Chapter 9

Transportation

Transportation involves the conversion of energy into motion. Transportation uses petroleum, natural gas, coal, nuclear fuel, and renewable energy – but mostly petroleum. In 2014, about 27.6% of the energy used in the United States went to transporting people and goods from one place to another. US EIA, “Use of Energy in the United States Explained.”

According to the EIA’s energy “sources/uses” chart (below), transportation constituted the second largest “user” of U.S. energy sources, after “industrial uses” which represented 32.3% of overall consumption.

Chapter collaborators:

Brodie Erwin (WF ’12)
Cameron Hill (WF ’12)
Jake Husain (WF ’14)
Lea Ko (WF ’13)
Derrick Lankford (WF ’12)
Tim Stewart (WF ’12)
Danielle Stone (WF ‘12)
Lindsay Watson (WF’13)
Sam Wellborn (WF ’13)
Doug Winn (WF ’14)
Ben Winikoff (WF ’15)

In this chapter, you will learn about:

- The evolution of transportation technology
  - The first evolution: coal-fired railroads and steamboats
  - The second evolution: the internal combustion and the creation of our national highway system

- The political and policy decisions that have shaped U.S. transportation
  - Creation of our national highway system
  - Modest support for mass transit systems
  - Lack of support for high-speed rail

- Alternative fuels for transportation
  - Ethanol mandates in the United States
  - Biodiesel and delayed mandates
  - Future of cellulosic fuels

- The use of alternative non-gasoline transportation methods
  - The history and future of electric vehicles
  - Natural gas vehicles, including trucks
  - Fuel cell vehicles and the future

- The current (and future) standards regulating the auto industry
  - Air pollution/emissions regulation
  - CAFE fuel efficiency standards
  - Government bailout of U.S. auto industry
  - Cash for Clunkers

- Transportation energy solutions for the future
  - New urbanism
  - Coordinated vehicle systems
### Chapter 9 – Transportation

9.1 Evolution of American Transportation  
  9.1.1 Transportation at the Founding  
  9.1.2 First Evolution: Railroads and Steamboats  
  9.1.3 Second Evolution: Internal Combustion Engine  
  9.1.4 Creation of America’s Highway Infrastructure

9.2 Fueling Transportation  
  9.2.1 Re-emergence of Electric Cars  
  9.2.2 Compressed Natural Gas Vehicles  
  9.2.3 Hydrogen Fuel Cell Vehicles

9.3 Biofuels  
  9.3.1 Mandating Biofuel Consumption  
  9.3.2 Conventional Ethanol  
  9.3.3 Biodiesel  
  9.3.4 Cellulosic Ethanol

9.4 Regulation of Auto Industry  
  9.4.1 US Vehicle Manufacturing during Great Recession  
  9.4.2 CAFE Standards: EISA 2007 & Obama Administration Agreements  
  9.4.3 Cash for Clunkers  
  9.4.4 Automotive Air Pollution Regulation

9.5 Cars and Suburban Sprawl  
  9.5.1 American Decentralization  
  9.5.2 American Recentralization  
  9.5.3 Improving the Motor Vehicle Network

**Sources:**  
9.1 Evolution of American Transportation

Modes of transportation have evolved over our country’s lifespan. And as transportation has evolved, so have the laws.

9.1.1 Transportation at the Founding

At the time of our nation’s founding, animal, human, and wind power were the predominant sources of energy for transportation. Horses and oxen pulled the wagons out west, canal networks were created to transport goods from landlocked colonies to colonies with sea ports, mail was delivered via horseback, and the high seas were ruled by ships powered by strong ocean winds.

With economic growth and the need for faster interstate transportation, the individual states lacked the means to create an efficient transportation system on a national level. Consequently, the early years of the nineteenth century were marked by debates over the proper role of the federal government in stimulating and improving a system of national transportation.

The first proposal for a national road system came in 1808 when Treasury Secretary Albert Gallatin proposed an extensive turnpike system from Maine to Georgia. Gallatin’s plan never came to fruition because of the turmoil that led to the War of 1812. However, as the nation grew following the war, Gallatin’s turnpike plan became a template for those seeking to create a national transportation system. In 1816, Congressman John Calhoun introduced a bill to fund and support a unified national system of roads and canals, but his efforts were derailed by regional squabbles. These disagreements continued to block national development of roads and canals until the twentieth century.

9.1.2 First Evolution: Railroads and Steamboats

The steam engine revolutionized transportation. Steam-driven steamboats and railroads – fueled mostly by coal – constituted the first evolution of transportation in American society.

The steam engine changed transportation on America’s waterways. Steamboat travel gained widespread support when in 1807 Robert Fulton journeyed up the Hudson River from New York to Albany. Within a few decades, paddlewheel steamboats were a familiar sight on America’s rivers. These boats carried passengers, a variety of cargo, and even towed barges.
Private railroad companies created the country’s first national transportation system on land. Following the Civil War, railroads made it possible to carry heavy loads over long distances much faster and cheaper than had their horse-drawn predecessors. The increased comfort and convenience of railroad cars made passenger travel commonplace in American society. In 1872, just three years after the intercontinental railway was completed, one million passengers traveled between Omaha, Nebraska and San Francisco, California.

Transportation in city streets was also transformed between 1890 and 1920 when electric railroad trolleys replaced horse-drawn streetcars. In that period, trolley use rose from 2 billion to 15.5 billion trips annually, making city transportation cheaper and more efficient.

9.1.3 Second Evolution: Internal Combustion Engine

The development of the internal combustion engine, fueled by gasoline, sparked the automobile movement that continues to provide the majority of our transportation today. The Duryea Brothers opened the first American automobile manufacturing plant in 1895, and they were quickly followed by many others, including Henry Ford in 1908. The internal combustion engine was soon put also into trucks, and the new trucking industry quickly began to compete with railroads and river barges for the national transportation of goods.

In the twentieth century, calls for the creation of a national transportation network grew with the increased use of the automobile, which was unhindered by the need for an extensive track system. As people bought automobiles, the pattern of urban development changed and the convenience of driving your own vehicle dominated the government’s transportation decisions. Buses replaced electric streetcars in cities and became the most common form of mass transportation. By 1910, it was clear the nation needed a unified national road system.

9.1.4 Creation of America’s Highway Infrastructure

The interest in a highway infrastructure was originally driven by Americans’ new interest in bicycles in the 1890s. The introduction in 1896 of bicycle tires increased the demand for better roads. Then by 1910 it was automobiles that most required better roadways. At the start of World War I, automobile production in American was around 200,000 cars a year, and America’s drivers were ready to explore the flexibility that came with traveling without a railroad track.

In response to the interest of bicyclists and increasing automobile production, the U.S. Department of Agriculture created the Office of Road Inquiry to tie together road networks being developed within the various states. WWI made clear the need for better roads, with the heavy
military-related truck traffic during the war. To develop a national highway system the Federal Aid Road Act of 1916 established a new Federal Bureau of Public Roads.

By the 1920s each state had a road-building agency to oversee construction of major roads. A federal-state agency cooperation, which still characterizes America’s road building programs, developed. The federal government provided money, research, and oversight; state highway offices undertook the actual road construction and maintenance. The timing for a national highway plan coincided with America’s growing passion for the automobile. By 1930, for example, annual auto production reached five million vehicles.

During the Depression, road construction was a way of providing jobs for the unemployed. Presidents Hoover and Roosevelt both increased the amount of federal money provided for highway construction throughout the 1930s. In the rush to provide road-building jobs, many of the highway plans did not fit a cohesive system to optimize the efficiency of road travel. Highway engineers, instead of creating the most efficient road network, identified the demands of drivers and supplied the roads they wanted.

World War II highlighted the flaws in America’s highway system. Compared to the road systems in Europe, especially Germany’s autobahns, America’s highways were congested and in disrepair. A Historical Perspective on American Roads. After WWII, a coalition of trucking companies, auto manufacturers, and oil companies lobbied aggressively for better highways. In response, President Eisenhower persuaded Congress that an extensive upgrade of the national highway system was essential to national defense. Eisenhower argued that in case of an attack or invasion, roads could provide for rapid evacuation of cities, something impossible with the pre-WWII highway system. See Society in the 1950s.

How were all of these new roads paid for? The modern highway program came into existence through the Highway Trust Fund (HTF). Before the Highway Revenue Act of 1956 and its establishment of the HTF, roads received financing from the General Fund of the U.S. Treasury. The new program increased taxes on gas, tires, and other automotive supplies and directed these new revenues to highway construction and maintenance. This tax was initially three cents per gallon, but increased through the years to the current tax of 18.4 cents per gallon of gasoline. Highway Trust Fund. While the Highway Revenue Act mandated the construction of an extensive new national highway network, the question remained where exactly the roads would be placed.

When the construction of a highway disrupts a community, the interests of the affected community and the broader public must be balanced. In 1971, the Supreme Court considered the placement of an interstate highway in Citizens to Preserve Overton Park v. Volpe, 401 U.S. 402
The Secretary of Transportation had approved the construction of a highway through a public park in Memphis, Tennessee, angering city residents and conservation organizations. Two federal statutes prohibited the Secretary of Transportation from authorizing highway construction that destroyed natural resources if there was a “feasible and prudent” alternative route. The Memphis park contained a zoo, golf course, and outdoor theater, as well as 170 acres of forest, 26 of which would be destroyed by the highway. The petitioners contended that the Secretary’s approval of the highway was invalid because he had not found there were no “feasible and prudent” alternative routes. The Court remanded the case to the lower court, stressing that the environmental impact and community disruption were important considerations in deciding whether highway construction was proper. Eventually, Interstate 40 through Memphis was re-routed to avoid Overton Park.

The National Highway System, originally designed for interstate traffic, has come to be an integral piece of the American suburban lifestyle. Notice the transformation of the original NHS as a highway system connecting major urban centers to one also serving suburban transportation.

Then:

Map: [Wikipedia](#)
Now:

Map: McGraw Hill

The NHS led to a dramatic change in mobility and the average American’s perception of their ability to travel. Continuous changes in the NHS, such as widening the roads and developing new interchanges, has increased the speed and efficiency of travel – as well as our reliance on the car.

9.2 Fueling Transportation

Environmental and climate-change concerns arise because of how our vehicles are fueled – today mostly by petroleum-based fuels. As ubiquitous as petroleum fuel is today, when the energy source was first discovered, it was rare and exceedingly expensive. Since oil was scarce, the first cars were actually powered by electricity and were essentially carriages with electric motors and batteries. See inset picture of 1896 Dey-Griswold Electric Phaeton. Electric cars in 1899 and 1900 outsold every other type of car in America as they “did not have the vibration, smell, and noise
associated with gasoline cars.” History of Electric Cars.

A number of factors led to the demise of the early electric car. First, a new system of roads required vehicles able to cover longer distances. Second, crude oil was discovered in Texas, thus reducing the price of gasoline and increasing its availability. Third, the electric starter for gasoline-powered engines was invented in 1912, obviating the need for a cumbersome hand crank. Finally, Henry Ford began to mass produce affordable internal combustion vehicles; at $650 his Model T was half the price of an electric car. History of Electric Cars.

Today, almost all cars, trucks, planes, and boats are powered by petroleum. However, as oil prices have risen, and with concerns about carbon emissions, plug-in electric vehicles and other low-carbon (or no-carbon) alternatives have begun to appear on American roads.

9.2.1 Re-emergence of Electric Cars

Since the 1990s, electric cars have grown in popularity. In 1990, General Motors unveiled a fully electric concept car called the Impact. The car was fully powered by electricity with no emissions from the tailpipe. There was a significant groundswell in interest, especially in California where the California Air Resources Board (CARB) sought to develop standards for motor vehicles with the goal of reducing emissions.

Initially, CARB encouraged the production of no-emission electric cars by requiring automakers to produce 2% of their vehicles as “zero emission vehicles” by 1998 – rising to 10% by 2003. In 1996, GM created the Saturn EV1, which had zero emissions and a range of between 50 and 100 miles, depending on the battery design. GM began leasing the vehicles in December 1996. While initially expensive at $640/month, the cost was eventually reduced to $349/month. At one point, over 800 of these cars were leased to consumers in Southern California.

However, in 2003, CARB changed the rules to encourage the production of hybrid and fuel cell vehicles, instead of insisting on electric vehicles. See CARB, “2003 Zero Emission Vehicle Program Changes – Fact Sheet.” In response, GM stopped development of the Saturn EV1 and, upon expiration of the outstanding leases, crushed all of the cars. Some smelled a conspiracy between GM and the oil industry.

But interest in electric cars has had a resurgence. Most car manufacturers have introduced or will soon introduce plug-in electric cars and hybrids. This has not been limited to economy cars. The Tesla Model S, introduced in 2012, was the first fully-electric luxury sedan to achieve major success. In June 2014, Tesla opened its patents to hurry the development of high-performance electrics by other car makers. Tesla stated, “the world would all benefit from a common, rapidly-
evolving technology platform.” In October 2014, Ford announced its entrance into the full-size, high-tech, high-performance, long-range electric vehicle market.

At the federal level, President Obama has announced a target of one million electric cars on the road by 2015. DOE Report. This target is being pursued using federal incentive programs, including Corporate Average Fuel Economy (CAFE) standards and tax incentives. The following chart shows how the one-million vehicle target could be reached.

<table>
<thead>
<tr>
<th>Manufacturer and Model</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisker Karma PHEV</td>
<td>1,000</td>
<td>5,000</td>
<td>10,000</td>
<td>10,000</td>
<td>10,000</td>
<td>36,000</td>
</tr>
<tr>
<td>Fisker Nina PHEV</td>
<td>5,000</td>
<td>40,000</td>
<td>75,000</td>
<td>75,000</td>
<td>195,000</td>
<td></td>
</tr>
<tr>
<td>Ford Focus EV</td>
<td>10,000</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>70,000</td>
<td></td>
</tr>
<tr>
<td>Ford Transit Connect EV</td>
<td>400</td>
<td>800</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>4,200</td>
</tr>
<tr>
<td>GM Chevrolet Volt</td>
<td>15,000</td>
<td>120,000</td>
<td>120,000</td>
<td>120,000</td>
<td>120,000</td>
<td>505,000</td>
</tr>
<tr>
<td>Navistar eStar EV (truck)</td>
<td>200</td>
<td>800</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>4,000</td>
</tr>
<tr>
<td>Nissan LEAF EV</td>
<td>25,000</td>
<td>25,000</td>
<td>50,000</td>
<td>100,000</td>
<td>100,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Smith Electric Vehicles</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Newton EV (truck)</td>
<td>1,000</td>
<td>5,000</td>
<td>10,000</td>
<td>20,000</td>
<td>20,000</td>
<td>55,000</td>
</tr>
<tr>
<td>Tesla Motors Model S EV</td>
<td>1,000</td>
<td>5,000</td>
<td>10,000</td>
<td>20,000</td>
<td>20,000</td>
<td>57,000</td>
</tr>
<tr>
<td>Tesla Motors Roadster EV</td>
<td>2,000</td>
<td>5,000</td>
<td>10,000</td>
<td>20,000</td>
<td>20,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Think City EV</td>
<td>2,000</td>
<td>5,000</td>
<td>10,000</td>
<td>20,000</td>
<td>20,000</td>
<td>57,000</td>
</tr>
</tbody>
</table>

**DOE Report.**

CAFE standards, discussed in detail in section 9.4, have helped to expand fuel-efficient vehicle options available to consumers. See MIT Energy Initiative Report. Such options are displayed in the following chart:

<table>
<thead>
<tr>
<th>Vehicle Class</th>
<th>Explanation</th>
<th>Pros</th>
<th>Cons</th>
<th>Typical MPG</th>
<th>Price</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Combustion</td>
<td>An internal combustion engine drives vehicle propulsion</td>
<td>Inexpensive; well-developed technology</td>
<td>Limited greenhouse gas emissions control</td>
<td>~10 - 30 mpg</td>
<td>$</td>
<td>Any number of vehicles produced since the early 20th century</td>
</tr>
<tr>
<td>Model Type</td>
<td>Configuration</td>
<td>Benefits</td>
<td>Efficiency (mpg)</td>
<td>Price</td>
<td>Example Models</td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>------------------</td>
<td>-------</td>
<td>--------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Mild hybrid/Belted Alternator</td>
<td>An internal combustion engine primarily drives vehicle propulsion with limited assistance from a battery-powered electric motor</td>
<td>Relatively inexpensive; based on proven, established technology</td>
<td>~29</td>
<td>$$</td>
<td>2013 Chevrolet Malibu; 2013 Buick Lacrosse</td>
<td></td>
</tr>
<tr>
<td>Hybrid</td>
<td>An internal combustion engine and a battery-powered electric motor work together to drive vehicle propulsion</td>
<td>More complicated drivetrains may result in costly long-term maintenance</td>
<td>~38-50</td>
<td>$$$</td>
<td>2010 Toyota Prius; 2013 Ford Fusion Hybrid</td>
<td></td>
</tr>
<tr>
<td>Plug-in Hybrid</td>
<td>Battery-powered electric motor primarily drives vehicle propulsion with support from an internal combustion engine, usually only for battery recharge; battery can be charged via external plug</td>
<td>Improved fuel economy; inexpensive electric refueling; enhanced range</td>
<td>~100 equivalent</td>
<td>$$$$</td>
<td>2013 Ford Fusion Energi; 2013 Chevrolet Volt</td>
<td></td>
</tr>
<tr>
<td>Full electric</td>
<td>Battery-powered electric motor drives vehicle propulsion; battery is charged via external plug</td>
<td>Poorly developed charging infrastructure and above-average pricing may stifle consumer interest</td>
<td>~105</td>
<td>$$$$$</td>
<td>2013 Ford Focus EV; 2013 Tesla Model S</td>
<td></td>
</tr>
</tbody>
</table>

### 9.2.2 Compressed Natural Gas Vehicles

In addition to electric cars, another alternative to petroleum-fueled vehicles is compressed natural gas (CNG) vehicles. CNG vehicles are substantially similar to gasoline-fueled vehicles. Natural gas is stored in a tank, piped to an internal combustion engine, mixed with air and
combusted, driving pistons to turn a crankshaft. PSNC Energy. In fact, typical gasoline-powered vehicles can be converted to run on natural gas and the EPA has issued guidance stating that original vehicle warranties must remain valid after conversion (except where the conversion has caused the covered failure). Natural Gas Vehicles for America.

Contrary to popular perception, CNGs are relatively safe despite the natural gas tanks. The gas has a very high ignition point (1100°F) so it is rare for the gas to spontaneously ignite. The gas is stored in thick steel tubes, which have various mechanisms for releasing the gas should a problem occur. For example, some CNG containers have built-in temperature sensors so if the heat reaches a certain level, the gas is released before it can ignite.

How popular are CNGs in the United States and around the world? CNGs are not yet popular in the United States, in part due to the lack of infrastructure and fueling stations for the transportation of gas. Some countries, like Brazil and Argentina, have over one million CNG vehicles, which is about 5% of the in-country vehicles. IEA Report.

<table>
<thead>
<tr>
<th>Country</th>
<th>NGV market share (%)</th>
<th>Country</th>
<th>NGV market share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>61</td>
<td>Tajikistan</td>
<td>5</td>
</tr>
<tr>
<td>Armenia</td>
<td>30</td>
<td>India</td>
<td>5</td>
</tr>
<tr>
<td>Pakistan</td>
<td>26</td>
<td>Egypt</td>
<td>5</td>
</tr>
<tr>
<td>Bolivia</td>
<td>26</td>
<td>Kyrgyzstan</td>
<td>3</td>
</tr>
<tr>
<td>Argentina</td>
<td>24</td>
<td>Ukraine</td>
<td>3</td>
</tr>
<tr>
<td>Colombia</td>
<td>24</td>
<td>Bulgaria</td>
<td>2</td>
</tr>
<tr>
<td>Iran</td>
<td>14</td>
<td>Italy</td>
<td>2</td>
</tr>
<tr>
<td>Malaysia</td>
<td>11</td>
<td>Moldova</td>
<td>1</td>
</tr>
<tr>
<td>Myanmar</td>
<td>8</td>
<td>Trinidad &amp; Tobago</td>
<td>1</td>
</tr>
<tr>
<td>Peru</td>
<td>7</td>
<td>China</td>
<td>1</td>
</tr>
<tr>
<td>Brazil</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: NGV Energy, NGV Communications Group.

IEA Report

The number of CNG vehicles worldwide has increased steadily since 2000. Many countries have been quick to adopt the use of this alternative fuel. New Delhi converted approximately 60,000 rickshaws into CNG-powered vehicles. And in 2002, the Indian Supreme Court ordered the city’s entire bus fleet to convert to CNG power, a decision resulting from a government-issued air pollution guidance. Who Changed Delhi’s Air?. A government report stated...
that while the number of vehicles in New Delhi doubled, the pollution rate was nearly halved.

The United States has had moderate success implementing CNG vehicle requirements. Many large cities with air pollution problems -- including Atlanta, Las Vegas, and Los Angeles -- have adopted CNG-vehicle requirements for buses, taxis and other highly-used vehicles. By fueling much-used vehicles with natural gas, the vehicles’ contribution to emission levels has been reduced.

One reason the United States has lagged in the production/demand for CNG vehicles is customer preferences. CNG tanks take up a lot of room in vehicles and limit trunk space and vehicle size. In addition, only a few models are in production and only a few fueling stations across the country. Finally, U.S. consumers perceive that CNG tanks are not safe for driving. The EIA has projected a rapid increase in natural gas-powered transportation, especially in heavy-duty vehicles and in freight rail. However, natural gas would still only account for 3% of the total transportation sector’s energy consumption by 2040.
9.2.3 Hydrogen Fuel Cell Vehicles

Another potential replacement for petroleum is fuel cells, electrochemical systems in which hydrogen gas powers the vehicle. Hydrogen gas flowing through channels separates into protons and electrons, which can be used to generate power. EERE Report. The only significant byproduct is water. The process is much more efficient than other forms of energy production, such as internal combustion or steam engines, because there is no heat loss or need to turn the reaction into energy through mechanical means. See Department of Energy, “Comparison of Fuel Cell Technologies.”

Several initiatives are currently underway to increase the application of fuel-cell-powered vehicles. Under the Energy Policy Act of 2005, 42 USC § 13201 et seq., the Department of Energy (DOE) can enter into grants for the development and use of such vehicles in local governments. For example, the Chicago Transit Authority currently has three hydrogen-powered fuel cell buses. In 2003, President Bush announced a $1.2 billion Hydrogen Fuel Initiative to aid in the efforts of government and private sector investments into developing commercially successful hydrogen fuel technology. See CNN, “Bush touts benefits of hydrogen fuel.” However, in 2009, DOE Secretary Chu announced the department was not continuing research under the program. See Huffington Post, “Chu Says ‘No’ To Hydrogen Fuel Cell Research.” Despite this setback, California has continued to develop hydrogen initiatives by granting funding to construct new hydrogen fueling stations.
Some car manufacturers have also started producing fuel cell-powered vehicles. Honda has deployed a hydrogen fuel cell vehicle named the FCX Clarity. Featured on the British car show Top Gear (see also Top Gear Video), the FCX Clarity uses hydrogen fuel cell technology to generate electricity, stores the electricity in a lithium-ion battery, and then transfers the power to an electric drive motor for vehicle propulsion.

While fuel cell technology is promising, it has several disadvantages. First, fuel cells are currently ten times more expensive than an internal combustion engine and hydrogen is 3-4 times more expensive to produce than gasoline. Second, the current production of hydrogen typically involves the conversion of natural gas, a process that results in carbon dioxide emissions. EESI. Third, battery-powered cars are about three-and-a-half times more efficient than hydrogen-fuel-powered cars. See “A Cost Comparison of Fuel-Cell and Battery Electric Vehicles.” Finally, the public’s perception of hydrogen safety is generally negative, though hydrogen is no more dangerous than gasoline or similar fuels.

In sum, there are a number of alternative-fuel vehicles available to the driving public. How private industry develops these vehicles will be depend on market forces, technological developments, and federal (and sometimes state) standards.

9.3 Biofuels
Over the past couple decades, the increase in the price of oil and the growing awareness of the environmental harm and climate effects of petroleum use have led to an interest in cleaner, cheaper biofuels.

Biofuels are produced either directly or indirectly from organic material derived from living organisms. Traditional, unprocessed biofuels include firewood, charcoal and animal dung. See Greenfacts, "Scientific Facts on Liquid Biofuels for Transport." The most common types of modern biofuels include ethanol and biodiesel. See: NREL, "Biofuel Basics." Ethanol is an alcohol made by fermenting biomass (biological material) in a process similar to beer brewing. In the United States, ethanol is most commonly used as a blending agent with gasoline. Biodiesel -- created from plant oils or animal fat -- can be used in a diesel engine and is sometimes blended with petroleum-based diesel.

While the federal government and some states have sought to create incentives for the production and use of biofuels, there is much disagreement about how beneficial biofuels are economically and environmentally. See Congressional Budget Office, “Using Biofuel Tax Credits to Achieve Energy and Environmental Policy Goals.” Many tout this type of fuel as a method for energy security because biofuels are a renewable resource that can be created domestically, while others believe the benefits are illusory given that the production of some biofuels uses as much petroleum-based fuels as is produced in biofuels. In addition, biofuel production can affect food supply and is not economically feasible with present technology.

### 9.3.1 Biofuel Production

Biofuels (especially ethanol) have been supported by federal mandates. Section 1501 of the Energy Policy Act of 2005, 42 USC § 3201 et seq., required the EPA to establish a Renewable Fuel Standard (RFS) to increase the amount of renewable fuel that can be blended with gasoline. See EPA, “Renewable Fuels: Regulations & Standards.” The Act also required that 9 billion gallons of ethanol to be blended in gasoline in 2008, increasing to 36 billion gallons by 2022. In May 2009, the EPA proposed revisions to the RFS, known as RFS2, including new greenhouse gas emission standards and increasing the amount of ethanol to be blended in gasoline.

Critics of these mandates claim that the renewable fuel mandate subsidizes the pockets of corn farmers and corn-based ethanol producers at the expense of consumers and aid programs that depend on excess corn for food. How Stuff Works, “Biofuel Criticism.” Land for corn harvesting is a limited resource, and ethanol critics note that corn should be used primarily as a food source, rather than an energy source. Furthermore, poverty-stricken regions could receive less access to corn, a vital food source, if surplus corn is used as an energy source. Due to concerns about corn-based ethanol, the Energy Independence and Security Act of 2007 (EISA),
Chapter 9 – Transportation

42 USC § 17001 et seq., requires that corn-based ethanol production reach a peak in 2015 so that other types of more-advanced biofuels can be created. Additionally, the EPA Administrator has authority to temporarily waive part of the biofuels mandate to ease market concerns should they arise.

9.3.2 Conventional Ethanol

The most important type of biofuels is ethanol. As of 2011, the majority of ethanol came from cornstarch, with only experimental amounts coming from other sources. In the United States, most ethanol is blended into gasoline at up to 10%. The resulting fuel is called E10 or “gasohol.” Since the 1970s, cars and light trucks built for the United States market have been able to run on this E10 blend. Certain carmakers also produce a limited number of Flexible Fuel Vehicles, which can run on a blend of gasoline and ethanol containing up to 85% ethanol. However, this “E85” is hard to find because it requires a separate supply stream in which ethanol is mixed with gasoline onsite.

While ethanol use was previously restricted to 10% by volume in gasoline, the EPA took actions in 2010 and 2011 to expand the use of ethanol. In response to requests by 54 ethanol manufacturers, the EPA granted waivers under the Clean Air Act to enable gasoline with up to 15% ethanol to be introduced commercially. This E15 gasoline may be used in vehicles model year 2001 and newer. Practical barriers remain to expanded ethanol use because most fuel stations do not have enough pumps to offer this new blend. See: New York Times: "A Bit More Ethanol in the Gas Tank."

The Obama Administration announced a goal of installing 10,000 blender pumps by 2015, which would dispense blends including E85, E50, E30 and E20. Green Car Congress. The USDA has also issued rules to provide incentives for the installation of blender pumps. In response to the EPA’s approval of E15, a lawsuit was filed by a group of car manufacturers, food makers and oil refiners in 2012. "Federal appeals court upholds EPA plan to add more ethanol to gasoline." The plaintiffs argued that approval of the higher ethanol blend would harm them by increasing the price of corn and subjecting car manufacturers to increased liability over potential engine malfunctions. The DC Circuit rejected the lawsuit, and held that there was no causal link between the EPA’s decision and the alleged costs the petitioners would incur.

Impact on energy security. One popular argument for the use of biofuels is energy security. While the United States can produce biofuels domestically, it has historically imported a large part of its oil. The security concern is that the use and importation of oil makes the United States dependent on the foreign supply of oil and the international market prices for oil. If something were to happen to an oil-producing country, the U.S. economy would be adversely affected. With
biofuels on the rise, it remains to be seen whether such biofuels will ever make a dent in our use of oil imports. According to a 2008 analysis by Iowa State University, the growth in US ethanol production has resulted in retail gasoline prices to be US $0.29 to US $0.40 per gallon lower than would otherwise have been the case. While it’s estimated that 36 billion gallons of domestic ethanol will be used annually by 2022, the United States consumed 134 billion gallons of gasoline in 2011. US Energy Information Administration. The EIA suggests that biofuels may be able to displace 27% of transportation fuels by 2050. See Platts.

**Impact on carbon emissions.** While biofuels look to become more widely used in the United States over the next decades, cost-benefit analyses of biofuels like ethanol remain inconclusive. While ethanol may seem to be a “renewable” source of energy, studies suggest it takes more imported “unclean” energy to produce usable ethanol than that usable ethanol itself provides in energy. To make ethanol, and biodiesels generally, a great amount of fossil fuels must be used. For example, Cornell Ecologist David Pimental has concluded that “Ethanol production using corn grain requires 29% more fossil energy than the ethanol fuel produced.” David Pimental and Tad W. Patzek, *Ethanol Production Using Corn, Switchgrass, and Wood*, 14 Natural Resources Research 65 (2005).

Thus, ethanol critics claim that ethanol does not improve the environment or combat climate change. See USA Today, “Ethanol comes with environmental impact, despite green image.” Although the burning of ethanol simply returns recently captured carbon into the atmosphere – thus producing (in theory) no net increase in atmospheric carbon -- ethanol production is fueled mostly by fossil fuels, and carbon emissions from those processes must be added into the equation when considering ethanol’s net environmental effects.

Given the increasing evidence on the total environmental impact of “clean” biofuels, some governments are scaling back their support for biofuels. For example, Germany (once a leading producer of biofuel in Europe) has canceled tax exemptions for biodiesel in 2009. Since repealing the tax exemptions, demand for biofuels in Germany has fallen by half. “Germany Biofuel Industry Collapsing Under New Taxes”

The debate on biofuels, however, continues. The criticism of corn-based ethanol being carbon-positive does not necessarily apply to other types of ethanol and biofuels. For example, ethanol produced from cane sugar (the prevalent method of production outside the United States) results in a mostly carbon-neutral fuel. This is also true of biodiesel produced from agricultural and recycled oils, or in some cases from algae and sewage. See National Biodiesel Board, “What is biodiesel?”; Wikipedia, Biodiesel.
Impact on food prices. Using corn to produce ethanol has consequences across many markets, food and otherwise. For instance, in 2008, corn-based ethanol production decreased the livestock feed supplies, thus driving feed (and meat and corn sweetener) prices higher. See Congressional Budget Office, “The Impact of Ethanol Use on Food Prices and Greenhouse-Gas Emissions.” In response, many states, most notably Texas, asked the EPA for exemptions to the ethanol-blending mandate, arguing that droughts throughout the Midwest have devastated crops and that diverting corn to ethanol production will further raise prices and limit the availability of corn for consumption. The EPA denied the requests. See "EPA rejects governors' requests to waive ethanol mandate."

Similar criticisms have been echoed in the international community. In 2008, the UN special rapporteur for the right to food, Jean Ziegler of Switzerland, found a steep increase in worldwide food prices and asserted that “producing biofuels is a crime against humanity.” However, a 2010 study by the World Bank found the link between food prices and biofuel production to be exaggerated, stating, “the effect of biofuels on food prices has not been as large as originally thought, but that the use of commodities by financial investors (the so-called "financialization of commodities") may have been partly responsible for the 2007/08 spike [in food prices."

Impact on rural development. Midwestern farmers have been vocal supporters of ethanol. Selling corn for ethanol production has been so profitable that many farmers have planted corn rather than soybeans. While some farmers have benefited from increased ethanol production, the benefit to rural communities as a whole has been mixed. For example, increased ethanol production has generally hurt livestock producers by driving up the cost of feed.
Renewable Fuel Association

**Delivery infrastructure.** Nearly all U.S. ethanol production facilities are located in the Midwest, close to where most corn is grown. Because ethanol is usually delivered on rail cars and barges, instead of through pipelines, high shipment costs affect its price.

Ethanol pipelines are rare because ethanol is an alcohol that can corrode and crack pipes. **New York Times: "An ethanol pipeline begins service."** To move ethanol in a pipeline, special additives are required. The first ethanol pipeline in the United States, completed in 2008, transported ethanol from Tampa to Orlando. In 2012, a new ethanol pipeline was completed between New Jersey and New York. **Biofuels Digest.** A much larger pipeline, the largest in the world extending 1,800 miles across seven states, is also being considered. **CNN: "Building the world's longest ethanol pipeline,"** The pipeline would carry ethanol from the ethanol production hub of the Midwest to the Northeast.
As of 2014, this $3.5 billion pipeline has been placed on hold. "Ethanol pipeline on hold." The pipeline depends on public financing or federal loan guarantees, neither of which has yet been approved by Congress.

### 9.3.3. Biodiesel Potential

The agricultural industry has long promoted “biodiesel” made from agricultural material. See Biodiesel, “Biodiesel Basics.” The idea of vegetable oil as fuel has been around since the creation of the diesel engine. Advantages of biodiesel are many: it is biodegradable, non-toxic, and safer to handle than petroleum-based diesel; it produces less air pollutants, other than nitrogen oxides, and less greenhouse gas emissions (a biodiesel 20% blend reduces carbon dioxide emissions by 15%). See "Biodiesel compared to petroleum diesel."

Still, biodiesels gave disadvantages, most notably their high cost of production. And biodiesel blends above 5% are not approved by many vehicle manufacturers. Further, biodiesels provide lower fuel economy, less power, and pure biodiesels are unusable in low temperatures.

The most common blends of biodiesels with petroleum-based diesel are in 2%, 5%, and 20% increments (known as B2, B5, and B20, respectively). Individual engine warranties generally accept B5 and will sometimes accommodate B20 as well. The most common source of biodiesel production in the United States is soybean oil. In Europe, rapeseed and sunflower oil is most often used.
One interesting method of biodiesel production being explored is through algae. See Oilgae. Scientists are searching among thousands of algae species to find one that has the most efficient and desirable characteristics for biofuel production. Algae grow quickly, consume carbon dioxide, and can generate more than 5,000 gallons yearly, on a single acre – by comparison, ethanol generates 350 gallons per acre. One American venture, Sapphire Energy, hopes to make millions of barrels a day from tens of thousands of acres devoted to algae farms across the Gulf Coast and Pacific Northwest. In June 2012, Sapphire began harvesting algae and by the end of the year, 100 acres of algae had been cultivated. "Sapphire's algae-to-oil farm begins to take shape." The company claims that by the end of 2014, the farm will be able to produce 1.5 million gallons of crude oil per year or 100 barrels per day.

Chinese scientists are also focusing on algae as a source of biofuel production. To mitigate the impact on cropland, scientists note that the coastline of mainland China stretches for some 18,000 kilometers and has extensive “swamp wetland and marches suitable for large scale cyclic cultivation of oil-bearing microalgae.”

9.3.4. Cellulosic Ethanol

Another potential source of biofuel is cellulosic ethanol produced from wood, grasses, or the non-edible parts of plants. Wikipedia, “Cellulosic ethanol.” The potential of cellulosic ethanol is unknown; its production still awaits scientific advances for breaking down cellulosic material.

At present, cellulosic ethanol would seem costly. One study has found that the cost of a conventional grain ethanol plant was about $111 million, but around $854 million for an advanced biorefinery. In addition, many of the possible sources of cellulose ethanol -- such as rice straw, wheat straw, forest thinning and switchgrass -- have significant transportation costs.

Nonetheless, cellulosic ethanol has important advantages, including that it would reduce nitrogen oxide emissions, the main cause of smog and haze. How Stuff Works: "Benefits of Cellulosic Ethanol." Furthermore, cellulose is an inexhaustible resource, and even more widely available than corn or any other source of ethanol.

Under both Presidents Bush and Obama, the federal government has provided approximately $1.5 billion in grants and loan subsidies to cellulosic ethanol producers. Wall Street Journal: "Review and outlook: the cellulosic ethanol debacle." An energy bill passed in 2007 established a tax credit of $1.01 per gallon produced. A later law mandated that oil companies begin to blend cellulosic fuel. The EISA mandate was 100 million gallons in 2010, 250 million gallons in 2011 and 500 million gallons in 2012. Despite these mandates, cellulosic fuel production has not increased as expected. The EPA revised the previous mandates in 2011, lowering the 2011
Renewable Fuel Standard for biodiesels from 250 million gallons to 6.6 million. See EPA, “Renewable Fuel Standard (RFS).” However, even though existing output of cellulosic biofuels has come only from pilot and demonstration projects, the EPA found that “a number of companies appear to be poised to expand production over the next several years.”

Despite these goals, in 2013 the D.C. Court of Appeals threw out a federal rule on renewable fuels, saying that a quota set by the EPA for incorporating liquids made from woody crops and wastes into car and truck fuels was based on wishful thinking rather than realistic estimates of what could be achieved. Therefore, in the short-term at least, it appears that cellulosic ethanol cannot meet the energy security and environmental goals of a gasoline alternative.

9.4 Regulation of U.S. Automobiles

To help consumers and reduce net emissions, the federal government regulates both fuel efficiency and vehicle emission standards. Corporate Average Fuel Economy (CAFE) standards provide minimum fuel economy standards for vehicles sold in the United States, and the EPA under the Clean Air Act regulates vehicle emissions.

In addition, the government has played a significant role in the U.S. auto industry. In response to the Great Recession, the government provided large loans to Chrysler and GM in a successful effort to help these companies avoid bankruptcy. Around the same time, the government instituted a “Cash for Clunkers” program with a dual goal of promoting fuel efficiency and increasing auto sales.

9.4.1 Restructuring U.S. Vehicle Manufacturing after the Great Recession

The near-collapse of the U.S. auto industry resulted from two forces that had their origins in the 1990s. Fuel efficiency regulations favored vehicle fuel inefficiency, and dividends to shareholders were paid out at the expense of research and development budgets for more efficient vehicles. As a result, the industry was ill-prepared to weather the combination of higher fuel prices and a world-wide economic downturn.

After the terrorist attacks on September 11, 2001, consumers became reluctant to buy big-ticket items, especially cars. In response, automakers offered large incentives that encouraged car buyers, but led to production levels that were not sustainable. Eventually, companies were forced to reduce production volumes, while keeping many (excess) workers under union agreements.

The year 2007 marked a historic turning point in the American automotive industry. The Great Recession hit the industry especially hard. New vehicle sales plummeted starting in the
autumn of 2007, reaching decade lows. For the first time, U.S. automakers’ share of the domestic market fell below 50%. Sales continued to fall in 2008, dropping to their lowest levels since 1992. Edmunds Auto Observer, “2008 US Auto Sales Are Worst Since 1992.” At the same time, oil prices rose sharply, skyrocketing to $145/barrel during the summer of 2008. The rise was thought to have been caused by speculation surrounding the increase in oil demand of developing nations, especially China and India. Stanford, "Investor Flows Were Behind the 2008 Oil Price Ride”.

In 2008, Chrysler and GM were on the brink of bankruptcy. The federal government gave the companies emergency loans totaling $17.4 billion, which was increased to $65 billion in 2009. See US News, “Bush Offers Chrysler, GM $17.4 Billion Bailout – With Strings.” In spite of this, GM filed for bankruptcy in June 2009. See CNN, “GM Bankruptcy: End of an era.” At the time, it was estimated that the “rescue” of the car industry could cost American taxpayers close to $100 billion. See The Wall Street Journal, “GM Collapses Into Government’s Arms.” The government assumed ownership and management authority of GM while the company steered through and emerged from bankruptcy proceedings. Wikipedia, "Effects of the 2008-2010 Automotive Industry Crisis on the United States.

After the bailout and despite dire predictions, the US automakers rebounded. In July 2011 the government sold its remaining stake in Chrysler to FIAT. US NEWS, “US Sells Remaining Chrysler Shares to FIAT.” In 2012, after substantial sector growth in which US automaker posted 13% year-over-year growth, both GM and Chrysler paid back all off their emergency loan debt. In December 2013, the Treasury Department sold its final shares of GM stock. While the government said it lost about $10.5 billion on its investment of $49.5 billion, the government’s exit paved the way for an influx of fresh investor money into the companies.

9.4.2 CAFE Standards: EISA 2007 & Obama Administration Agreements

While the auto market was beginning its downward spiral in 2007, Congress revised the existing CAFE standards in the Energy Independence and Security Act (EISA), which was signed into law by President Bush in December 2007.

Since 1975 vehicle fuel efficiency has been regulated under the Corporate Average Fuel Economy (CAFE) standards. In response to the 1973 Arab Oil Embargo, Congress enacted the first CAFE standards in 1975 with the goal of increasing fuel economy for cars and light trucks sold in the United States. Regulatory oversight of the CAFE standards falls to the National Highway Transportation Safety Administration.
Historically, CAFE is a fuel economy minimum, expressed in miles per gallon, for an individual auto manufacturer’s fleet of cars or light trucks. If a manufacturer’s fleet falls below the CAFE minimum, the manufacturer must pay a penalty of $5.50 per 0.1 miles per gallon for each vehicle sold below the CAFE minimum produced by the manufacturer for U.S. domestic sale during the offending year. As of 2011, CAFE standards were determined per vehicle model based on the vehicle’s “footprint,” or a mathematical formula that multiples the vehicle’s wheel base by its track width. NHTSA, "Corporate Average Fuel Economy Standards, Final Rule".

Both EISA and later agreements under the Obama administration have continued to raise CAFE minimum standards. Under a 2011 agreement between the Obama administration and the major U.S. automakers, CAFE standards will rise to 54.5 miles per gallon for cars and light-duty trucks by 2025. Wikipedia, "Corporate Average Fuel Economy".

<table>
<thead>
<tr>
<th>Model Year</th>
<th>Passenger Cars</th>
<th>Light Trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;footprint&quot;: 41 sq ft (3.8 m²) or smaller (e.g. 2011 Honda Fit)</td>
<td>&quot;footprint&quot;: 55 sq ft (5.1 m²) or bigger (e.g. Mercedes-Benz S-Class)</td>
</tr>
<tr>
<td></td>
<td>&quot;footprint&quot;: 41 sq ft (3.8 m²) or smaller (e.g. Chevy s10)</td>
<td>&quot;footprint&quot;: 75 sq ft (7.0 m²) or bigger (e.g. Ford F-150)</td>
</tr>
<tr>
<td>2012</td>
<td>36 27 28 21</td>
<td>30 23 22 17</td>
</tr>
<tr>
<td>2013</td>
<td>37 28 28.5 22</td>
<td>31 24 22.5 17</td>
</tr>
<tr>
<td>2014</td>
<td>38 28 29 22</td>
<td>32 24 23 18</td>
</tr>
<tr>
<td>2015</td>
<td>39 29 30 23</td>
<td>33 25 23.5 18</td>
</tr>
<tr>
<td>2016</td>
<td>41 31 31 24</td>
<td>34 26 24.5 19</td>
</tr>
<tr>
<td>2017</td>
<td>44 33 33 25</td>
<td>36 27 25 19</td>
</tr>
<tr>
<td>2018</td>
<td>45 34 34 26</td>
<td>37 28 25 19</td>
</tr>
<tr>
<td>2019</td>
<td>47 35 35 26</td>
<td>36 28 25 19</td>
</tr>
<tr>
<td>2020</td>
<td>49 36 36 27</td>
<td>39 29 25 19</td>
</tr>
<tr>
<td>2021</td>
<td>51 37 38 28</td>
<td>42 31 25 19</td>
</tr>
<tr>
<td>2022</td>
<td>53 38 40 30</td>
<td>44 33 26 20</td>
</tr>
<tr>
<td>2023</td>
<td>56 40 42 31</td>
<td>46 34 27 21</td>
</tr>
<tr>
<td>2024</td>
<td>58 41 44 33</td>
<td>48 36 28.5 22</td>
</tr>
<tr>
<td>2025</td>
<td>60 43 46 34</td>
<td>50 37 30 23</td>
</tr>
</tbody>
</table>

9.4.3 Cash for Clunkers
In the summer 2009, Congress approved a program called the Car Allowance Rebate System, commonly referred to as “Cash for Clunkers.” The program had two goals: (1) put more fuel-efficient vehicles on the road; and (2) stimulate the economy by boosting new car sales, which had been declining precipitously for the previous two years. Committee on Energy & Commerce – Democrats, “New GAO Study Confirms ‘Cash for Clunkers’ Program Helped Economy, Environment.”

Cash for Clunkers worked like this: people with old, low-mpg cars were eligible for a $3,500-$4,500 credit towards the purchase of a new, high-mpg car. Although the program officially started on July 1, 2009, the processing of claims did not begin until July 24, and the program ended a month later on August 24. It was supposed to last until November, but so many people participated that the funding was exhausted before then. Wikipedia, “Car Allowance Rebate System.” All told, the government gave $2.88 billion in credits on the purchase of 700,000 new vehicles, just under the $3 billion authorized by Congress for the program. US Department of Transportation, “Cash for Clunkers ‘wildly successful.’”

Cash for Clunkers produced some interesting effects. For starters, it resulted in Asian automakers gaining a larger share of the U.S. market. Reuters, “Japanese, Koreans gain most from cash for clunkers.” Toyota benefited the most, accounting for 19.4% of Cash for Clunkers sales, followed by GM with 17.6%, Ford with 14.4% and Honda with 13.0%. US Department of Transportation, “Cash for Clunkers” The program also raised the price of used cars, given that the program required trade-ins to be scrapped, thus taking otherwise useable used cars out of the national supply. Boston.com, "'Clunkers' a Classic Government Folly.

Was the Cash for Clunkers program a success? Some commentators argued that the net effect of this supply shortage amounted to a tax on the poor. Foundation for Economic Education, “The ‘I Hate the Poor’ Act of 2009.” Others claimed that Cash for Clunkers was an economic-stimulus success. CNN, “Cash for Clunkers: Real Stimulus.” A recent study from the University of Delaware found that the costs of the program exceeded the benefits by an average of $2,000 per car, with total costs outweighing all benefits by $1.4 billion. Wikipedia, “Car Allowance Rebate System.” Another study analyzing fuel saving resulting from the program showed $2.8 billion in saving thanks to the early retirement of less-efficient vehicles. Truecostblog.com, "Was Cash For Clunkers a Success?".

9.4.4 Automotive Air Pollution Regulation

Car and light-truck emission standards are regulated by the Environmental Protection Agency (EPA) under the Clean Air Act (CAA). In 1990, the CAA was amended to define emission standards for vehicles starting in model-year 1996. This came to be known as Tier 1.
For model years after 2004, Tier 2 (with a gradual phase-in period) has set national emission standards for all cars and light trucks. Edmunds.com, "Untangling US Vehicle Emissions Regulations".

Tier 2 regulates five tailpipe pollutants—non-methane organic gases, carbon monoxide, oxides of nitrogen, particulate matter, and formaldehyde. The amount of each of these pollutants that a total fleet may emit is determined through eight “permanent” certification levels, known as bins – with Bin 8 allowing for the most emissions, and bin 1 for none. A fleet may contain as many bin 8 vehicles as the manufacturer so desires, so long as the rest of the fleet is balanced out with vehicles of a low enough bin that the total fleet meets the minimum level required during that model year. In determining a vehicle’s emissions, the EPA measures emissions released in both city and highway driving scenarios. Edmunds.com, "Untangling US Vehicle Emissions Regulations, Part II".

Over time, the industry has made huge improvements in emissions, mostly through technological innovation such as catalytic converters, advanced combustion systems, and computerized engine management. That said, much debate remains as to the extent to which government may facilitate more rapid emissions and efficiency improvements in the automotive sector, with many arguing that increased public private partnership can both improve the U.S. automotive sector and the environment. Scientific American, "Transforming the Auto Industry".

The CAA also gives the EPA the authority to regulate the additives and composition of fuels, such as gasoline and diesel fuel, if the agency finds the substance may “reasonably be anticipated to endanger the public health or welfare.” See 42 USC § 7545(c)(1). Under the CAA, emissions of carbon monoxide, sulfur, and ozone have all declined on a per-vehicle basis.

A famous example of the exercise of this power is the phase out and subsequent ban on leaded gasoline that occurred during the 1970s and 1980s. In 1972 the EPA announced that all gas stations had to phase out use of leaded gasoline, an action upheld by the courts in Lead Industries of America v. EPA (2d Cir. 1980). Environmental History Timeline, "Special Timeline: Leaded Gasoline".

9.5 Cars and Suburban Sprawl

9.5.1 American Decentralization

America has had a tendency toward decentralization. Compared to people in other cultures, Americans seem to seek a higher degree of personal space and privacy. Private vehicles – and the interstate highway system -- have been a means to achieving this end.
After World War II, mass transit was discouraged. Under the Interstate Highway Act of 1956, all taxes on gasoline and related equipment have been used exclusively for road construction and maintenance. Although in the 1990s Congress enacted legislation to encourage mass transit, the initiatives produced little effect. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), significantly increasing the funds for non-highway modes of transportation, brought attention to other modes of transportation, but did not cause a dramatic shift away from highway transit. The Transportation Equity Act for the Twenty-First Century (TEA-21) of 1998 supported initiatives broadening the range of transportation alternatives, but again little happened.

Then in 2005, Congress took a step away from public transit in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), 23 USC § 101 et seq., which represented a return to the historical preference for highways. Under the Act, funding for new roads was distributed to the states, but mass transit projects had to compete with projects from throughout the nation for funding.

### 9.5.2 American Recentralization

Historically, individual vehicles like cars (as opposed to mass transit vehicles like buses) were a virtual necessity for most people who lived in the rural parts of the United States. Many alternative forms of public transportation, like subways, are only found in large cities. But alternative public transportation is on the rise. New technologies -- such as light rail and bus rapid transit (free-ranging buses with faster and more flexible service than standard bus lines) -- have made mass transit cost-effective in metropolitan areas. Between 1995 and 2002, transit trips increased by 20% nationwide.

In addition, some cities have created biking lanes and bike-rental stations. Commuting by bicycle is up 43% between 2000 and 2008.

High-speed rail is popular in industrialized nations, especially in Europe and Asian countries. In the United States, the Passenger Rail Investment and Improvement Act of 2008 and the American Recovery and Reinvestment Act of 2009 sought to support the development of these projects. In 2010, the Obama administration announced that it was awarding $8 billion to California, Florida, Ohio, and other states to begin developing a high-speed rail program.

But the President’s plans for a high-speed rail are in disarray and the projects are unable to get funding from a divided Congress. See “Obama’s New Cabinet Can Make Trains Run on Time.” Thus far, only California’s system looks like it will be up and running within the next 25
years. **Construction of the first phase** is expected to begin in 2014. There are many factors that have stunted the development of a high-speed rail: the governors of Wisconsin and Florida cancelled the high-speed lines planned for their states; and in California, the Obama administration vested power in the California High-Speed Rail Authority, which has little experience and a small staff. See, “Obama’s New Cabinet.” It has been estimated given the high costs of high-speed rail its widespread use in the United States will not become a reality until gas prices reach $18 per gallon.

Another approach to transportation issues has been urban planning -- known as new urbanism. By promoting dense urban development so that everything a person needs would be within walking distance, planners seek to reduce the need for automobile travel. Such neighborhoods emphasize walkways and bike paths. Some websites promoting new urbanism allow you to calculate the “walk score” of your current or future neighborhood. See walkscore.com. As gas prices rise and environmental consciousness spreads, these new urban neighborhoods have become more appealing. Many younger Americans realize that we cannot afford the “two SUV lifestyle.”

### 9.5.3 Improving our Motor Vehicle Network

Even with the increase in alternative forms of transportation, many believe that the motor vehicle network will still need to be improved to handle more traffic. One idea for improving the motor vehicle network is peak-hour pricing, which would charge drivers a premium for traveling at peak times. See Wikipedia, “Congestion Pricing.” However, implementation on a large scale has proven daunting, as demonstrated by the legislative defeat of a “congestion fee” proposed for

The New York City program met resistance from various quarters. Some argued that it would only benefit people in Manhattan and would cause surrounding suburbs to become more congested. Others argued that the congestion fee would benefit a small group of wealthy motorists, but most New Yorkers would find the program to be an annoyance. Nonetheless, the success of such programs in other cities around the world, such as London, may encourage American cities to consider them. See Wikipedia, “London Congestion Charge.”

Another proposal for improving the motor vehicle network is “connected vehicles,” using wireless connectivity technologies. Connected vehicles, which operate through sensors, actuators, and GPS systems, are being implanted into future electric cars. The idea is that cars would communicate safety and mobility information with each other thus making roads safer and reducing congestion. This connectivity has raised privacy concerns for some, who claim that it would create a personal tracking system since it emits location, speed, and direction of travel, but others point to the safety and sustainability benefits that connected vehicles would provide, such as traffic management, predictable routing, pre-pay parking, and overall shorter travel time.

The image below shows how a possible intelligence system could work in a vehicle. The image demonstrates that weather, location, and safety information would be sent to the connected vehicle system and would be sent to individual vehicles.

Diagram: The Detroit Bureau