

Petroleum Reduction Technologies

THE IMPORTANCE OF PETROLEUM REDUCTION TECHNOLOGIES

Acknowledgment: This material is based upon work supported by the U.S. Department of Energy Clean Cities Program under Award Number DE-EE001696.



U. S. Department of Energy



**National Alternative Fuels
Training Consortium**

A Program of

 **West Virginia University**

Clean Cities Learning Program

*Alternative Fuel and Advanced Technology Vehicles
Curricula, Training, and Education and Outreach Activities*

WORKSHOP BOOKLET

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National Alternative Fuels Training Consortium

A Program of



The Importance of Petroleum Reduction Technologies

The United States owns 2%-3% of the world's oil reserves, yet uses approximately 25% of the world's oil. As the world continues to become a mobile society, there is an increased urgency to find new energy sources, in order to maintain our freedom and lifestyle choices, and to coincide with our technological advancements.

As Americans continue their addiction to petroleum usage by owning multiple vehicles and expecting transportation on demand, energy independence is key.

Energy independence not only affects our nation's homeland security, but the security of all other developed countries, too. Petroleum prices continue to rise and have created financial hardships for Americans over the last several years. However, the massive utilization of gasoline and diesel fuels to operate conventional automobiles impacts more than just our wallets.

Vehicle emissions and pollutants produced from conventional internal combustion engines create global environmental concerns. They affect the planet's ecological balance, and our air quality continues to deteriorate at an alarming pace. The threat of global climate change adds another critical dimension, along with subsequent consequences for all of mankind.

There is a great need to continue building a strong alternative fuels and advanced technology vehicle industry infrastructure. The benefits of petroleum reduction technologies include energy independence and improved environmental conditions for years to come.

About the U.S. Department of Energy Clean Cities Program

The Clean Cities Program strives to advance the nation's economic, environmental, and energy security by supporting local decisions to adopt practices that contribute to the reduction of petroleum consumption. Clean Cities is part of the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy's Vehicle Technologies Program. Clean Cities has a network of approximately 90 volunteer coalitions that develop public/private partnerships to promote alternative fuel and advanced technology vehicles, fuel blends, fuel economy, hybrid vehicles, and idle reduction (see **Figure 1**).

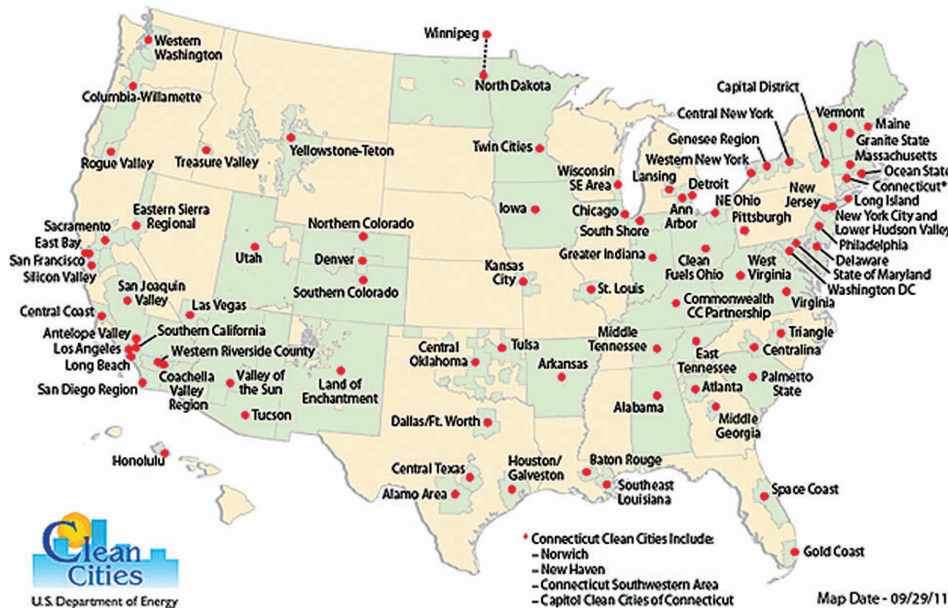


Figure 1: Clean Cities coalition locations. Source: DOE.

Clean Cities coalitions make an impact in their communities every day. Their activities stimulate local economies, facilitate the adoption of new transportation technologies, and make communities cleaner, healthier places to live.

About the National Alternative Fuels Training Consortium

The National Alternative Fuels Training Consortium (NAFTC) is a pioneer and a national leader in promoting programs and activities that help to alleviate America’s addiction to petroleum and lead to energy independence and the greater use of cleaner transportation. The NAFTC is the only nationwide alternative fuel and advanced technology vehicle training organization in the United States.

The NAFTC’s mission is to provide the training infrastructure for implementing widespread use of alternative fuels, alternative fuel vehicles (AFVs), and advanced technology vehicles, in an effort to increase our nation’s energy security, lessen our dependence on petroleum, and improve our air quality by reducing greenhouse gas emissions from our transportation system.

The NAFTC is a program of West Virginia University and consists of National Training Centers (NTCs) located nationwide from Maine to California. Each NTC provides Training with Impact through its experienced instructors and real world shop facilities.

About the Clean Cities Learning Program

The Clean Cities Learning Program is a project funded by a grant from the U.S. Department of Energy (DOE) Clean Cities Program under Award Number DE-EE0001696.

Developed by the National Alternative Fuels Training Consortium (NAFTC), West Virginia University, and its partners, the Clean Cities Learning Program will raise awareness and foster a greater understanding of alternative fuel and advanced technology vehicles. This effort will provide Clean Cities Coalitions and other stakeholders with state-of-the art curricula and training, education and outreach materials, and a concentrated marketing and communications plan.

One of the most unique aspects of this project is the focus on developing a nationwide partnership between Clean Cities Coalitions and NAFTC National Training Centers. This partnership will provide target audiences with awareness and technical education that encourage decisions to adopt vehicles and fuels that will significantly reduce the consumption of petroleum-based fuels.

Reducing Petroleum Consumption

Petroleum is the most consumed energy source in the U.S. (see Figure 2). Current consumption levels are higher than domestic production levels, so a significant amount of petroleum is imported from other countries. According to the Energy Information Administration (EIA), the U.S. spends \$297 billion per year, or \$5.7 billion per week, on petroleum imports. Transportation accounts for a large portion of U.S. energy consumption (see Figure 3).

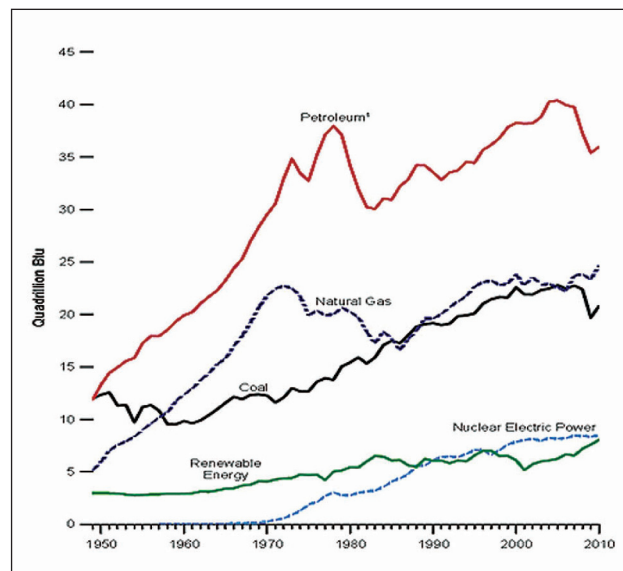


Figure 2: Primary energy consumption by major source, 1949-2010. Source: EIA Annual Energy Review 2011.

Figure 4 illustrates the relationship between the supply source and demand sector information and includes the electric power sector, which is not included in Figure 3. The reliance of the transportation sector on petroleum sources is alarming but emphasizes the opportunity to significantly reduce U.S. petroleum consumption by focusing on alternatives, such as alternative fuel and advanced technology vehicles.

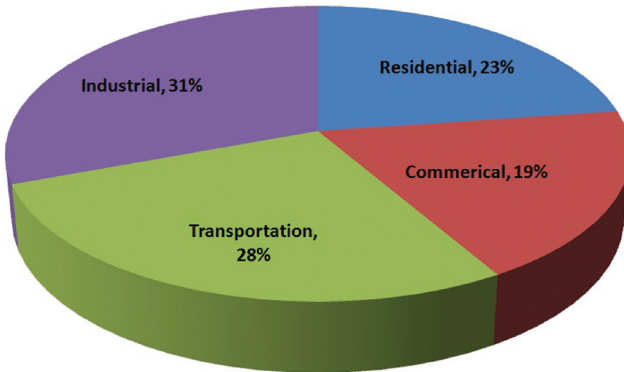


Figure 3: End-use shares of total energy consumption, 2010. Source: EIA Annual Energy Review 2011.

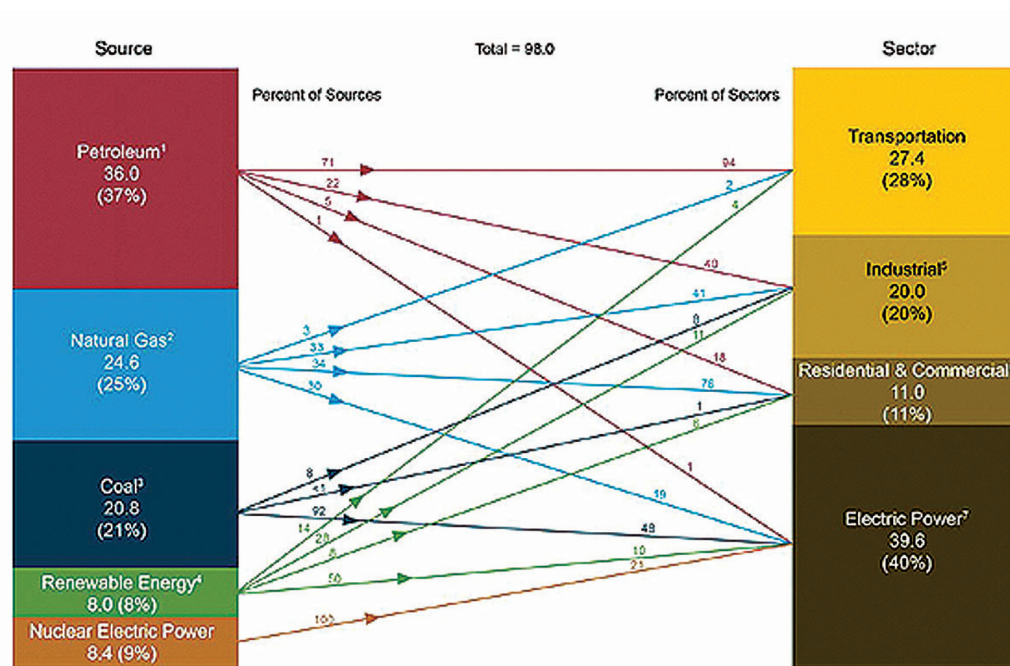


Figure 4: Primary energy consumption by source and sector, 2010. Source: EIA Annual Energy Review 2011.

Reducing Emissions

Vehicle emissions can have negative effects on air quality as well as human health. On a global scale, the use of fossil fuels is the chief contributor of anthropogenic (caused by human activity) greenhouse gas (GHG) emissions (see **Figure 5**). The main GHG of concern is carbon dioxide (CO₂).

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Shifting the focus to the U.S., transportation activities account for the second largest portion of the nation's CO₂ emissions (see **Figure 6**). This emphasizes the opportunity to significantly reduce GHGs through the use of alternative fuels and reduced petroleum consumption.

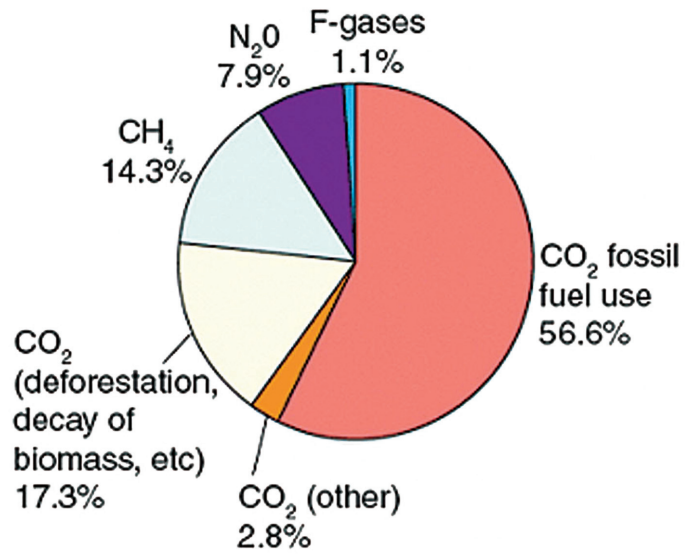


Figure 5: Global anthropogenic greenhouse gas emissions, 2004. Source: Intergovernmental Panel on Climate Change 4th Assessment. Report: Climate Change 2007: Synthesis Report.

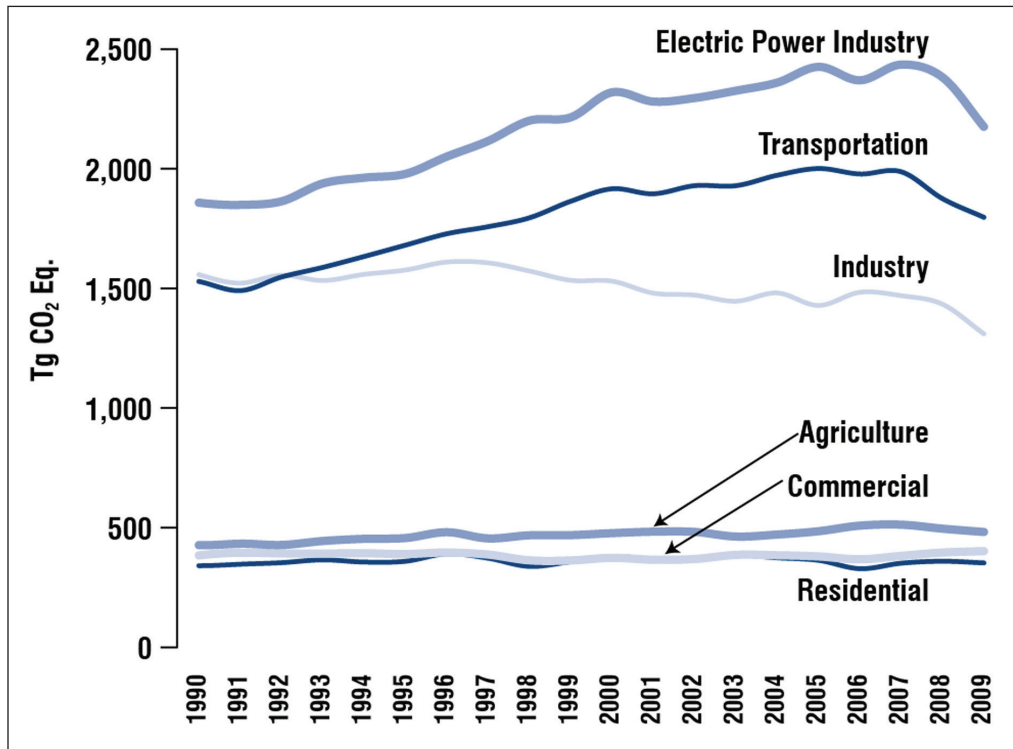


Figure 6: Emissions allocated to economic sectors. Source: U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2009.

The U.S. EPA regulates the production of emissions other than CO₂ for conventional and alternative fuel vehicles. The main regulated emissions are oxides of nitrogen (NO_x), carbon monoxide (CO), hydrocarbons (HC), and particulate matter (PM). These emissions have negative environmental and health effects (see **Figure 7**). They also can lead to secondary emissions problems such as the formation of smog in heavily congested area. Smog or ground level ozone is monitored by the EPA and also has negative impacts on health and the environment.

Regulated Emission	Abbreviation	Negative Impacts
Oxides of nitrogen	NO _x	Contributes to smog/ozone formation and acid rain
Carbon monoxide	CO	Poisonous, can displace oxygen causing suffocation
Hydrocarbons	HC	May be carcinogenic and contributes to smog
Particulate matter	PM, soot	May be carcinogenic, respiratory irritant, can contribute to smog and acid rain

Figure 7: Major regulated tailpipe emissions. Source: NAFTA.

Reduced petroleum consumption and decreased emissions are not the only benefits of utilizing alternative fuel and advanced technology vehicles. According to the Pew Charitable Trust, jobs in the environmentally friendly production industry, which includes biofuel and hybrid electric vehicle production, increased by 67% from 1998 to 2007. There is great potential for alternative fuel and advanced technology vehicles to continue contributing to economic growth. The increase in jobs in these industries is the result of research and development efforts, feedstock generation, renewable fuel production and distribution, vehicle conversions and maintenance, and fueling infrastructure development.

The Need for Alternative Fuels and Advanced Technology Vehicles

Alternative fuel and advanced technology vehicles have evolved significantly over the years. The production and use of these vehicles have been driven by multiple forces, including federal and state regulation, consumer acceptance, and consumer demand.

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Federal Requirements

First enacted by Congress in 1975, the purpose of Corporate Average Fuel Economy (CAFE) standards is to reduce energy consumption by increasing the fuel economy of cars and light-duty trucks. The Act was passed in response to the 1973 Oil Embargo. The near-term goal was to double new car fuel economy by model year 1985. The current goal of 27.5 has been in place for years, but the current administration has nearly doubled the standard through 2025.

Figure 8 shows the CAFE standards for light-duty passenger cars from its inception to the 2025 goal of more than 50 MPG.

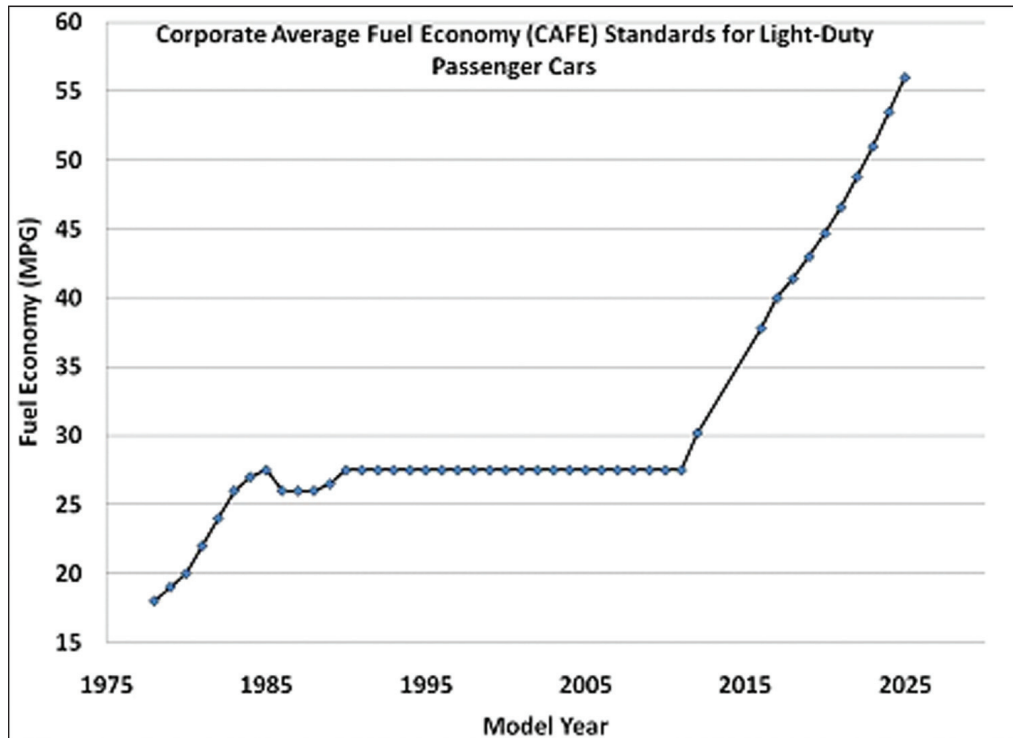


Figure 8: CAFE fuel economy standards for passenger cars. Source: National Highway Traffic Safety Administration (NHTSA).

The Energy Policy Act of 1992 (EPA 1992) was enacted with the purpose of reducing U.S. dependence on imported petroleum and improving air quality by addressing all aspects of energy supply and demand. EPA 1992 encourages the use of alternative fuel and advanced technology vehicles through voluntary and regulatory activities and approaches carried out by the DOE. Voluntary activities to promote alternative fuel and advanced technology vehicles, mainly focused on local efforts, are implemented primarily through the Clean Cities Program. EPA 1992 regulations require that certain federal, state, and alternative fuel provider fleets build an inventory of AFVs.

DEFINITION: ALTERNATIVE FUELS

As defined by EPAAct 1992, alternative fuels are methanol, ethanol, and other alcohols; blends of 85% or more of alcohol with gasoline (E85); natural gas and liquid fuels domestically produced from natural gas; liquefied petroleum gas (propane); hydrogen; electricity; biodiesel (B100); coal-derived liquid fuels; other than alcohol, derived from biological materials; and P-Series fuels (added to the definition in 1999).

EPAAct 1992 also defines alternative fuels and gives the authority to DOE to add to the list of authorized alternative fuels if certain criteria are met.

EPAAct 1992 was amended by the Energy Conservation Reauthorization Act of 1998, the Energy Policy Act of 2005, the Energy Independence and Security Act of 2007, and the National Defense Authorization Act of 2008. Additionally, Executive Orders 13149, 13423, and 13514 were signed in 2000, 2007, and 2009, respectively. Together, these actions have added alternative fuel use requirements for federal fleets; given state and alternative fuel provider fleets alternative compliance options; and defined hybrid electric, fuel cell, and advanced lean-burn vehicles as AFVs.

Federal regulations also encourage the production of alternative fuel and advanced technology vehicles. In 2010, the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Transportation's National Highway Traffic Safety Administration jointly issued a final rule that requires vehicle manufacturers of passenger cars, light-duty trucks, and medium-duty passenger vehicles to improve fleet-wide fuel economy and reduce fleet-wide GHG emissions annually. These regulations are more stringent as compared to past fuel economy standards and will likely push automobile manufacturers to produce more AFVs and advanced technology vehicles.

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State and Local Requirements

In addition to the federal requirements that apply to state fleets, most states have enacted regulations related to alternative fuel and advanced technology vehicle acquisitions as well as alternative fuel use. While not subject to federal regulations, municipal fleets are often required to use alternative fuel and/or fuel-efficient vehicles as a result of local regulations and directives. For example, the New York City Administrative Code requires that at least 80% of the New York City light-duty, non-emergency fleet, and 20% of bus fleets operated in New York City are AFVs. Alternative fuel use requirements are also enacted at the local levels. All diesel vehicles in the San Francisco municipal fleet, for example, must operate using biodiesel blends of at least 20% (B20).

Consumer Acceptance

Many groups and individuals make up the network necessary to support the alternative fuel and advanced technology vehicles industry, including:

- Current and prospective users (fleets, consumers)
- Vehicle and component manufacturers
- Fuels industry representatives (infrastructure developers, producers, etc.)
- Government officials
- Automotive service technicians

Ensuring that these groups and individuals are properly informed about the key aspects of the vehicles, fuels, and technologies is essential to the continued success of alternative fuel and advanced technology vehicles.

Myths and misinformation related to alternative fuel and advanced technology vehicles can spread quickly and have negative effects on the industry as a whole. Education, outreach, and training are critical elements to ensure that all individuals and groups involved, including potential future users of alternative fuel and advanced technology vehicles, are presented with an accurate picture of the industry.

Alternative fuel and advanced technology vehicles are important for many reasons, including their potential to significantly reduce the nation's consumption of petroleum. AFVs, such as natural gas vehicles, and advanced technology vehicles, such as electric drive systems, are more common on our roads today.

As consumers become more familiar with these fuels and technologies, the combined impact of alternative fuel and advanced technology vehicles usage will increase. The first modern mass production hybrid was the Toyota Prius (see **Figure 9**).



Figure 9: Toyota Prius, the first modern hybrid electric vehicle commonly found on today's roadways. Source: Toyota.

Consumer Demand

Consumer interest in alternative fuel and advanced technology vehicles is growing as a result of many factors, including higher conventional fuel costs, more vehicle options, improved technology and reliability, and an increasing concern for the environment. Vehicle manufacturers listen to consumer demand and have begun developing new vehicle technologies. With the Chevy Volt, for example, General Motors responded to consumer concerns about the reduced vehicle range of battery electric vehicles by extending the range through the use of an onboard generator powered by gasoline or a compatible alternative fuel.



Did You Know?

The U.S. Energy Information Administration estimates that, in the near future, alternative fuel and advanced technology vehicles will comprise more than 20% of the light-duty vehicles in the United States.

These driving forces have combined to create demand and transform markets, leading to a steady increase in the number of AFVs on the road (see **Figure 10**). In 2012, J.D. Power and Associates forecasted that hybrid electric vehicles (HEVs) could represent 9% of the U.S. vehicle market share by 2015; 192,706 light-duty HEVs were sold in 2010, according to the Electric Drive Transportation Association (EDTA).

Many of the vehicles on the road are produced by original equipment manufacturers (OEM) and are manufactured to use alternative fuels. Other vehicles can be converted to use alternative fuels. These vehicles are typically referred to as aftermarket conversions or retrofits. The EPA and the California Air Resources Board certify aftermarket conversions to ensure the vehicles meet applicable emissions standards. One thing is certain: alternative fuel and advanced technology vehicles are here today and here to stay. These will continue to evolve to incorporate improved technology and adapt to the changing market.

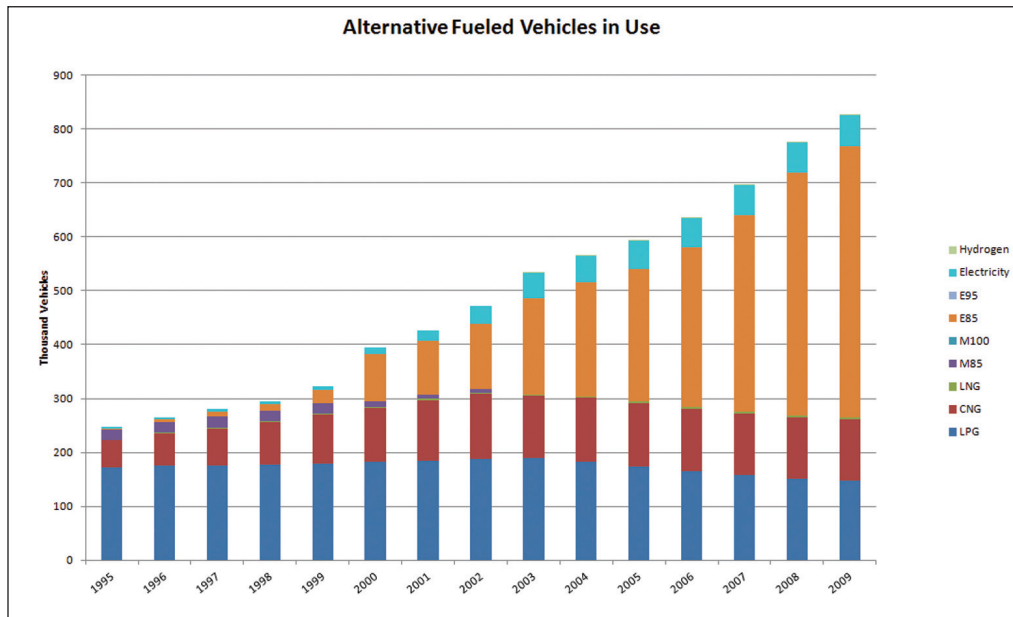


Figure 10: Alternative fuel vehicles in use (1995-2009). Source: AFDC. Note: The graph does not include concept or demonstration vehicles.

Summary

As fuel prices continue to rise and consumers and fleet managers become more environmentally conscious, petroleum reduction technologies will continue to become more widely available. The EPA continues to lower emissions regulations, while the CAFE standards continue to increase, resulting in new research and developments. In order to produce cleaner and more fuel-efficient vehicles, manufacturers are utilizing advanced technology vehicles and various alternative fuels. As these technologies are implemented by manufacturers, consumers must be aware of their potential and be willing to accept with an open mind these improvements. These advanced technology vehicles and petroleum reduction technologies will provide multiple advantages, including benefits to human health, the environment, the economy, and to energy security efforts.

This curriculum will provide a better understanding and awareness of alternative fuels and advanced technology vehicles, as it relates to petroleum reduction technologies.

By examining all of the workshop topics presented here, participants will be able to further understand and choose a technology that is best suited to their personal or fleet needs. The use of each of these petroleum reduction technologies will provide the potential benefit of sustainability and an overall reduction in the nation's carbon footprint.

Notes

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This document is subject to periodic review and/or revision. Users are strongly cautioned to obtain the latest version.

Comments and suggestions are invited from all users for consideration by the NAFTC in connection with such review. Please send all comments to the NAFTC, to the attention of the Executive Director.

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For questions or further information, please contact:

National Alternative Fuels Training Consortium

Attention: Executive Director

1100 Frederick Lane

Ridgeview Business Park

Morgantown, WV 26508

Telephone: 304-293-7882

Fax: 304-293-6944

<http://www.naftc.wvu.edu>

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The National Alternative Fuels Training Consortium (NAFTC) is working in partnership with the U.S. Department of Energy (DOE) Clean Cities Program to develop the turn-key Clean Cities Learning Program to raise awareness and foster a greater understanding of alternative fuels, alternative fuel vehicles, and advanced vehicle technologies through a targeted outreach and education effort. This program will enable Clean Cities Coalitions and other stakeholders to better implement petroleum reduction technologies by advancing the use of alternative fuels, alternative fuel vehicles, advanced vehicle technologies, and idle reduction technologies through state-of-the-art curricula, training, and education and outreach materials, all of which will be disseminated by the NAFTC and U.S. DOE Clean Cities.

Training courses include...

Petroleum Reduction Technologies

Designed specifically to raise awareness and foster a greater understanding of alternative fuels, alternative fuel vehicles, advanced vehicle technologies, petroleum reduction technologies, fuel economy and idle reduction, and related technologies. Workshops will be available on the following topics:

- Biodiesel
- Ethanol
- Natural Gas
- Propane
- Electric Drive
- Hydrogen
- Fuel Economy
- Idle Reduction
- Fleet Applications

First Responder Safety Training

Designed specifically to reduce the risks taken by first responders when responding to an incident involving alternative fuels, alternative fuel vehicles, and advanced technology vehicles.

4-hour workshops will be available on the following topics:

- First Responder Safety Training: Biofuels (biodiesel and ethanol) and Biofuel Vehicles
- First Responder Safety Training: Gaseous Fuels (natural gas and propane) and Gaseous-Fuel Vehicles
- First Responder Safety Training: Hydrogen and Hydrogen-Powered Vehicles
- First Responder Safety Training: Electric Drive Vehicles



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The U.S. DOE Clean Cities Program is a government-industry partnership designed to reduce petroleum consumption in the transportation sector by advancing the use of alternative fuels and vehicles, idle reduction technologies, hybrid electric vehicles, fuel blends, and fuel economy measures.

www.naftc.wvu.edu/cleancitieslearningprogram
www.cleancities.energy.gov

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1100 Frederick Lane
Morgantown, WV 26508



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