V. SAFETY, ENERGY, AND ENVIRONMENTAL IMPLICATIONS OF FREIGHT TRANSPORTATION

Growing demand for freight transportation heightens concerns about its safety, energy consumption, and environmental impacts. While safety in all freight modes continues to be monitored actively, the environmental implications of freight transportation only recently have been considered separately from passenger travel. At the same time, the availability of energy consumption data has declined with the demise of the Vehicle Inventory and Use Survey.

Table 5-1. Fatalities by Freight Transportation Mode: 1980-2009

	1980	1990	2000	2008	2009
Total transportation fatalities (passenger and freight)	**NA**	**47,350**	**44,384**	**NA**	**NA**
Highway (passenger and freight)	**51,091**	**44,599**	**41,945**	**(R) 37,423**	**33,808**
Large truck occupants[1]	1,262	705	754	(R) 682	503
Others killed in crashes involving large trucks	4,709	4,567	4,528	(R) 3,563	2,877
Large truck occupants[1] (percent)	2.5	1.6	1.8	1.8	1.5
Others killed in crashes involving large trucks (percent)	9.2	10.2	10.8	9.5	8.5
Railroad (passenger and freight)	**1,417**	**1,297**	**937**	**800**	**703**
Highway-rail crossing[2]	833	698	425	(R) 289	245
Railroad[2,3]	584	599	512	(R) 511	458
Waterborne (passenger and freight)	**487**	**186**	**111**	**109**	**185**
Vessel-related[4]	206	85	42	56	54
Freight ship	8	0	0	0	1
Tank ship	4	5	0	0	1
Tug/towboat	14	13	1	5	3
Offshore supply	NA	2	0	0	0
Fishing vessel	60	47	26	25	25
Mobile offshore drilling units	NA	0	0	4	1
Platform	NA	1	0	0	0
Freight barge	NA	0	0	1	0
Tank barge	NA	0	0	0	0
Miscellaneous[5]	56	11	15	21	23
Not vessel-related[4]	281	101	69	53	131
Pipeline	**19**	**9**	**38**	**(R) 8**	**14**
Hazardous liquid pipeline	4	3	1	2	4
Gas pipeline	15	6	37	(R) 6	10

Key: NA = not available; R = revised.
[1]Large trucks are defined as trucks over the 10,000 pound gross vehicle weight rating, including single-unit trucks and truck tractors.
[2]Includes Amtrak.
[3]Includes train accidents and other incidents. Most fatalities involve trespassers who are included under other incidents (428 in 2009).
[4]Vessel-related casualties include those involving damage to vessels such as collisions or groundings. Fatalities not related to vessel casualties include deaths from falling overboard or from accidents involving onboard equipment.
[5]Includes industrial vessel, passenger (inspected), passenger (uninspected), recreational, research vessel, unclassified, and unknown data.
Note: Caution must be exercised in comparing fatalities across modes because significantly different definitions are used.

While the amount of freight transportation activity has increased in recent decades, the number of fatalities has declined or remained stable in each mode, with the exception of

Table 5-1. Fatalities by Freight Transportation Mode: 1980-2009
Sources: Total and Pipeline: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, *National Transportation Statistics*, available at www.bts.gov as of August 13, 2010. **Highway:** U.S. Department of Transportation, National Highway Transportation Safety Administration, National Center for Statistics and Analysis, *Traffic Safety Facts, Large Trucks* (annual issues). **2008-2009:** U.S. Department of Transportation, National Highway Transportation Safety Administration, National Center for Statistics and Analysis, *Traffic Safety Facts—Highlights* (August 2010). **Highway-Rail Grade Crossings:** U.S. Department of Transportation, Federal Railroad Administration, Office of Safety Analysis, available at http://safetydata.fra.dot.gov/officeofsafety/default.asp as of August 13, 2010. **Waterborne:** U.S. Department of Homeland Security, U.S. Coast Guard, Data Administration Division, personal communication, October 15, 2010.

not vessel-related waterborne casualties. Trucks account for approximately 10 percent of all highway fatalities. The vast majority of fatalities involve passenger travel on highways.

The highway and railroad modes account for almost all of the injuries in freight transportation, but the number of injuries has dropped substantially since 2000.

Table 5-2. Injured Persons by Freight Transportation Mode: 1980-2009

	1980	1990	2000	2008	2009
Total injured persons (passenger and freight)	**NA**	**NA**	**3,259,673**	**NA**	**NA**
Highway (passenger and freight)	**NA**	**3,230,666**	**3,188,750**	**2,346,000**	**2,217,000**
Large truck occupants[1]	NA	41,822	30,832	23,000	17,000
Others injured in crashes involving large trucks	NA	108,000	109,000	NA	NA
Large truck occupants[1] (percent)	NA	1.3	1.0	1.0	0.8
Others injured in crashes involving large trucks (percent)	NA	3.3	3.4	NA	NA
Railroad (passenger and freight)	**62,246**	**25,143**	**11,643**	**(R) 8,949**	**7,738**
Highway-rail grade crossing[2]	3,550	2,407	1,219	(R) 969	712
Railroad[2,3]	58,696	22,736	10,424	(R) 7,942	7,177
Waterborne (passenger and freight)	**NA**	**NA**	**665**	**628**	**722**
Vessel-related[4]	180	175	151	159	186
Freight ship	8	10	5	11	8
Tank ship	9	13	3	3	4
Tug/towboat	27	19	18	20	39
Offshore supply	NA	9	6	2	0
Fishing vessel	28	31	21	17	35
Mobile offshore drilling units	NA	13	0	2	1
Platform	NA	9	0	0	0
Freight barge	NA	3	2	1	0
Tank barge	NA	3	0	7	1
Miscellaneous[5]	98	12	96	96	98
Not related to vessel casualties[4]	NA	NA	514	469	536
Pipeline	**192**	**76**	**81**	**(R) 61**	**63**
Hazardous liquid pipeline	15	7	4	2	4
Gas pipeline	177	69	77	(R) 59	59

Key: NA = not available; R = revised.
[1]Large trucks are defined as trucks over the 10,000 pound gross vehicle weight rating, including single-unit trucks and truck tractors.
[2]Includes Amtrak.
[3]Includes train accidents and other incidents. Most injuries involve workers on duty (4,180 in 2009).
[4]Vessel-related injuries include those involving damage to vessels, such as collisions or groundings. Injuries not related to vessel casualties include those from falls overboard or from accidents involving onboard equipment.
[5]Includes industrial vessel, passenger (inspected), passenger (uninspected), recreational, research vessel, unclassified, and unknown data.
Note: Numbers may not add to totals due to some injuries being counted in more than one mode.

Table 5-2. Injured Persons by Freight Transportation Mode: 1980-2009
Sources: Total and Pipeline: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, *National Transportation Statistics*, available at www.bts.gov/ as of August 13, 2010. **Highway:** U.S. Department of Transportation, National Highway Transportation Safety Administration, National Center for Statistics and Analysis, *Traffic Safety Facts, Large Trucks* (annual issues). **2008-2009:** U.S. Department of Transportation, National Highway Transportation Safety Administration, National Center for Statistics and Analysis, *Traffic Safety Facts—Highlights* (August 2010). **Highway-Rail Grade Crossings:** U.S. Department of Transportation, Federal Railroad Administration, Office of Safety Analysis, available at http://safetydata.fra.dot.gov/officeofsafety/default.asp as of August 13, 2010. **Waterborne:** : U.S. Department of Homeland Security, U.S. Coast Guard, Data Administration Division, personal communication, October 15, 2010.

Table 5-3. Accidents by Freight Transportation Mode: 1980-2009

	1980	1990	2000	2008	2009
Highway (passenger and freight)	**NA**	**6,471,000**	**6,394,000**	**5,811,000**	**NA**
Large truck[1]	NA	371,801	437,861	380,000	NA
Large truck[1] (percent of total)	NA	5.7	6.8	6.5	NA
Rail (passenger and freight)					
Highway-rail grade crossing[2,3]	10,612	5,715	3,502	(R) 2,410	1,909
Railroad[2,4]	8,205	2,879	2,983	(R) 2,461	1,878
Waterborne (passenger and freight)					
Vessel-related	4,624	3,613	5,403	5,599	5,475
Pipeline					
Hazardous liquid pipeline	246	180	146	(R) 120	102
Gas pipeline	1,524	198	234	(R) 274	265

Key: NA = not available; R = revised.
[1]Large trucks are defined as trucks over the 10,000 pound gross vehicle weight rating, including single-unit trucks and truck tractors.
[2]Includes Amtrak.
[3]Includes both accidents and incidents. Most highway-rail grade crossing accidents are also counted under highway.
[4]Train accidents only.

The number of crashes and other freight transportation accidents have declined in all modes except water in recent years, despite an increase in freight transportation activity.

Because most hazardous materials are transported by truck, most incidents related to the movement of hazardous materials occur on highways or in truck terminals. A very small share of hazardous materials transportation incidents are the result of a

Table 5-4. Hazardous Materials Transportation Incidents: 1980-2009

	1980	1990	2000	2008	2009
Total	**15,719**	**8,879**	**17,557**	**(R) 16,906**	**14,777**
Accident-related	486	297	394	(R) 320	266
Air	**223**	**297**	**1,419**	**(R) 1,278**	**1,357**
Accident-related	0	0	3	8	2
Highway	**14,161**	**7,296**	**15,063**	**(R) 14,781**	**12,691**
Accident-related	347	249	329	(R) 286	227
Rail	**1,271**	**1,279**	**1,058**	**(R) 749**	**641**
Accident-related	134	48	62	26	37
Water[1]	**34**	**7**	**17**	**98**	**88**
Accident-related	2	0	0	**0**	**0**
Other[2]	**30**	**0**	**0**	**NA**	**NA**
Accident-related	3	0	0	NA	NA

Key: NA = not available; R = revised.
[1]Water category only includes packaged (nonbulk) marine. Non-packaged (bulk) marine hazardous materials incidents are reported to the U.S. Coast Guard and are not included.
[2]Other category includes freight forwarders and modes not otherwise specified.
Notes: Hazardous materials transportation incidents required to be reported are defined in the Code of Federal Regulations (CFR), 49 CFR 171.15, 171.16 (Form F 5800.1). Hazardous materials deaths and injuries are caused by the hazardous material in commerce. Accident related means vehicular accident or derailment. Each modal total also includes fatalities caused by human error, package failure, and causes not elsewhere classified. As of 2005, the "Other" data is no longer included in the hazardous materials information system report.

Table 5-3. Accidents by Freight Transportation Mode: 1980-2009
Sources: Highway: U.S. Department of Transportation, National Highway Transportation Safety Administration, National Center for Statistics and Analysis, *Traffic Safety Facts, Large Trucks* (annual issues). **2008-2009:** U.S. Department of Transportation, National Highway Transportation Safety Administration, National Center for Statistics and Analysis, *Traffic Safety Facts—Highlights* (August 2010). **Highway-Rail Grade Crossings:** U.S. Department of Transportation, Federal Railroad Administration, Office of Safety Analysis, available at http://safetydata.fra.dot.gov/officeofsafety/default.asp as of August 13, 2010. **Waterborne:** U.S. Department of Homeland Security, U.S. Coast Guard, Data Administration Division, personal communication, October 15, 2010. **Pipeline:** U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, National Transportation Statistics, available at www.bts.gov as of August 13, 2010.

Table 5-4. Hazardous Materials Transportation Incidents: 1980-2009
Source: U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Hazardous Materials Safety, Hazardous Materials Information System Database, available at www.phmsa.dot.gov/hazmat/library/data-stats as of July 8, 2010.

vehicular crash or derailment (referred to as "accident related"). Less than 2 percent of incidents were accident related in 2009, but they accounted for 83 percent of all property damage. Most incidents occur because of human error or package failure, particularly during loading and unloading.

Table 5-5. Commercial Motor Carrier Compliance Review Activity by Safety Rating: 2000-2009

	2000		2008		2009	
Safety rating	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Satisfactory	5,309	51.1	(R) 6,517	(R) 65.7	6,859	68.0
Conditional	3,354	32.3	(R) 2,755	(R) 27.8	2,778	27.5
Unsatisfactory	1,481	14.3	(R) 438	(R) 4.4	301	3.0
Not rated	245	2.4	(R) 216	(R) 2.2	152	1.5
Total	**10,389**	**100.0**	**(R) 9,926**	**100.0**	**10,090**	**100.0**

Key: R = revised.
Notes: A compliance review is an on-site examination of a motor carrier's records and operations to determine whether the carrier meets the Federal Motor Carrier Safety Administration's safety fitness standard. This entails having adequate safety management controls in place to ensure acceptable compliance with applicable safety requirements to reduce the risk associated with: alcohol and controlled substance testing violations; commercial driver's license standard violations; inadequate levels of financial responsibility; the use of unqualified drivers; improper use and driving of motor vehicles; unsafe vehicles operating on the highways; failure to maintain crash registers and copies of crash reports; the use of fatigued drivers; inadequate inspection, repair, and maintenance of vehicles; transportation of hazardous materials; driving and parking rule violations; violation of hazardous materials regulations; and motor vehicle crashes and hazardous materials incidents. Numbers and percents may not add to totals due to rounding.

The safety fitness of motor carriers has improved markedly over the past few years. In 2009, the share of motor carriers rated satisfactory was 68 percent, up from 51 percent in 2000.

Less than one-fourth of all roadside inspections of commercial vehicles result in the vehicle being taken out of service (OOS) for a serious violation. A much lower percentage of driver and hazardous materials inspections results in OOS orders. In 2009, about 6 percent of driver inspections and 5 percent of hazardous materials inspections result in an OOS order.

The number of gallons of fuel burned by commercial trucks increased significantly over the past 28 years. Between 1980 and 2008, the fuel consumed in highway freight transportation increased from 20 billion to nearly 37 billion gallons annually. This is due to a substantial increase in the number of trucks on the road, an increase in the average number of miles traveled per truck, and a doubling of truck miles traveled. Over the same period, fuel use in Class I freight railroads hovered around 3.9 billion gallons.

Table 5-5. Commercial Motor Carrier Compliance Review Activity by Safety Rating: 2000-2009
Source: U.S. Department of Transportation, Federal Motor Carrier Administration, Motor Carrier Management Information System (MCMIS), Compliance Review Activity by Safety Rating for Calendar Years, available at www.fmcsa.dot.gov as of July 8, 2010.

Table 5-6. Roadside Safety Inspection Activity Summary by Inspection Type: 2000-2009

	2000		2007		2008		2009	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
All inspections								
Number of inspections	2,453,776	100.0	3,416,942	100.0	3,317,187	100.0	3,530,382	100.0
With no violations	639,593	26.1	1,034,702	30.1	1,041,262	31.4	1,176,351	33.3
With violations	1,814,183	73.9	2,382,240	69.9	2,275,925	68.6	2,354,031	66.7
Driver inspections								
Number of inspections	2,396,688	100.0	3,267,279	100.0	3,176,813	100.0	3,429,882	100.0
With no violations	1,459,538	60.9	2,068,417	63.2	2,012,241	63.3	2,100,760	61.2
With violations	937,150	39.1	1,198,862	36.8	1,164,572	36.7	1,329,122	38.8
With OOS violations	191,031	8.0	223,099	6.9	204,542	6.4	196,625	5.7
Vehicle inspections								
Number of inspections	1,908,300	100.0	2,388,451	100.0	2,278,230	100.0	2,349,072	100.0
With no violations	584,389	30.6	810,192	33.8	746,362	33.6	779,891	33.2
With violations	1,323,911	69.4	1,578,259	66.2	1,513,868	66.5	1,569,181	66.8
With OOS violations	452,850	23.7	532,265	22.4	509,800	22.4	506,878	21.6
Hazardous materials inspections								
Number of inspections	133,486	100.0	199,732	100.0	192,516	100.0	222,587	100.0
With no violations	101,098	75.7	164,252	82.0	159,799	83.0	153,219	68.8
With violations	32,388	24.3	35,480	18.0	32,717	17.0	69,368	31.2
With OOS violations	9,964	7.5	10,195	5.2	9,648	5.0	10,323	4.6

Key: OOS = out of service.
Notes: A roadside inspection is an examination of individual commercial motor vehicles and drivers to determine if they are in compliance with the Federal Motor Carrier Safety Regulations and/or Hazardous Materials Regulations. Serious violations result in the issuance of driver or vehicle OOS orders. These violations must be corrected before the driver or vehicle can return to service. Moving violations also may be recorded in conjunction with a roadside inspection.

Table 5-7. Fuel Consumption by Transportation Mode: 1980-2008

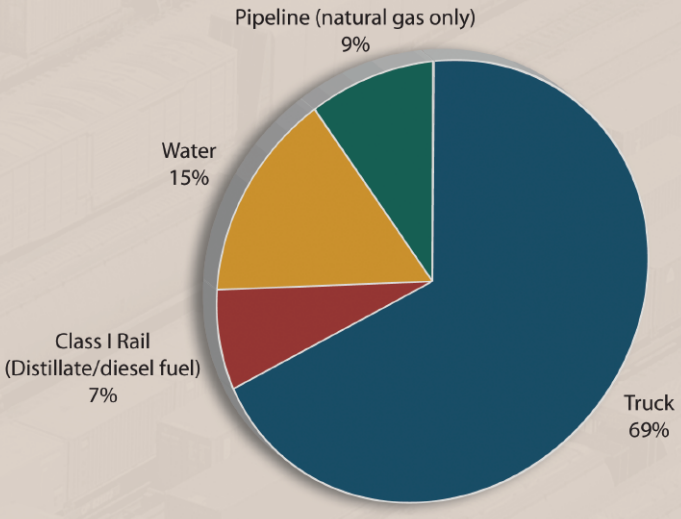
	1980	1990	2000	2007	2008
Highway					
Gasoline, diesel and other fuels (million gallons)	114,960	130,755	162,555	(R) 176,190	170,765
Truck, total	19,960	24,490	35,229	(R) 38,589	36,703
Single-unit 2-axle 6-tire or more truck	6,923	8,357	9,563	(R) 10,044	9,889
Combination truck	13,037	16,133	25,666	(R) 28,545	26,814
Truck (percent of total)	17.4	18.7	21.7	(R) 21.9	21.5
Rail, Class I (in freight service)					
Distillate / diesel fuel (million gallons)	3,904	3,115	3,700	4,062	3,886
Water					
Residual fuel oil (million gallons)	8,952	6,326	6,410	6,327	5,066
Distillate / diesel fuel oil (million gallons)	1,478	2,065	2,261	1,924	1,187
Gasoline (million gallons)	1,052	1,300	1,124	1,222	1,136
Pipeline					
Natural gas (million cubic feet)	634,622	659,816	642,210	(R) 621,364	647,958

Key: R = revised.

Table 5-6. Roadside Safety Inspection Activity Summary by Inspection Type: 2000-2009
Source: U.S. Department of Transportation, Federal Motor Carrier Administration, Motor Carrier Management Information System (MCMIS), Roadside Inspection Activity Summary for Calendar Years, available at www.ai.volpe.dot.gov/ as of September 25, 2010.

Table 5-7. Fuel Consumption by Transportation Mode: 1980-2008
Sources: Highway: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics* (Washington, DC: annual issues), table VM-1, available at www.fhwa.dot.gov/policyinformation/statistics/2008/ as of April 20, 2010. **Rail:** Association of American Railroads, *Railroad Facts* (Washington, DC: annual issues), p. 40.. **Water:** U.S. Department of Energy, Energy Information Administration, *Fuel Oil and Kerosene Sales 2008* (Washington, DC: 2009), tables 2, 4, and similar tables in earlier editions. **Pipeline:** U.S. Department of Energy, *Natural Gas Annual 2008* (Washington, DC: January 2010), table 15 and similar tables in earlier editions.

Figure 5-1. Share of Energy Consumption by Freight Transportation Mode: 2008



Note: Data do not include energy consumed by oil pipelines (crude petroleum and petroleum products) or coal slurry/water slurry pipelines.

In 2008, trucking accounted for more than two-thirds of freight transportation energy consumption. Water was a distant second with roughly one-sixth of freight energy consumption.

Since 1980, miles per gallon by single-unit trucks (based on total travel and fuel consumption) increased by more than 45 percent. Total fuel consumed increased by about 43 percent whereas miles traveled more than doubled, indicating that miles per gallon increased from 5.8 to 8.5 between 1980 and 2008.

Table 5-8. Single-Unit Truck Fuel Consumption and Travel: 1980-2008

	1980	1990	2000	2007	2008
Number registered (thousands)	4,374	4,487	5,926	6,807	6,791
Vehicle miles (millions)	39,813	51,901	70,500	(R) 82,014	83,951
Fuel consumed (million gallons)	6,923	8,357	9,563	(R) 10,044	9,889
Average miles traveled per vehicle	9,103	11,567	11,897	(R) 12,049	12,362
Average miles traveled per gallon	5.8	6.2	7.4	8.2	8.5
Average fuel consumed per vehicle (gallons)	1,583	1,862	1,614	(R) 1,476	1,456

Key: R = revised.

Figure 5-1. Share of Energy Consumption by Freight Transportation Mode: 2008
Sources: Highway: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics* (Washington, DC: annual issues), table VM-1, available at www.fhwa.dot.gov/policyinformation/statistics/2008/ as of April 25, 2010. **Rail:** Association of American Railroads, *Railroad Facts* (Washington, DC: annual issues), p. 40. **Water:** U.S. Department of Energy, Energy Information Administration, *Fuel Oil and Kerosene Sales 2008* (Washington, DC: 2009), tables 2, 4, and similar tables in earlier editions; U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics* (Washington, DC: annual issues), table MF-24, available at www.fhwa.dot.gov/policyinformation/statistics/2008/ as of April 25, 2010. **Pipeline:** U.S. Department of Energy, *Natural Gas Annual 2008*, (Washington, DC: January 2010), table 15 and similar tables in earlier editions.

Table 5-8. Single-Unit Truck Fuel Consumption and Travel: 1980-2008
Source: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics* (Washington, DC: annual issues), table VM-1, available at www.fhwa.dot.gov/policyinformation/statistics/2008/ as of April 25, 2010.

In contrast to single-unit trucks, miles per gallon by combination trucks (based on total travel and fuel consumption) increased by only 2 percent over the past 28 years. During the same period, vehicle miles traveled more than doubled, resulting in a doubling of gallons of fuel consumed.

Table 5-9. Combination Truck Fuel Consumption and Travel: 1980-2008

	1980	1990	2000	2007	2008
Number registered (thousands)	1,417	1,709	2,097	2,221	2,216
Vehicle miles traveled (millions)	68,678	94,341	135,020	(R) 145,046	143,507
Fuel consumed (million gallons)	13,037	16,133	25,666	(R) 28,545	26,814
Average miles traveled per vehicle	48,472	55,206	64,399	65,307	64,764
Average miles traveled per gallon	5.3	5.8	5.3	5.1	5.4
Average fuel consumed per vehicle (gallons)	9,201	9,441	12,241	(R) 12,853	12,101

Key: R =revised.

Diesel prices were about 64 percent higher in June 2010 than 10 years earlier (in inflation-adjusted terms).

Figure 5-2. Monthly Diesel Prices: January 1999-June 2010

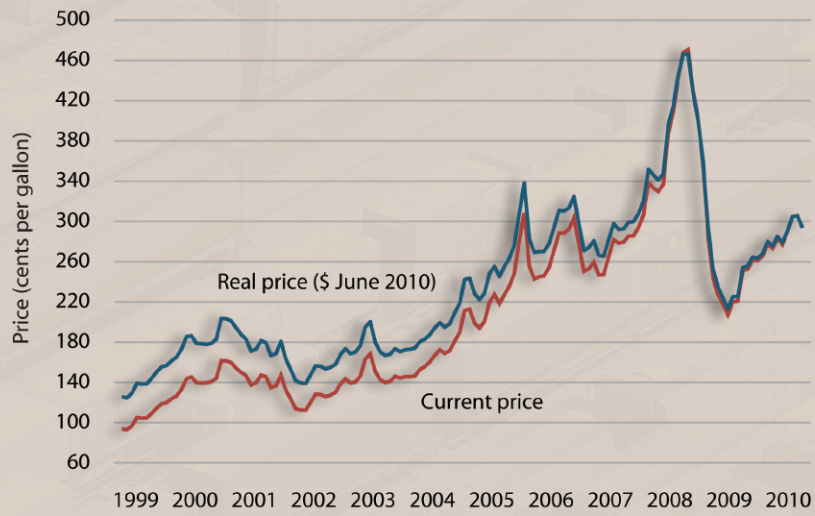


Table 5-9. Combination Truck Fuel Consumption and Travel: 1980-2008
Source: U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics* (Washington, DC: annual issues), table VM-1, available at www.fhwa.dot.gov/policyinformation/statistics/2008/ as of April 25, 2010.

Figure 5-2. Monthly Diesel Prices: January 1999-June 2010
Sources: Diesel price: U.S. Department of Energy, Energy Information Agency, U.S. Petroleum Prices, available at www.eia.doe.gov as of August 9, 2010. **Consumer price index:** U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index – All Urban Consumers, Monthly, available at www.bls.gov as of August 9, 2010.

Energy intensity is the amount of energy used in producing a given level of output or activity, in this case vehicle miles and ton miles. Compared with 1980, the energy intensity of both trucking and freight rail has improved. Domestic freight water transportation, measured by Btu per ton mile, has become less energy efficient.

Table 5-10. Energy Intensities of Domestic Freight Transportation Modes: 1980-2008

	1980	1990	2000	2007	2008
Highway (Btu per vehicle mile)	24,758	22,795	23,449	(R) 23,252	22,077
Railroad (Class I) (Btu per freight car mile)	18,742	16,619	14,917	14,846	14,573
Railroad (Class I) (Btu per ton mile)	597	420	352	320	305
Domestic water (Btu per ton mile)	358	387	473	590	418

Key: Btu = British thermal unit; R = revised.

Table 5-10. Energy Intensities of Domestic Freight Transportation Modes: 1980-2008
Source: Oak Ridge National Laboratory, *Transportation Energy Data Book: Edition 29* (Oak Ridge, TN: annual issues), table 2.16, available at http://cta.ornl.gov/data/index.shtml as of August 10, 2010.

Air quality is affected by freight vehicle emissions. Compared with gasoline-fueled cars and trucks, diesel-fueled heavy trucks emit small amounts of carbon monoxide (CO_2) but large amounts of nitrogen oxides (NO_X). However, since 1990 heavy-duty truck emissions of NO_X have declined by 67 percent.

Freight transportation also accounts for about one-third of emissions of particulate matter 10 microns in diameter (PM-10) from mobile sources. Most PM-10, however, comes from agricultural fields, wildfires, and fugitive dust. Consequently, freight transportation is a minor factor when considering total PM-10 emissions.

Table 5-11. Estimated National Average Vehicle Emissions Rates of Heavy-Duty and Light-Duty Vehicles: 1990-2009 (grams per mile)

	1990	2000	2008	2009
Gasoline (assuming zero RFG)				
Cars				
Exhaust HC	2.79	0.97	0.39	0.36
Nonexhaust HC	1.21	0.91	0.57	0.51
Total HC	4.00	1.88	0.95	0.87
Exhaust CO	42.89	18.53	9.68	9.20
Exhaust NO_x	2.70	1.29	0.67	0.61
Light trucks				
Exhaust HC	3.68	1.45	0.55	0.51
Nonexhaust HC	1.37	0.98	0.62	0.58
Total HC	5.05	2.43	1.17	1.09
Exhaust CO	56.23	26.81	12.49	11.76
Exhaust NO_x	2.62	1.54	0.94	0.88
Heavy trucks				
Exhaust HC	3.66	1.22	0.42	0.32
Nonexhaust HC	2.74	1.62	0.99	0.92
Total HC	6.40	2.84	1.41	1.24
Exhaust CO	85.61	31.08	12.38	9.96
Exhaust NO_x	7.19	5.26	2.94	2.58
Diesel				
Cars				
Exhaust HC	0.68	0.80	0.29	0.23
Exhaust CO	1.49	1.78	1.09	0.99
Exhaust NO_x	1.83	1.81	0.69	0.53
Light trucks				
Exhaust HC	1.59	1.02	0.55	0.48
Exhaust CO	2.67	1.77	0.93	0.82
Exhaust NO_x	2.71	1.76	0.94	0.82
Heavy trucks				
Exhaust HC	2.21	0.79	0.45	0.42
Exhaust CO	10.06	4.10	2.31	2.01
Exhaust NO_x	23.34	18.05	8.61	7.77

Key: CO = carbon monoxide; HC = hydrocarbon; NO_X = nitrogen oxides; RFG = reformulated gasoline.

Table 5-12. Freight Nitrogen Oxides (NO_X) and Particulate Matter (PM-10) Emissions by Freight Transportation Mode: 2002

	NO_x Emissions				PM-10 Emissions			
			As a percent of:				As a percent of:	
Mode	**Tons (thousands)**	**Percent**	**All mobile sources**	**All sources**	**Tons (thousands)**	**Percent**	**All mobile sources**	**All sources**
Heavy-duty vehicles	3,782.0	66.8	33.0	17.9	120.0	64.7	23.3	0.5
Freight railroads	857.2	15.1	7.5	4.1	21.3	11.5	4.1	0.1
Marine vessels	1,011.0	17.9	8.8	4.8	44.0	23.7	8.5	0.2
Air freight	8.2	0.1	0.1	0.0	0.3	0.2	0.1	0.0
Total	**5,658.4**	**100.0**	**49.4**	**26.8**	**185.6**	**100.0**	**36.0**	**0.8**

Note: Numbers and percents may not add to totals due to rounding.

TABLE 5-11. ESTIMATED NATIONAL AVERAGE VEHICLE EMISSIONS RATES OF HEAVY-DUTY AND LIGHT-DUTY VEHICLES: 1990-2009
Source: U.S. Environmental Protection Agency, National Vehicle and Fuel Emissions Laboratory, MOBILE6.2.3 model, personal communication, September 25, 2010.

TABLE 5-12. FREIGHT NITROGEN OXIDES (NO_X) AND PARTICULATE MATTER (PM-10) EMISSIONS BY FREIGHT TRANSPORTATION MODE: 2002
Source: U.S. Department of Transportation, Federal Highway Administration, *Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level, Final Report* (Washington, DC: 2005), available at www.fhwa.dot.gov/environment/freightaq/ as of June 2, 2010.

Table 5-13. Current and Projected Nitrogen Oxides (NO_X) Emissions by Freight Transportation Mode: 2002, 2010, and 2020

	Tons (thousands)			Percent change, 2002 to 2010	Percent change, 2002 to 2020
	2002	2010	2020		
Heavy-duty trucks	3,782.0	2,186.9	662.6	-42	-82
Freight rail	857.2	563.2	486.4	-34	-43
Commercial marine	1,011.0	987.2	938.6	-2	-7
Air freight	8.2	10.0	12.4	22	51
Total freight	**5,658.4**	**3,747.3**	**2,100.0**	**-34**	**-63**

Trucks are by far the largest contributor to freight emissions nationally, producing two-thirds of NO_X from the freight sector. However, as noted earlier, freight emissions of NO_X have declined significantly since the U.S. Environmental Protection Agency required the use of ultra low sulfur diesel fuel in heavy-duty trucks and other diesel-powered highway vehicles beginning in 2006.

Trucks produced two-thirds of PM-10 emissions from the freight sector. Freight emissions of PM-10 are forecast to decline by one-quarter over the next decade, primarily from a reduction in heavy-duty truck emissions. The required use of ULSD fuel in heavy-duty trucks and other diesel-powered highway vehicles will reduce PM emissions and enable the use of advanced pollution control technologies to meet emissions standards.

Table 5-14. Current and Projected Particulate Matter (PM-10) Emissions by Freight Transportation Mode: 2002, 2010, and 2020

	Tons (thousands)			Percent change, 2002 to 2010	Percent change, 2002 to 2020
	2002	2010	2020		
Heavy-duty trucks	120.0	65.4	34.8	-46	-71
Freight rail	21.3	15.7	13.0	-26	-39
Commercial marine	44.0	42.9	44.1	-2	0
Air freight	0.3	0.3	0.3	-3	-10
Total freight	**185.6**	**124.3**	**92.1**	**-33**	**-50**

Table 5-13. Current and Projected Nitrogen Oxides (NO_X) Emissions by Freight Transportation Mode: 2002, 2010, and 2020
Source: U.S. Department of Transportation, Federal Highway Administration, *Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level, Final Report* (Washington, DC: 2005), available at www.fhwa.dot.gov/environment/freightaq/ as of June 2, 2010.

Table 5-14. Current and Projected Particulate Matter (PM-10) Emissions by Freight Transportation Mode: 2002, 2010, and 2020
Source: U.S. Department of Transportation, Federal Highway Administration, *Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level, Final Report* (Washington, DC: 2005), available at www.fhwa.dot.gov/environment/freightaq/ as of June 2, 2010.

In addition to CO, NO_x, and particulate matter emissions, the transportation sector releases large quantities of greenhouse gases (GHGs), such as carbon dioxide (CO_2), methane, nitrous oxide, and hydrofluorocarbons. These gases trap heat in the atmosphere, affecting the earth's temperature. Some greenhouse gases occur naturally while others are produced by human activities, such as the burning of fossil fuels.

Table 5-15. U.S. Greenhouse Gas Emissions by Economic End-Use Sector: 1990-2008 (electricity-related emissions distributed among sectors)[1] (millions of metric tonnes of CO_2 equivalent)

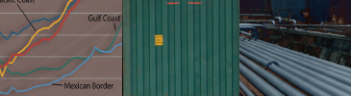
Sector	(R)1990	(R)1995	(R)2000	(R)2005	(R)2007	2008
Industry[2]	2,179.8	2,228.0	2,239.2	2,071.1	2,084.2	2,018.4
Transportation[3]	1,548.2	1,698.3	1,935.8	2,020.9	2,008.6	1,890.8
Commercial	946.8	1,000.2	1,141.5	1,216.5	1,240.1	1,250.6
Residential	954.0	1,024.5	1,162.4	1,242.2	1,226.9	1,215.6
Agriculture	464.2	497.1	518.7	523.5	550.5	531.6
U.S. Territories[4]	33.7	40.7	46.9	58.9	57.8	49.9
Total	**6,126.8**	**6,488.8**	**7,044.5**	**7,133.2**	**7,168.1**	**6,956.8**

Key: R = revised.
[1]Emissions from electricity generation are allocated to each economic end-use sector on the basis of each sector's share of aggregate electricity consumption. This method assumes each sector consumes electricity that is generated from the national average mix of fuels according to their carbon intensity.
[2]Industry includes manufacturing, construction, and mining. Six manufacturing industries—petroleum refinieries, chemicals, primary metals, paper, food, and nonmetallic mineral products—represent the vast majority of energy use and thus GHG emissions in the industrial sector.
[3]Includes emissions from military aircraft (16.3 million of metric tonnes) and "other" transportation, primarily lubricants (9.5 million of metric tonnes). Emissions from international bunker fuels are not included.
[4]Electricity-related emissions were not distributed to U.S. Territories.
Notes: Greenhouse gas (GHG) emissions include CO_2, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. CO_2 equivalent is computed by multiplying the weight of the gas being measured by its estimated Global Warming Potential (GWP). The Intergovernmental Panel on Climate Change developed the GWP concept to compare the ability of one GHG to trap heat in the atmosphere to another gas. Carbon comprises 12/44 of CO_2 by weight. Numbers may not add to totals due to rounding.

When emissions from electricity generation are allocated among end-use sectors (on the basis of each sector's share of electricity consumption), the industrial sector produces the largest amount of GHG emissions, followed closely by transportation. The transportation sector is responsible for about 27 percent of all greenhouse gases emitted in the United States and nearly 7 percent of all greenhouse gases emitted globally.[1]

[1]Intergovernmental Panel on Climate Change, *Climate Change 2007: Synthesis Report* (Geneva, Switzerland: 2008)

Table 5-15. U.S. Greenhouse Gas Emissions by Economic End-Use Sector: 1990-2008
Source: U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008*, EPA 430-R-10-006 (Washington, DC: 2010), table ES-8, available at www.epa.gov/climatechange/emissions/usinventoryreport.html.



From 1990 to 2008, transportation GHG emissions rose by 22 percent. However, transportation sector emissions decreased by nearly 6 percent from 2007 to 2008, likely the result of higher fuel prices, which led to a decrease in fuel consumption, and the economic downturn.

CO_2 accounts for nearly all of the transportation sector's GHG emissions, primarily from the combustion of fossil fuels. Almost all of the energy consumed by the sector is petroleum-based and includes motor gasoline, diesel fuel, jet fuel, and residual oil. Gasoline-fueled passenger cars and light-duty trucks are responsible for more than 60 percent of CO_2 emissions in the transportation sector while the combustion of diesel fuel in heavy-duty trucks and jet fuel in aircraft produced much of the rest.

Table 5-16. U.S. Transportation Sector Carbon Dioxide (CO_2) Emissions from Fossil Fuel combustion by Fuel Type: 1990-2008 (millions of metric tonnes of CO_2 equivalent)

Fuel	(R)1990	(R)1995	(R)2000	(R)2005	(R)2007	2008
Petroleum	**1,449.7**	**1,569.6**	**1,773.9**	**1,862.2**	**1,858.4**	**1,749.4**
Motor gasoline	983.6	1,041.7	1,135.7	1,187.3	1,180.4	1,129.4
Distillate fuel oil	262.9	324.2	402.5	458.1	476.3	441.9
Jet fuel	176.2	170.9	199.8	193.5	169.3	153.6
Residual fuel[1]	22.6	29.1	33.3	19.3	29.0	21.4
Aviation gasoline	3.1	2.7	2.5	2.4	2.2	2.0
Liquefied petroleum gas	1.3	1.0	0.7	1.6	1.3	1.2
Natural Gas	**36.0**	**38.4**	**35.6**	**33.1**	**35.3**	**35.8**
Transportation Total[2]	**1,485.8**	**1,608.0**	**1,809.5**	**1,895.3**	**1.893.7**	**1,785.3**
U.S. Total[2]	**4,735.7**	**5,029.5**	**5,593.4**	**5,753.3**	**5,757.0**	**5,572.8**
Transportation Sector as % of Total	**31.4**	**32.0**	**32.4**	**32.9**	**32.9**	**32.0**

Key: R = revised.
[1]Fluctuations in emissions estimates reflect data collection problems.
[2]Electricity-related emissions are not included in the transportation sector and U.S. totals.
Notes: CO_2 equivalent is computed by multiplying the weight of the gas being measured by its estimated Global Warming Potential (GWP). The Intergovernmental Panel on Climate Change developed the GWP concept to compare the ability of one GHG to trap heat in the atmosphere to another gas. Carbon comprises 12/44 of CO_2 by weight. Numbers may not add to totals due to rounding. Electricity-related emissions are not included in this table.

Table 5-16. U.S. Transportation Sector Carbon Dioxide (CO_2) Emissions from Fossil Fuel Combustion by Fuel Type: 1990-2008
Source: U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008*, EPA 430-R-10-006 (Washington, DC: 2009), Annex 2, tables A-11, A-12, A-14, A-19, A-22, A-24, and A-29, available at www.epa.gov/climatechange/emissions/usinventoryreport.html as of April 30, 2010.

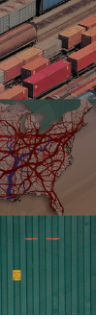
Table 5-17. U.S. Greenhouse Gas Emissions from Domestic Freight Transportation: 1990-2008 (millions of metric tonnes of CO_2 equivalent)

Mode	(R)1990	(R)1995	(R)2000	(R)2005	(R)2007	2008	Percent change, 1990 to 2008
Trucking	231.1	277.7	354.5	408.3	425.2	401.2	73.6
Freight Rail	34.5	39.1	42.8	46.7	47.8	44.4	28.7
Ships and Other Boats[1]	30.6	42.2	48.3	27.9	37.9	24.1	-21.2
Pipelines[2]	36.1	38.3	35.2	32.3	34.4	34.9	-3.3
Commercial Aircraft	23.7	24.8	29.6	26.0	20.3	18.0	-24.1
Freight Total	**356.0**	**422.1**	**510.5**	**541.2**	**565.5**	**522.6**	**47.0**
Passenger Total	**1,145.6**	**1,240.8**	**1,391.8**	**1,451.1**	**1,416.5**	**1,342.2**	**17.0**
Transportation Total[3]	**1,548.2**	**1,698.3**	**1,935.8**	**2,020.9**	**2,008.6**	**1,890.8**	**22.1**
Freight as % of Transportation Total	**23.0**	**24.9**	**26.4**	**26.8**	**28.2**	**27.6**	**20.0**

Key: CO_2 = carbon dioxide; R = revised.
[1]Fluctuations in emissions estimates reflect data collection problems.
[2]Includes only CO_2 emissions from natural gas used to power pipelines.
[3]Includes greenhouse gas emissions from military aircraft (16.3 million metric tonnes); "other" transportation, primarily lubricants (9.5 million metric tonnes); and electricity-related emissions. Emissions from international bunker fuels are not included.
Notes: U.S. Environmental Protection Agency (EPA) used U.S. Department of Energy fuel consumption data to allocate freight and passenger rail emissions. EPA used U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics data on freight shipped by commercial aircraft and the total number of passengers enplaned to split commercial aircraft emissions. Each passenger was estimated to weigh an average of 150 pounds and luggage was estimated to weigh 50 pounds. Previous *Inventories* included commercial aircraft emissions under passenger travel. CO_2 equivalent is computed by multiplying the weight of the gas being measured by its estimated Global Warming Potential (GWP). The Intergovernmental Panel on Climate Change developed the GWP concept to compare the ability of one GHG to trap heat in the atmosphere to another gas. Carbon comprises 12/44 of CO_2 by weight. Numbers may not add to totals due to rounding.

Since 1990, the rate of growth of GHG emissions from freight sources has been more than twice as fast as that for passenger travel (47 percent vs. 17 percent). Trucking accounts for the lion's share of freight emissions followed by freight rail, a distant second.

Table 5-17. U.S. Greenhouse Gas Emissions from Domestic Freight Transportation: 1990-2008
Source: U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008,* EPA 430-R-10-006 (Washington, DC: 2010), Annex 3, table A-109 and A-110, available at www.epa.gov/climatechange/emissions/usinventoryreport.html as of April 30, 2010.



Between 1990 and 2008, medium- and heavy-duty truck emissions rose by more than 70 percent, the largest percentage increase of any major transportation mode. An increase in truck freight movement is largely responsible for the rise in emissions.

Table 5-18. Medium- and Heavy-Duty Truck Greenhouse Gas Emissions: 1990-2008 (millions of metric tonnes of CO_2 equivalent)

	1990	1995	2000	2005	2007	2008
Carbon dioxide (CO_2)(R)	230.1	274.8	345.8	396.0	412.5	388.6
Methane	0.2	0.2	0.1	0.1	0.1	0.1
Nitrous Oxide	0.8	1.0	1.2	(R)1	1.1	1.0
Hydrofluorocarbons(R)	<0.05	1.7	7.4	11.1	11.5	11.6
Total Truck (R)	**231.1**	**277.7**	**354.5**	**408.3**	**425.2**	**401.2**
Total U.S. Transportation[1] (R)	**1,548.2**	**1,698.3**	**1,935.8**	**2,020.9**	**2,008.6**	**1,890.8**
Total U.S.[1] (R)	**6,126.8**	**6,488.8**	**7,044.5**	**7,133.2**	**7,168.1**	**6,956.8**
Truck share of transportation total (percent)(R)	**14.9**	**16.4**	**18.3**	**20.2**	**21.2**	**21.2**
Truck share of U.S. total (percent)(R)	**3.8**	**4.3**	**5.0**	**5.7**	**5.9**	**5.8**

Key: CO_2 = carbon dioxide; R = revised.
[1]Transportation and U.S. totals include greenhouse gas emissions from military aircraft (16.3 million metric tonnes in 2008); "other" transportation, primarily lubricants (9.5 million metric tonnes in 2008); and electricity-related emissions. Emissions from international bunker fuels are not included.
Notes: CO_2 equivalent is computed by multiplying the weight of the gas being measured by its estimated Global Warming Potential (GWP). The Intergovernmental Panel on Climate Change developed the GWP concept to compare the ability of one GHG to trap heat in the atmosphere to another gas. Carbon comprises 12/44 of CO_2 by weight. Medium- and heavy-duty trucks weigh 8,501 pounds and above. Numbers may not add to totals due to rounding.

Table 5-18. Medium- and Heavy-Duty Truck Greenhouse Gas Emissions: 1990-2008
Source: U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008*, EPA 430-R-10-006 (Washington, DC: 2010), tables 2-15 and ES-8, available at www.epa.gov/climatechange/emissions/usinventoryreport.html as of April 30, 2010.