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Field Operations Program: Overview of Advanced Technology Transportation

Update for CY 2002

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Field Operations Program—Overview of Advanced Technology Transportation, Update for CY 2002

In FY 2000, the U.S. Department of Energy's (DOE) Field Operations Program (FOP) produced a document that provided an overview of the transportation market in terms of energy use, vehicle sales, emissions, potential FOP partners, advanced technology vehicle availability, and other important factors. The document was intended to give a "snapshot" of current vehicle technologies and trends. DOE program managers use the document to plan test and evaluation activities that focus resources where they have the greatest impact. In 2001, an update to the original document was published. This document is the update for CY 2002. All of these publications are available at www.ott.doe.gov/otu/field_ops/prog _info.html.

The information in this document is based on several sources, which are listed in the Appendix. Most of the statistics came from the following sources:

- The Energy Information Administration's (EIA) *Annual Energy Review*, *Monthly Energy Review*, and *Alternatives to Traditional Transportation Fuels;*
- *Transportation Energy Data Book* (edition 21), published by DOE's Oak Ridge National Laboratory; and
- The U.S. Environmental Protection Agency's (EPA) National Air Pollution Emissions Trends Web site, www.epa.gov/ttn/chief/trends/index.html.

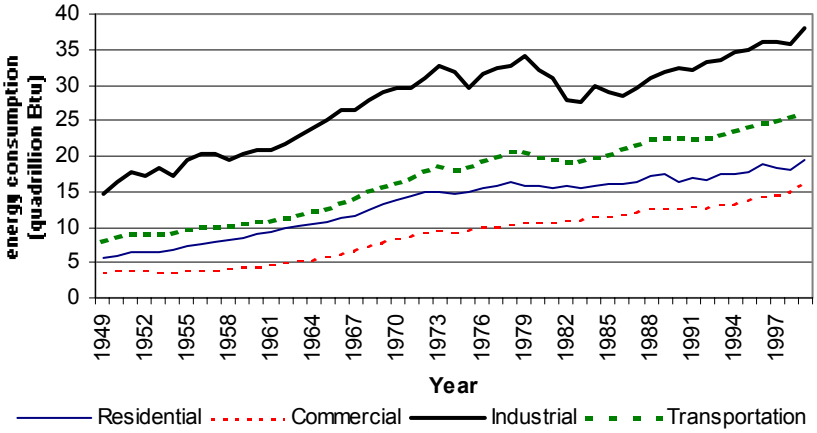
These publications are usually produced annually. We used the most recent volumes available. The information on advanced technology vehicles in development came from various sources, including vehicle manufacturers and news services. Because this information changes daily, we set February 1, 2002, as the cut-off date for inclusion in this document. However, the vehicle tables will be updated on a quarterly basis and posted as separate documents on the Internet at www.ott.doe.gov/otu/field_ops/prog_info.html.

Transportation Energy Use

The transportation sector in the United States is a major consumer of energy. Figure 1 shows the total U.S. energy consumption from 1950 to 2000, categorized by transportation, residential, commercial, and industrial consumption. During 2000, transportation accounted for approximately 27% of the total energy consumption of 98.5 quadrillion Btu/year (source: EIA's *Annual Energy Review*). This is a 1.7% increase over total energy use for 1999.

Figure 1. Energy Use by Sector

(Source: EIA's *Annual* and *Monthly Energy Review*)



While U.S. petroleum consumption has steadily increased, domestic production of petroleum has decreased. Figure 2 shows the dramatic difference between consumption and production. Although the gap only increased by 0.07% from 1999 to 2000, the average increase since 1985 was 4.5% per year. The balance of petroleum consumed by the U.S. is imported. According to EIA's *Monthly Energy Review*, nearly 59% of the petroleum consumed in the U.S. during 2000 (19.5 million barrels per day) was imported. In 2000, 45.4% of the total U.S. petroleum imports came from OPEC countries. (Table A in the Appendix lists U.S. petroleum imports by country.)

Figure 2. U.S. Petroleum Consumption vs Production

(Source: EIA's *Annual Energy Review*)

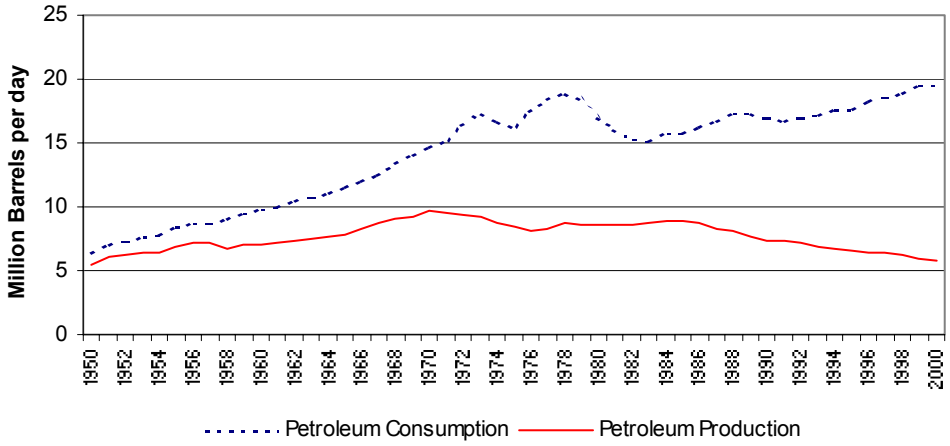
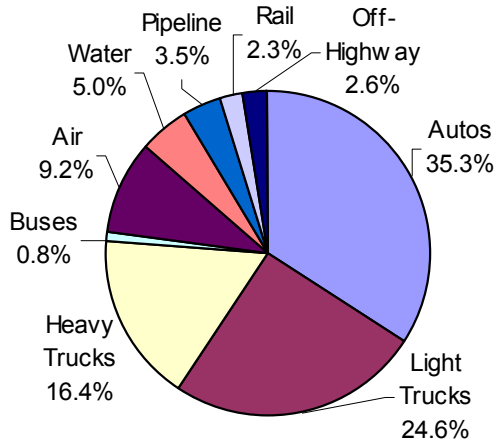
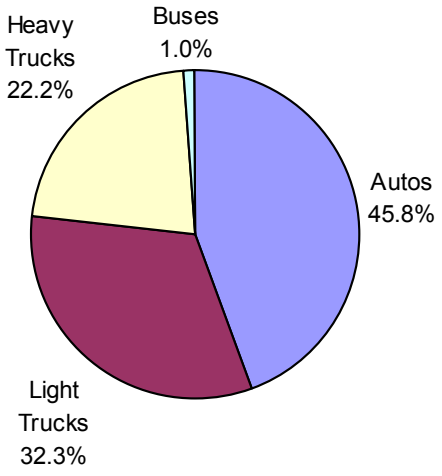


Figure 3. Transportation Energy Use by Mode (total = 26.7 trillion Btu - 1999)



(Source: *Transportation Energy Data Book 21-2001*)

Figure 4. Highway Energy Use by Mode (total = 20.5 trillion Btu - 1999)

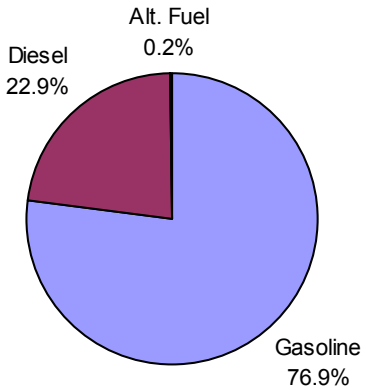


(Source: *Transportation Energy Data Book 21-2001*)

Figure 3 shows that in 1999, highway vehicles (including automobiles, heavy-duty and light-duty trucks, and buses) accounted for 77% of total transportation energy use. This is a slight decrease from the previous year. Figure 4 gives the breakdown of highway energy use by mode for 1999. The mix of vehicle types hasn't significantly changed since 1998.

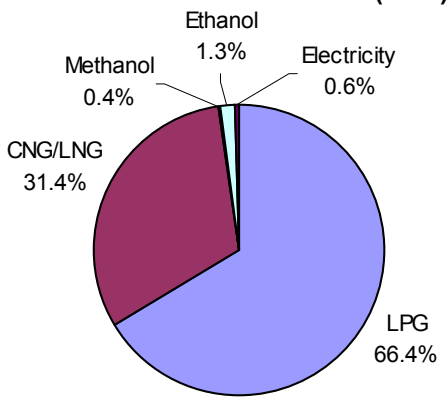
In 2001, an estimated 164 billion gallons of fuel were consumed in the U. S.—an increase of 1.5% over the previous year. Figure 5 shows the breakdown of fuel use by fuel type. Gasoline continues to make up approximately 77% of the fuel consumed. This percentage includes oxygenated fuels (methyl tertiary butyl ether [MTBE] and ethanol), which make up about 3% of the gasoline total. Diesel fuel comprises 22.9% of total vehicle fuel consumption during 2001.

Figure 5. Estimated Consumption of Fuels in the US (2001)



(Source: EIA's *Alternatives to Traditional Transportation Fuels*)

Figure 6. Estimated Consumption of Alternative Fuels in the US (2001)



(Source: EIA's *Alternatives to Traditional Transportation Fuels*)

Figure 6 breaks down alternative fuel use by type of fuel. Although alternative fuel makes up only 0.2% of the total fuel consumed in the United States, alternative fuel use has increased by about 4% per year during the past four years. Table 1 shows the percent difference in alternative fuel use for the past four years by

fuel type. Use of natural gas has increased steadily since 1997. Ethanol use continues to climb mainly because of the production of original equipment manufacturer (OEM) vehicles that are E85 compatible as standard and an increase in fueling stations offering E85. The majority of these new E85 stations are located in the Midwest. Electric vehicle use is also growing, especially in California where more than 16% of the total U.S. alternative fuel vehicles (AFVs) reside.

Table 1. Percent Difference in Alternative Fuel Use Since 1997

Fuel	Percent difference from previous year			
	1998	1999	2000	2001
LPG	1.35	0.23	0.23	0.21
CNG/LNG	14.06	17.2	13.35	10.18
Ethanol (E85+neat ethanol)	-26.08	19.48	59.23	36.14
Electricity	19.01	19.05	27.11	17.8
Overall	3.91	4.47	4.25	3.55

(Source: EIA's *Alternatives to Traditional Transportation Fuels*)

Vehicle Stock and Yearly Sales

The Federal Highway Administration estimates that approximately 221 million vehicles (including automobiles, trucks, and buses) were in use in the U.S. during 2000. The majority of these vehicles were used for personal transportation, while only 6% were fleet vehicles. Figures 7a and b show the annual sales of vehicles for 1999 through 2001. Sales of automobiles and light trucks in 1999 broke the previous record set in 1986. Sales for 2000 were 2.7% higher than 1999. Despite predictions of low sales in 2001, light-duty vehicle sales were only 1.3% lower than in 2000. Automobiles as a group lost sales by nearly 4%, while light-duty trucks gained by 1.4%. The percentage of automobile verses light-duty trucks was nearly equal: 50.4% automobiles, 49.6% light-duty trucks. Sales of heavy-duty trucks (class 4 -8) declined by 25% in 2001, with the class 8 sector being hardest hit at 34% lower than 2000 figures.

Figure 7a. Vehicle Annual Sales - Light- & Medium-Duty

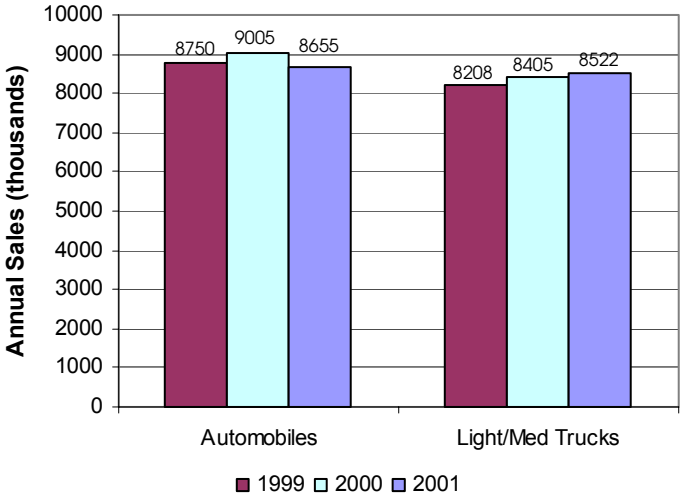
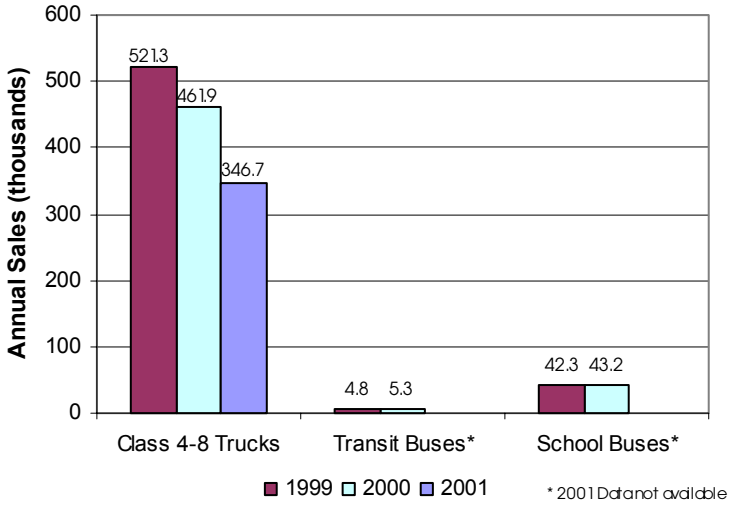


Figure 7b. Vehicle Annual Sales - Heavy-Duty



(Sources: *Automotive News Magazine*, American Public Transportation Association, and *School Bus Fleet Magazine*)

Alternative Fuel Vehicles

The use of AFVs has seen a slow but steady increase over the last decade. In 2000, an estimated 432,344 AFVs were in use in the U.S., representing an average 7% increase per year since 1992. Table 2 lists the

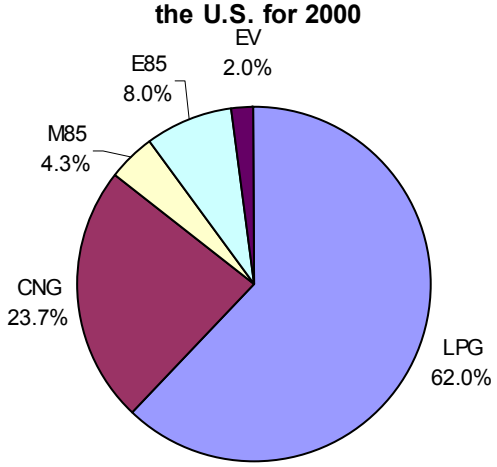
number of AFVs in the U.S. by fuel type and census region for 2000. Figure 8 breaks down the percentages of AFVs in use in 2000 by fuel type. Propane (or LPG) vehicles make up the bulk of AFVs at 62%. This includes original equipment manufacturer (OEM) products as well as aftermarket conversions. The second most common fuel used is natural gas, including compressed natural gas (CNG) and liquefied natural gas (LNG), which makes up 23.7% of the total. Alcohol-fueled vehicles that run on methanol and ethanol make up a combined 10.3% of the total AFVs, and electric vehicles (EVs) make up only 2%. According to EIA, the number of E85 compatible vehicles is around 34,700, a number that is deceptively low. Since 1998, most of the major OEMs have been producing certain models with an E85 engine as standard. The EIA counts include only vehicles that are intended to be used as flex-fuel vehicles. The National Ethanol Vehicle Coalition estimates that more than 2 million E85 vehicles will be on the road by the end of the 2002 model year.

Table 2. Estimated Number of Alternative Fuel Vehicles in the U.S. by Census Region, 2000

Region	LPG	CNG/LNG	Methanol	Ethanol	Electric Vehicles	Total by Region
Northeast	28,000	14,447	889	2,511	1067	46,914
South	100,000	32,682	832	10,738	2,144	146,396
Midwest	76,000	14,746	1,032	15,308	696	107,782
West	64,000	40,555	15,807	6,136	4,754	131,252
Total by Fuel	**268,000**	**102,430**	**18,560**	**34,693**	**8,661**	**432,344**

(Source: EIA's *Alternatives to Traditional Transportation*)

Figure 8. Estimated Percent of AFVs in the U.S. for 2000



(Source: EIA's *Alternatives to Traditional Transportation Fuels*)

The total number of stations offering alternative fuel increased by 4.4% over the last year. Table 3 shows the number of alternative fueling stations in the U.S. by fuel and census region. According to DOE's Alternative Fuels Data Center (AFDC), 5,443 fueling stations offered alternative fuels as of January 28, 2002. Stations offering E85 and electric charging stations saw an increase of nearly 31%. Methanol as a vehicular fuel has been decreasing over the past few years as a result of M85 products no longer being available. There are no longer any stations in the U.S. offering M85 fuel. Biodiesel is a fuel that has increased in popularity, mainly because the 20% blend of the fuel (B20) can be used in unmodified diesel engines.

Table 3. Number of Fueling Stations by Census Region and Fuel Type (as of 1/28/02)

Region	LPG	CNG	LNG	E85	Electricity	Biodiesel	Total
Northeast	378	190	1	0	50	1	620
South	1,277	394	17	10	141	2	1,841
Midwest	803	197	7	123	10	2	1,142
West	949	453	19	12	400	7	1,840
Total	3,407	1,234	44	145	601	12	5,443

(Source: www.afdc.doe.gov)

Currently, 28 light-duty OEM AFV models are available in the United States. These models operate on a variety of fuels, including CNG, LPG, electricity, and ethanol. Manufacturers are producing AFVs in all body styles to meet various fleet needs, from small two-seaters to full-size trucks and vans. For a list of AFVs available in the U.S. for model year 2002, see Table B in the Appendix.

Alternative fuel and advanced technology heavy-duty vehicles are also available. The major engine manufacturers currently offer 20 alternative fuel engines (see Table C in the Appendix). This number includes natural gas and LPG fueled engines. Bus and heavy-duty truck manufacturers use these engines in a wide variety of vehicles.

Emissions

As shown in Table 4, the transportation sector accounts for a large share of the national emissions of criteria pollutants. Highway vehicle emissions are somewhat less but still make up a significant portion of the overall contribution. These percentages are similar to the previous year.

Table 4. Transportation Share of U.S. Emissions in 1999
(Source: EPA's Air Pollution Trends Web site, www.epa.gov/ttn/chief/trends/index.html)

Pollutant	Highway's Share of All Emissions (%)
CO	51.3
NO_x	33.8
VOC	29.2
PM10	1.3
PM2.5	3.4
SO_2	1.9
NH_3	5.2

Figures 11a-11d show emissions of highway vehicles broken down by class. Light-duty automobiles and trucks account for the majority of CO and VOC emissions and a little over half the NO_x emissions, according to EPA's emission inventory. Heavy-duty trucks account for more than half the PM emissions.

Figure 11a. Highway CO Emissions

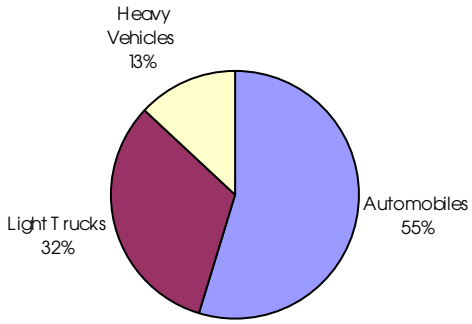


Figure 11b. Highway NOx Emissions

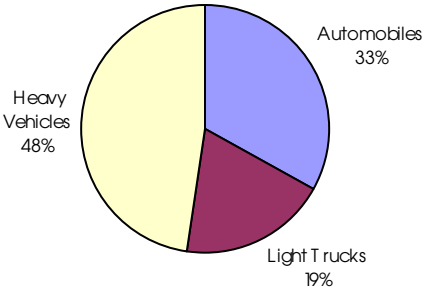


Figure 11c. Highway VOC Emissions

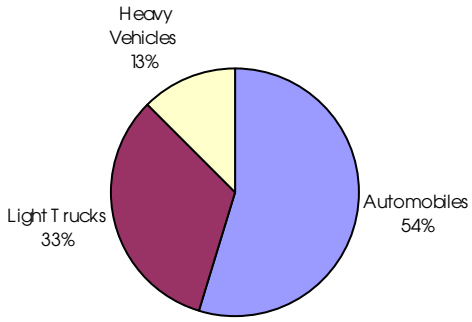
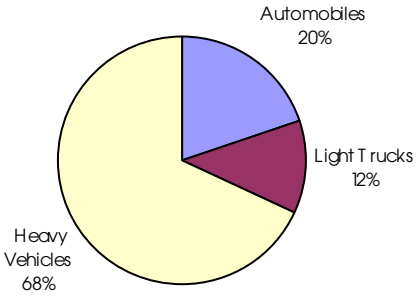


Figure 11d. Highway PM10 Emissions



(Source: EPA's Air Pollution Trends web site, www.epa.gov/ttn/chief/trends/index.html)

Advanced Technology Vehicles

The following sections provide a snapshot of the current market of advanced technology vehicles (ATVs). The tables contain an update to those provided in the original document and concentrate on the vehicles most likely to be available in the U.S. market. For a more complete listing of ATVs around the world, refer to the companion tables on the Internet at www. ott.doe.gov/otu/field_ops/prog _info.html.

Definitions of the terms used to describe the development stage of a given vehicle vary from manufacturer to manufacturer. For the purpose of this document, the following definitions apply:

- *Research* – In the early stages of development (drawings or models).
- *Concept* – An actual vehicle, usually operational, used by the manufacturer as a display or show vehicle.
- *Prototype* – A working vehicle, very close to a production model.
- *Demonstration* – Limited production of the vehicle being tested by the manufacturer in a real-world application.
- *Production* – Available to the public.

Hybrid Electric Technology

Light-Duty Vehicles

Automotive manufacturers continue to work on hybrid technology, especially for the light-duty market. Second year sales of the two hybrids introduced in the U.S. market, the Toyota Prius and the Honda Insight, were higher than in 2000. Sales of the Toyota Prius increased by 40% versus 2000. Sales of the Prius passed 14,000 units since its introduction in July 2000. Sales of the Honda Insight were up 25% versus 2000 totals, totaling 4,726 during 2001.

Table 5 lists the hybrid vehicles in production, as well as the most recent vehicles introduced in the past few years. (For more information on these and other light-duty hybrid vehicles introduced around the world, refer to the companion tables on the Internet.) Several new hybrid vehicles have been developed and introduced in the past year and more are reaching the market. The Honda Civic HEV is planned to go on sale in spring of 2002. As Honda's second hybrid vehicle to market, the Civic is expected to do well. Ford's hybrid version of their popular Escape SUV is expected to hit the market in early 2003. Notable examples of hybrids announced in the past year include the General Motors (GM) Silverado/Sierra pickup, the Daihatsu UFE, and the Toyota ES3. GM's HEV Sierra is expected to be the first hybrid available as a full size truck. Designed with the full power and towing capacity of a typical truck, the HEV Sierra is expected to have approximately 20% better fuel economy. GM plans to produce the truck for the 2004 model year (MY). Daihatsu introduced its UFE (Ultra Fuel Economy) at the Tokyo Motor Show in October 2001. This ultra-light four-seat coupe uses a direct injection gasoline engine and achieves 129 mpg. Toyota introduced the ES3 sedan at the Frankfort Auto Show in September of 2001. The ES3 (Eco Spirit Cubic) uses a 1.4 liter, direct injection, turbo diesel engine that achieves 88 mpg. The vehicle runs on ultra low sulfur diesel and employs the latest catalytic converter technology to reduce both NOx and PM. The hybrid system on this vehicle uses ultracaps to capture braking energy.

Table 5. Light-Duty Hybrid Electric Vehicles

OEM	Model	Body Style	Power Type	Fuel	Development Stage	Date Introduced/ Announced	Projected Production Date
Accura	RD-X	SUV	Hybrid	Gasoline	Concept	Jan-02	Not available
DaimlerChrysler	Durango	SUV	Hybrid	Gasoline	Prototype	Oct-00	2003
Daihatsu	UFE	Coupe	Hybrid	Gasoline	Concept	Oct-01	Not available
Dodge	PowerBox	SUV	Hybrid	CNG	Concept	Jan-01	Not available
Dodge	Ram Pickup Contractor Special	Truck	Hybrid	Gasoline or diesel	Prototype	Nov-00	2004
Ford	Escape	SUV	Hybrid	Gasoline	Demonstration	Jan-01	2003
General Motors	Silverado/Sierra	Truck	ParadiGM Hybrid	Gasoline		Jan-01	2004
Honda	Civic	Sedan	IMA[1] hybrid	Gasoline	Production	Jan-00	2002
Honda	Insight	Coupe	IMA[1] hybrid	Gasoline	Production	Dec-99	2000
Honda	DualNote	Sports car	IMA[1] hybrid	Gasoline	Concept	Oct-01	Not available
Hyundai	Santa Fe	SUV	Series hybrid	Gasoline	Prototype	Oct-00	2003
Toyota	HV-M4 (Estima)	Minivan	Parallel hybrid	Gasoline	Production	Oct-99	In Japan only
Toyota	Prius	Sedan	Parallel/series hybrid	Gasoline	Production	Jun-00	2000
Toyota	ES3	Sedan	Mild Hybrid	Diesel	Concept	Sep-01	Not available
Mazda	MX Sport Tourer	Sedan	Parallel hybrid	Gasoline	Concept	Feb-01	Not available

[1] Integrated Motor Assist

Heavy-Duty Vehicles

While the light-duty market for hybrid vehicles consists of many prototypes and a few models commercially available on a limited basis, the heavy-duty hybrid market is characterized by multiple projects involving small numbers of vehicles in development. The past two years has seen an increase in numbers of heavy-duty vehicles on order. According to the APTA 2001 Vehicle Databook, there were 42 hybrid buses in active service as of January 1, 2001, with more than 400 on order and a potential for approximately 100 more. Table 6 lists some of the more significant heavy vehicle projects. DOE's Office of Heavy Vehicle Technologies and the Field Operations Program at the National Renewable Energy Laboratory (NREL) are conducting an evaluation of New York City Transit's hybrid buses. The results are expected to be released in early 2002 through the AFDC Web site at www.afdc.doe.gov, or by calling 1-800-423-1DOE.

Table 6. Heavy-Duty Hybrid Electric Vehicles

Project	Vehicles Deployed	Hybrid Type	Vehicle Type	Fuel Used	Project Start Date	No. in Project	Status of Project
APS/El Dorado EZ Rider 300		Series	Bus	Various			Active
AVS/Arizona	Tempe AZ	Parallel	Shuttle bus	LNG	Feb-01	31	Ordered
AVS/Arizona	Tampa, FL	Parallel	Shuttle bus	Diesel	Feb-01	10	Ordered
AVS/Capstone	Tampa, FL	Parallel	Bus	CNG/LNG	in devel.	10	Ordered
AVS/Capstone	Chattanooga Area RTA	Series	Bus	CNG	8/99 (on order)	7	
AVS/PEI/UQM	CARTA		Paratransit		2000	6	Ordered
AVS/PEI/UQM	CARTA		Paratransit		2000	3	Ordered
AVS/PEI/UQM	CARTA		Shuttle		2000	1	Ordered
AVS/Solectria	Falls Church, VA		Shuttle		2000	4	Ordered
Blue Bird/H-Power	Sacramento Municipal Facility		Paratransit		2000	1	Ordered
Blue Bird/Solectria	TBD		School			1	Ordered
Cedar Rapids Electric Transit Consortium	Cedar Rapids, IA		Bus	Diesel	Sep-96	4	Active
Electric Fuel Corp/NovaBUS	Clark County, Nevada		Bus	Battery/battery system	Late 98	1	Active
Flexible	Cleveland RTA	Series	Bus	Natural gas			Active
Gillig/Enova			Bus		Test & eval. by 2001		
GM Allison/Gillig		E^p parallel	Bus	Diesel			Active
GMC	San Francisco, CA MUNI		Truck	Diesel	in devel.	2	
ISE Research Military Tractor		Series	Military tractor	Diesel	May-99		
ISE Research/El Dorado	Los Angeles DOT		Paratransit		2000	4	Ordered
ISE Research/El Dorado RE-29-E	Los Angeles DOT	Series	Bus	Propane	Mar-99	5	Active
ISE Research/New Flyer	Omnitrans, San Bernadino, CA	Series	Bus	CNG	Mar-00	5	Ordered
ISE Research/Peterbilt	LA	Parallel	Truck (class 8)	CNG/LNG	Jun-99	1	
Navistar MD Truck	UPS: NY, Atlanta, LA	Series	Truck	Diesel	Jun-98		
New Flyer/Allison	OCTA	E^s series	Bus	Diesel	Dec-00	1	Active
Nova Bus/ISE Research	LA - Foothills Transit		Transit		2001	1	Ordered
Orion	San Francisco, CA MUNI		Bus	Diesel	in devel.	2	Active
Orion IV Hybrid Bus	NYC MTA, NJ	Series	Bus	Diesel	Sep-98	10	Active
Orion VII/BAE	New York		Bus	Diesel		200	Ordered
Orion/BAE	Minneapolis, MN		Transit		2001	5	Ordered
Orion/BAE	NYCT		Transit		2001	125	Ordered
Orion/Lockheed Martin	Boston, MA		Bus	Diesel	May-99	2	Active
TDM/UQM/Siemens	Warner Robbond AFB, GA		Shuttle		1999	8	Active
Transportation Techniques (Transteq)	Denver RTD	Series	Mall shuttle bus	CNG	Oct-98	36	Active
Volvo Trucks/U.S. Army	Army's Tank-Automotive & Armaments Command		Truck (class 8)	Diesel	Dec-00	1	

Fuel Cell Technology

Light-Duty Vehicles

Most manufacturers continue to develop prototype vehicles powered by fuel cells. Table 7 lists some of the models introduced in the past few years, some of which are currently being tested in California at the California Fuel Cell Partnership (CaFCP).

Table 7. Light-Duty Fuel Cell Vehicles

OEM	Model	Body Style	Demo at CaFCP?	Fuel Cell Type	Fuel Type	Development Stage	Date of Introduction	Projected Production Date
Daihatsu	MOVE FCV	Microvan		PEM	Methanol			
DaimlerChrysler	NECAR 4	Sedan	➳	PEM	Hydrogen	Prototype	1999	2004
DaimlerChrysler	NECAR 5	Sedan	➳	PEM	Methanol	Concept	2000	2004
DaimlerChrysler	Natrium	Minivan		PEM	Sodium Boro-hydride	Concept	Dec-2001	
Ford	FC5	Sedan	➳	PEM	Methanol	Concept	Sep-99	2004
Ford/Th!nk	Focus	Sedan		PEM	Methanol	Demonstration		2004
Ford/Th!nk	P2000	Sedan	➳	PEM	Hydrogen	Prototype		
GM/Opel	Zafira	Minivan			Methanol	Concept	1997	2004
GM/Opel	Zafira 2nd gen.	Minivan			Liquid hydrogen	Concept	1998	
GM	Autonomy	sports coupe				Concept	Jan-02	
GM	S-10	Truck			gasoline	Concept	Aug-01	
Honda	FCX-V3	Sedan	➳	PEM	Hydrogen	Prototype	Sep-00	2003
Hyundai	Santa Fe	SUV	➳	PEM	Hydrogen			
Jeep	Commander 2	SUV		PEM	Methanol	Concept	Oct-00	
Mazda	Demio FCEV	Sedan/wagon		PEM	Hydrogen	Prototype	Dec-97	
Mazda	Premacy FC-EV	Sedan/wagon		PEM	Methanol	Prototype	Feb-01	Testing in Japan 2/15
Mitsubishi	FCV	Sedan			Methanol	Concept		2003-2005
Nissan	Xterra	SUV	➳	PEM	Methanol			
Toyota	FCHV V4	SUV	➳		Hydrogen	Demonstration		2003
Toyota	FCHV V5	SUV			Methanol	Demonstration		2003
Toyota	FCHV V3	SUV		PEM	Hydrogen	Prototype	Feb-01	Test 2001
Volkswagen	Bora HyMotion	Sedan	➳		Hydrogen	Demonstration		

Heavy-Duty Vehicles

Fuel cell vehicles continue to be developed for the heavy-duty market. The majority of fuel cell projects to date use transit buses. Table 8 lists projects involving fuel cell heavy vehicles, including projects underway in Europe. For a more complete list of heavy-duty fuel cell projects, see the companion tables at www.ott.doe.gov/otu/field_ops/prog_info.html.

Several U.S. transit agencies are in the process of procuring fuel cell buses for demonstration programs required by the California Air Resources Board. AC Transit of Oakland, Calif., and SunLine Transit Agency of Thousand Palms, Calif., are finalizing plans to order several fuel cell buses for this demonstration. DOE through NREL is working with both agencies to evaluate this new technology.

Table 8. Heavy-Duty Fuel Cell Vehicles

Project Partners	Deployed	Vehicle Type	Fuel	Type	Length	Project Start Date	No. in Project
DaimlerChrysler Citaro/Ballard (P5 bus)	Nine European Cities and Perth, AU	Bus	Hydrogen	PEM	40 ft	Early 2002	30
DOE/FTA/ Georgetown Univ.	Gainesville, Fla.	Bus	Methanol	PAFC	30 ft	R&D testing 93	3
Georgetown/NovaBUS	Unknown	Bus	Methanol	PEM	40 ft		
IFC/Thor/ISE Research	SunLine, Thousand Palms, Calif.	Bus LF	Hydrogen	PEM	30 ft	Early 2002	1
Global Environment Facility	Brazil, Egypt, India, China, Mexico	Bus	Hydrogen			begin '02 to '03	40 to 50
Hino/Toyota FCHV-BUS1	In testing by manufacturer	Bus LF	Hydrogen	PEM	40 ft	prototype	

Additional Projects/Developments

Several developments in the last year could have an effect on advanced technology and AFVs in the United States. Of note are:

California Air Resources Board (CARB) Zero Emission Vehicle (ZEV) Mandate – In January 2001, CARB adopted a credit program to provide OEMs extra credit for placing ZEVs before the required date of the ruling. This was to encourage early placement of EVs into the market. The credit program would give an automaker multiple credits for selling small neighborhood electric vehicles prior to the start of the ruling. Concerns were made that these credits would allow an OEM to meet their mandate without selling a full-scale EV. In December of 2001, CARB modified the ruling to limit how auto manufacturers use advance credits to offset actual ZEV sales. CARB also announced that SUV, minivan, and pickup sales would count toward the baseline calculation of each OEMs vehicle sales. This means that the total number of EVs required by the mandate will be larger that previously expected.

Studies Link Pollution to Birth Defects and Asthma – Several studies released in 2001 show evidence of health effects of vehicular pollution. A study released by University of California-Los Angeles in December showed a link between air quality and infant birth defects. This article was published in the *American Journal of Epidemiology*. Results from another study by the University of California-Davis supports the idea that asthma in children and adults might be related to living in areas with poor air quality. Studies such as these could lead to increased air quality legislation.

CLEAR ACT Introduced – A bill was introduced to Congress to spur the use of vehicles that operate on alternative fuels as well as efficient advanced automotive technology. The Clean Efficient Automobiles Resulting from Advanced Car Technologies or CLEAR ACT would give credits to purchase efficient automobiles, such as fuel cell and hybrids; credits for AFVs; credits for alternative fuel use; and credits for installation of residential or retail fueling infrastructure.

Summary

The focus, direction, and funding of transportation programs and the marketplace for advanced technologies is continually changing and developing. Understanding these trends within the context of today's marketplace is critical to focusing public and private resources where they can have the most impact. Key points from this document include:

- The gap between U.S. consumption and production of petroleum is widening at the rate of 4.5% per year (average from 1985 through 2001).
- Light-duty trucks and automobiles continue to be the major consumer with respect to transportation energy use.
- Alternative fuel use continues to increase by 4% each year. This is insignificant compared to the increasing gap between production and consumption of petroleum.
- The number of alternative fuel stations increased by 4.4% versus the previous year.
- There is significantly more development in hybrid electric vehicles and fuel cell electric vehicles for light-, medium-, and heavy-duty vehicle markets.
- Fuel cells and hydrogen appear to be the vision of the future from the auto industry perspective.

Appendix

Table A. Average U.S. Petroleum Imports in 2000 by Source (thousand barrels per day)

Country	Affiliation	2000
Angola	Non-OPEC	301.42
Australia	Non-OPEC	55.97
Bahamas	Non-OPEC	0.00
Brazil	Non-OPEC	51.48
Canada	Non-OPEC	1806.97
China	Non-OPEC	44.10
Colombia	Non-OPEC	341.66
Ecuador, Non-OPEC	Non-OPEC	127.93
Gabon (Non-OPEC)	Non-OPEC	143.41
Italy	Non-OPEC	30.28
Malaysia	Non-OPEC	45.49
Mexico	Non-OPEC	1372.98
Netherland Antilles	Non-OPEC	90.00
Netherlands	Non-OPEC	29.96
Norway	Non-OPEC	343.49
Puerto Rico	Non-OPEC	14.71
Spain	Non-OPEC	24.56
Trinidad and Tobago	Non-OPEC	85.15
U.S.S.R.	Non-OPEC	72.08
United Kingdom	Non-OPEC	365.57
Virgin Islands	Non-OPEC	291.48
Bahrain	Non-OPEC	0.83
Iran	OPEC	0.00
Iraq	OPEC	619.68
Kuwait	OPEC	271.90
Qatar	OPEC	8.64
Saudi Arabia	OPEC	1571.79
United Arab Emirates	OPEC	15.14
Algeria	Other OPEC	224.99
Indonesia	Other OPEC	48.10
Libya	Other OPEC	0.00
Nigeria	Other OPEC	896.39
Venezuela	Other OPEC	1546.08
	Total Persian Gulf	2487.97
	Total Imports	11459.25

(Source: EIA's *Monthly Energy Review)*

Table B. Light-Duty AFVs Available in Model Year 2001 (including EVs)

Manufacturer	Model	Fuel	Design	Body
DaimlerChrysler	Voyager/Caravan/ Town & Country	E85	FFV	Minivan
Dodge	Ram van/wagon	CNG	Dedicated	Van
Ford	F-series	CNG	Bi-fuel	Truck
Ford	Crown Victoria	CNG	Dedicated	Sedan
Ford	F-series	CNG	Dedicated	Truck
Ford	Econoline	CNG	Dedicated	Van/wagon
Ford	Taurus	E85	FFV	Sedan
Ford	Explorer, Explorer Sport/Sport Track	E85	FFV	SUV
Ford	F-series	LPG	Bi-fuel	Truck
Ford	Ranger	EV	Dedicated	Truck
Ford	Ranger	E85	FFV	Truck
Ford	F-series Super Duty	LPG	Bi-fuel	Truck
Ford	E-series Cutaway	CNG	Dedicated	Van
Ford/Th!nk	Th!nk City	EV	Dedicated	2-seater
GM/Chevrolet	Sierra/ Silverado	CNG	Bi-fuel	Truck
GM/Chevrolet	Sierra/ Silverado	CNG	Dedicated	Truck
GM/Chevrolet	Cavalier	CNG	Bi-fuel	Sedan
GM/Chevrolet	Yukon/Tahoe	E85	FFV	SUV
GM/Chevrolet	Yukon XL/Suburban	E85	FFV	SUV
GM/Chevrolet	Sonoma /S-10	E85	FFV	Truck
GM/Chevrolet	Savana/Express	CNG	Bi-fuel	Van
GM/ Chevrolet	Medium-duty truck	LPG	Dedicated	Truck
Honda	Civic GX	CNG	Dedicated	Sedan
Mazda	B2000	E85	FFV	Truck
Nissan	Altra	EV	Dedicated	Sedan
Solectria	Citivan	EV	Dedicated	Van
Toyota	Camry	CNG	Dedicated	Sedan
Toyota	Rav4	EV	Dedicated	SUV

(Source: www.afdc.nrel.gov/afvehicles.html)

Table C. Heavy-Duty Alternative Fuel Engines Available

Manufacturer	Model	Displacement	Fuel	HP	Torque
Cummins Westport	B5.9G 230	5.9	CNG/LNG	230	500
Cummins Westport	B5.9G 195	5.9	CNG/LNG	195	420
Cummins Westport	B5.9G 150	5.9	CNG/LNG	150	375
Cummins Westport	B5.9LPG	5.9	CNG/LNG	195	420
Cummins Westport	C8.3G Plus 275	8.3	CNG/LNG	275	750
Cummins Westport	C8.3G Plus 250	8.3	CNG/LNG	250	660
Cummins Westport	C8.3G Plus 280	8.3	CNG/LNG	280	850
John Deere	6068H	6.8	CNG	225	640
John Deere	6081H 250	8.1	CNG	250	800
John Deere	6081H 280	8.1	CNG	280	900
Detroit Diesel	Series 50G	8.5	CNG/LNG	275	890
Detroit Diesel	Series 60G 330	12	CNG/LNG	330	1400
Detroit Diesel	Series 60G 400	12	CNG/LNG	400	1450
Mack	E7G-325	12	CNG/LNG	325	650
Mack	E7G 325	12	CNG/LNG	325	1180
Mack	E7G-350	12	CNG/LNG	350	1250
Caterpillar	3126B	7.2	CNG/LNG dual fuel	190	520
Caterpillar	3126B	7.2	CNG/LNG dual fuel	250	640
Caterpillar	C10	10.3	CNG/LNG	305	1050
Caterpillar	C12	12	CNG/LNG	410	1250

(Source: DOE OTT Heavy Vehicle and Engine Resource Guide. For more information, visit www.ctts.nrel.gov/heavy_vehicle/library.html.)

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