work in this area has supported natural gas engine/vehicle systems development and the technology is considered mature and ready for commercialization ..... -1,383

- **Fueling Infrastructure**

  No activity is planned. Work in this area has supported natural gas engine/vehicle systems development and the technology is considered mature and ready for commercialization ..... -1,185

- **Renewable and Synthetic Fuels Utilization**

  Initiate evaluation of properties and performance of commercially-available, biomass-based fuels in terms of molecular make-up, effect on engine performance, and effect on overall fuel when blended with petroleum based fuels. Initiate development of a specification for biomass-based fuels with enough detail to ensure that such fuels, when blended with petroleum-based feedstocks, will not impose any adverse effects on engine performance..... +2,405

Total, Non-Petroleum Based Fuels and Lubricants..... -1,447

Environmental Impacts

In Environmental Impacts, terminate all activities because the work is aligned with the mission of the Environmental Protection Agency ..... -1,975

Total Funding Change, Fuels Technology ..... **-9,694**

Technology Introduction

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Technology Introduction					
Legislative and Rulemaking (formerly Energy Policy Act Replacement Fuels)					
State & Fuel Provider Fleet	750	746	1,000	+254	+34.0%
Private & Local Fleet	250	199	300	+101	+50.8%
Fuel Petitions	100	105	314	+209	+199.0%
Federal Fleets	500	507	700	+193	+38.1%
Regulatory Support	92	37	200	+163	+440.5%
Total, Legislative and Rulemaking (formerly Energy Policy Act Replacement Fuels)	1,692	1,594	2,514	+920	+57.7%
Testing and Evaluation					
Vehicle Evaluation	1,934	2,358	2,450	+92	+3.9%
Infrastructure Testing	50	98	50	-48	-49.0%
Total, Testing and Evaluation	1,984	2,456	2,500	+44	-1.8%
Advanced Vehicle Competitions	894	889	1,000	+111	+12.5%
Total, Technology Introduction	4,570	4,939	6,014	+1,075	+21.8%

Description

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 research and by industry and government. The primary functions of Technology Introduction include legislative and rulemaking supporting the Energy Policy Act of 1992 (EPAct) alternative fuel and fleet activities; testing and evaluation of advanced technology vehicles; and advanced vehicle competitions. As identified in the National Energy Policy, consumer education and demonstration activities are critical to accelerating the use of advanced energy technologies.

Benefits

The Technology Introduction subprogram contributes to the VT program goal by accelerating the adoption and use of alternative fuels and advanced technology vehicles. These fuels and vehicles will reduce the consumption of petroleum based fuels thus contributing to achieving the program goal.

Detailed Justification

(dollars in thousands)

FY 2003	FY 2004	FY 2005
Legislative and Rulemaking (formerly Energy Policy Act Replacement Fuels) **1,692**	**1,594**	**2,514**

The Legislative and Rulemaking activity consists of the State and Alternative Fuel Provider Regulatory Program, Fuel Petitions, Private and Local Government Fleet Regulatory Program, Federal Fleet requirements and 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 as well as the Department's compliance with the Federal fleet requirements. The Department also reviews and processes petitions to designate new alternative fuels under EPAct.

- **State & Fuel Provider Fleet**..... **750** **746** **1,000**

  In FY 2005, encourage State fleets to use more alternative fuel in their light-duty vehicles.

  Participants include: NREL.

- **Private & Local Fleet**..... **250** **199** **300**

  In FY 2005, initiate EPAct Section 509 Report to Congress on the Secretary's recommendations for requirements and incentives to encourage the purchase and use of replacement fuels and alternative fuel vehicles.

  Participants include: NREL.

- **Fuel Petitions** **100** **105** **314**

  In FY 2005, complete review and evaluation of non-domestically produced Fischer Tropsch diesel. Issue a final determination of alternative fuel designation.

  Participants include: NREL, ANL, ORNL

- **Federal Fleets**..... **500** **507** **700**

  Added to the legislative and rule-making portion of Technology Introduction. In FY 2004, this effort was part of the Testing and Evaluation activity. In FY 2005, conduct an in-depth analysis of the successes and challenges in agency compliance. Encourage interagency partnerships with EPAct and Executive Order 13149 requirements. Expand the Federal Automotive Statistical Tool for greater analysis capacity.

(dollars in thousands)

FY 2003	FY 2004	FY 2005

Participants include: INEEL, NREL, GSA.

- **Regulatory Support** **92** **37** **200**

  In FY 2005, complete analysis and report to Congress on the EPAct replacement fuel goals.
  Participants include: NREL, ANL, ORNL.

Testing and Evaluation **1,984** **2,456** **2,500**

The Testing and Evaluation activity, in partnership with industry, validates the performance and emissions of near market-ready advanced technology vehicles and makes results 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.

- **Vehicle Evaluation** **1,934** **2,358** **2,450**

  In FY 2005, complete testing of hybrid electric medium-duty delivery truck. Complete initial evaluation of a light-duty hydrogen fueled internal combustion engine vehicle. Expand baseline performance and accelerated reliability testing of new hybrid electric vehicles. Expand data collection on fuel cell transit buses. Initiate evaluation of an additional heavy-duty truck idle reduction device. Initiate fleet evaluation of light duty fuel cell vehicles.
  Participants include: INEEL, NREL, ANL, FTA, APTA, DOT ORNL, EPA.

- **Infrastructure Testing** **50** **98** **50**

  In FY 2005, complete evaluation and analysis of infrastructure/vehicle/operator interface for high pressure hydrogen refueling.
  Participants include: INEEL, Other Federal Agencies.

Advanced Vehicle Competitions **894** **889** **1,000**

Advanced Vehicle Competitions provide educational opportunities for university students to learn and use real-world engineering skills while demonstrating the performance of critical vehicle technologies identified by the Department of Energy and industry. In FY 2005, we will begin the first year of a three-year new competition, Challenge X, in partnership with General Motors. Selected teams will be challenged to integrate advanced vehicle technologies and appropriate fuels to develop an approach that minimizes use of petroleum fuel. Many 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. (FreedomCAR, $1,000,000). *Past Participants include: 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.*

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Total, Technology Introduction	**4,570**	**4,939**	**6,014**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Legislative and Rulemaking	
▪ **State & Fuel Provider Fleet**	
Assist States in developing compliance plans that increase alternative fuel use	+254
▪ **Private & Local Fleet**	
Initiate the development of EPAct Section 509 Report on recommendations for requirements or incentives for replacement fuels	+101
▪ **Fuel Petitions**	
Publish fuel petition submission guidelines and processes. Initiate fuel testing procedures at NREL	+209
▪ **Federal Fleets**	
Covers the additional cost needed to analyze and report the Federal compliance activities in the FY 2005 milestone year. This includes necessary upgrades to the FAST data collection system and additional training materials.	+193
▪ **Regulatory Support**	
Develop and propose changes to programs based on new technologies	+163
Total, Legislative and Rulemaking	**+920**
Testing and Evaluation	
▪ **Vehicle Evaluation**	
Expand the evaluation of advanced heavy truck idle reduction technologies, which have the potential to save every heavy truck that stops idling between 1,500 and 2,000 gal. of diesel/fuel annually.	+92
▪ **Infrastructure Testing**	
The evaluation of the interface between hydrogen fuel station dispenser, vehicle operator, and hydrogen-fueled internal combustion engine vehicle was successfully completed in FY 2004.	-48
Total, Testing and Evaluation	**+44**

	FY 2005 vs. FY 2004 ($000)
Advanced Vehicle Competitions	
Covers the additional cost for transitioning to a new competition with new schools and new sponsors.	+111
Total Funding Change, Technology Introduction	**+1,075**

Technical/Program Management Support

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Technical/Program Management Support					
Technical/Program Management Support	2,005	2,095	1,903	-192	-9.2%
Total, Technical/Program Management Support	2,005	2,095	1,903	-192	-9.2%

Description

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, and market evaluations of research. These activities provide important benefits directly to the VT Program described above and are therefore an integral part of the R&D program.

Benefits

Thorough sound analysis is necessary to support effective and efficient decisions, implementation, and management of the VT program's complex and challenging research program. Effective and efficient management actions will contribute to achieving the program goal by better managing R&D risk and by effective management of the R&D portfolio.

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Technical/Program Management Support	**2,005**	**2,095**	**1,903**

In FY 2005, preparation of program strategic plan and operating plans; R&D feasibility studies and trade-off analyses; evaluations of the impact of new legislation on R&D programs; analyses 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. (FreedomCAR, $865,000; 21CT, $938,000).

Participants include: Sentech, Antares, QSS.

Total, Technical/Program Management Support	**2,005**	**2,095**	**1,903**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Technical/Program Management Support	
Reduced need for technology program/management support due to increased efficiency and improved use of technology	- 192
Total Funding Change, Technical/Program Management Support	**-192**

Biennial FreedomCAR Peer Review

Funding Schedule by Activity

(dollars in thousands)

	FY 2003	FY 2004	FY 2005	$ Change	% Change
Biennial FreedomCAR Peer Review					
Biennial FreedomCAR Peer Review	0	494	0	-494	-100.0%
Total, Biennial FreedomCAR Peer Review	0	494	0	-494	-100.0%

Description

Benefits

Collaboration with outside experts to gain their perspectives is extremely appropriate and productive in helping to assure that the program's research directions and priorities are properly aligned with the needs of auto manufacturers equipment suppliers, energy companies, other Federal agencies, State agencies, consumers, and other stakeholders. Thus the program mission is supported by this subprogram through the greater assurance that the programs R&D investments are well selected and effectively managed.

Detailed Justification

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Biennial FreedomCAR Peer Review	**0**	**494**	**0**

Conduct a biennial review of the FreedomCAR Partnership by an independent third 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 direction. Based on this evaluation, resource availability, and other factors, the FreedomCAR partners will consider new opportunities, make adjustments to technology specific targets, and set goals as appropriate.

Conducted peer review in FY 2004; therefore no funds are requested in FY 2005. Funds are expected to be requested in FY 2006 for the next review.

(dollars in thousands)

	FY 2003	FY 2004	FY 2005
Total, Biennial FreedomCAR Peer Review	**0**	**494**	**0**

Explanation of Funding Changes

	FY 2005 vs. FY 2004 ($000)
Biennial FreedomCAR Peer Review	
Conducted biennial peer review in FY 2004; therefore, no funds are requested in FY 2005	-494
Total, Biennial FreedomCAR Peer Review	**-494**