Introduction

The Genesis 2015 Initiative was announced by the University of South Carolina to convert all university vehicles to some form of alternative fuel by the year 2015. According to President Obama’s Speech on American Energy he stated, “One thing that the federal government has a lot of are cars and trucks…So, I have directed every agency in the federal government to make sure that by 2015 100% of the vehicles we buy will run on alternative fuels.”

Recent increase in oil production cost, oil demand, and environmental concerns have facilitated extensive research development and demonstration for cleaner alternative fuels and advanced propulsion technologies. A number of alternative fuel vehicles such as biodiesel, propane, ethanol, hydrogen, compressed natural gas, and electric vehicles are being used extensively in the United States.

Introduction of Alternative Fuels

Biodiesel

The majority of biodiesel is produced in the United States from soybean oil due to this feedstock’s abundance.

- Biodiesel is a nontoxic diesel fuel substitute, which makes it easier to handle, transport, and store.
- This fuel is biodegradable and it dissipates quickly after a spill.
- It is low volatile and does not ignite easily as gasoline increasing the margin of safety and fuel handling.
Propane

Propane is a byproduct of natural gas processing and petroleum refining. In its natural state, propane is a colorless and nontoxic gas.

- Propane gas turns into a liquid mixture under moderate pressure making it easier to transport and store in vehicle fuel tanks.
- Propane vehicles have greater engine efficiency when compared to gasoline. In its gaseous state, the fuel mixes readily with air in the combustion chamber to allow for nearly complete combustion. This can minimize problems with starting the vehicles in cold weather.
- It is environmental friendly and can lower carbon dioxide, carbon monoxide, and other toxic emissions.

Ethanol

E85 is the most popular blend for light-duty vehicles which contains 85 percent ethanol and 15 percent gasoline.

- Ethanol is less flammable than gasoline. Fires are less frequent and less severe when spills or releases of vapor occur. It is safer than gasoline to store, transport and refuel.
- Ethanol is water soluble and biodegradable hence land and water spills are usually harmless, dispersing and decomposing quickly.

Compressed natural gas (CNG)

CNG is a fossil fuel primarily composed of methane. It is stored and distributed in hard containers at a pressure of 2900–3600 psi.
• CNG when exposed to air is flammable. However, it burns at a relatively higher temperature when compared to gasoline, diesel, or even propane.

• The useful life of a CNG fuel storage cylinder is 15 years.

**Electric vehicles (EV)**

Electric vehicles use electricity from a power source to charge EV batteries and can travel from 40 to 120 miles on a single battery charge. Auto manufacturers are now selling “hybrid” vehicles that combine an electric motor with a separate gasoline or diesel engine.

• Electric vehicles are more energy efficient and produce less noise than gasoline or diesel powered vehicles.

• Hybrid vehicles can double the gas mileage of conventional gasoline or diesel powered vehicles and can reduce emissions significantly.

**Hydrogen**

Hydrogen gas is the primary fuel source for hydrogen vehicles. Hydrogen gas does not produce any harmful emissions when burned. Methane, fossil fuels, and other renewable energy sources such as wind, solar, and nuclear power are major producers for hydrogen fuel.

• A fuel cell vehicle uses hydrogen fuel which reacts with oxygen in a fuel cell to power an electric motor.

• Another implementation of a hydrogen vehicle is the internal combustion engine vehicle, where a conventional combustion engine directly burns hydrogen fuel.

*Vehicle Fleet of the University of South Carolina-Columbia Campus*
The University of South Carolina, Columbia has about 505 State Government vehicles that are being used for business, maintenance and transportation for students. Out of these there are 159 Flex Fuel vehicles, 21 Propane vehicles, 8 Electric vehicles, 48 diesel (B5) vehicles and 2 hydrogen buses. USC Vehicle Management and Parking services is proposing to convert the remaining gasoline vehicles into some form of alternative fuel by the year 2015. USC-Columbia is reaching out to the USC-Upstate campus and other campuses to participate in this project to reduce the nation’s dependence on foreign oil.

**Safety and Training**

One of the main objectives of University of South Carolina Vehicle Management and Parking Services Department is the use of safety methods and practices for alternative fuel vehicles. Safety practices included for alternative fuels are similar to those for a conventional petroleum fueling station. They include posting safety signs and keeping ignition sources away from the fuel. Every fuel station must include emergency telephone numbers for the fire department, police, maintenance and medical providers. Regular inspection of fueling nozzles, dispensers and receptacles is required. Use of cell phones, light matches and the smoking of cigarettes should be strictly prohibited at the premises of the fueling stations. If an emergency fire occurs, attempts should not be made to disconnect the nozzle from the vehicle. Evacuate the immediate area of fire, trigger the emergency safety device and contact the fire department. All the above procedures are included in the safety manual at all motor pool stations in South Carolina. All AFV’s undergo rigorous safety testing and meet the Federal Motor Vehicle Safety Standards.
The USC Vehicle Management and Parking Services Department is striving to promote safer alternative fuels and advanced vehicle technologies. Alternative fuel vehicles like CNG have safety devices including on board detectors and tank safety valves that allow fuel flow only when the engine is turned on. CNG buses in comparison to diesel buses have greater breaking distance due to increased fuel storage system weight. CNG burns cleaner than gasoline; hence the oil in a CNG vehicle does not require to be changed frequently. Propane fueling systems include a vaporizer that converts liquid propane to gas by the use of an engine coolant as a heat source. It also involves the use of a regulator which regulates fuel pressure to the mixer. Propane has a higher octane rating and its clean burning characteristics allow the engine to have an increased service life. Electric vehicles have lower centers of gravity than conventional and are less likely to roll over in an accident. Electric vehicles do not run on engine lubricating oil and gas tanks; hence it optimizes the danger of fire in a collision. National Fire Protection Agency (NFPA) has received grants from the US Department of Energy to develop emergency response safety programs on electric vehicles for emergency first responders.

The National Alternative Fuel Training Consortium (NAFTC) affiliated with West Virginia University is the only nationwide alternative fuel vehicle and advanced technology vehicle training organization in the United States. At present, it consists of 50 National Training Centers located from Maine to California. University of South Carolina is leading by example to provide training to first responders (police, fire department and medical technicians) on AFV’s so that they can provide emergency care when needed. The training will provide first responders with specific knowledge about the properties and characteristics of different alternative fuels. The first responders will also be informed about the safety techniques unique to each fuel type. Vehicles identification and key characteristics of vehicle components will be included along with
standard operating procedures of AFV’s. Vehicle drivers and fleet mechanics will also be trained to use fire extinguishers in order to act expeditiously if the vehicle catches fire. Drivers need to acquire knowledge on how to operate fuel storage tanks in order to refuel automobiles and vehicle fleets. Safety equipment such as high voltage gloves and face shields also play an important role to prevent shock while charging electric vehicles. USC proposes to deliver training to fleet mechanics, vehicle maintenance technicians and infrastructure installers to promote safe and appropriate repair, maintenance and installation of AFV/station equipment. Special training is required to operate certain alternative fuel vehicles such as Propane. Currently, a company called Palmetto Propane is providing training at a motorpool in Columbia, South Carolina. The University of South Carolina is incorporating the benefits of alternative fuels into technical degree programs such as electrical engineering technology, industrial maintenance, pharmacy and public health. Students are educated to emphasize on safety, production, storage, and use of different alternative fuels.

Public Health

Importance of Air Quality

Air quality is important because we cannot avoid breathing the air around us. On average an adult breathes 20 cubic meters, or 20,000 liters of air per day. Those that live in city areas should be very concerned with air quality opposed to those that live in less metropolitan areas because there are a greater exposure to pollutants coming from industrial and manufacturing facilities and automobile traffic. Rural areas are also at a high risk for air pollutants because they cannot afford the resources to keep the maintenance up to date on their vehicles. Exposure to air pollutants can result in respiratory illnesses like asthma and emphysema; bronchitis; cancer;
reduced lung function; lung damage; and brain and nervous system damage. The nose, eyes, and throat can also be affected by air pollutants and reduce the resistance to colds and other illnesses. The very young, very old and those with preexisting medical conditions can especially be affected by air pollutants.

*Health Related Issues Regarding Air Pollutants*

Congress passed the Clean Air Act in 1970 that established the National Ambient Air Quality Standards (NAAQS). These standards were set for the six common air pollutants: ozone, particulate matter, lead, carbon monoxide, nitrogen dioxide, and sulfur dioxide.

**Ozone**

- It depends on where you find ozone as to whether it can be harmful or beneficial.
- In the upper atmosphere ozone is beneficial because it blocks the sun’s harmful ultraviolet radiation.
- The chemical reaction between oxides of nitrogen and volatile organic compounds in the sunlight forms ground-level ozone.
- Ozone is a primary component of smog and causes breathing problems, reduces lung function, irritates the eyes and throat, and can trigger asthma or emphysema.

**Particulate Matter**

- Particulate matter is composed of airborne dust, smoke, soot, and other microscopic pollutants.
- Combustion engines, wood burning, road dust, construction dust, and agriculture are the major contributors to particulate matter.
- It can lead to health illnesses like lung damage, long term risk of cancer, and bronchitis.
Lead

- Lead is a heavy metal found in paint, leaded gasoline, and emissions from metal smelters.
- Lead causes brain and nervous system damage, peripheral nerve paralysis, learning problems and impairs production of hemoglobin in blood.

Carbon Monoxide

- Carbon monoxide is a poisonous gas that is caused by the incomplete combustion of fuels such as gasoline, wood, or natural gas.
- It reduces the ability of the blood to carry oxygen throughout the body and can be extremely hazardous to pregnant women, fetuses, and those with cardiovascular disease.

Nitrogen Dioxide

- Nitrogen dioxide is resulted when fuels like gasoline are not completely burned in air and air contains about 70 percent nitrogen.
- Nitrogen is the key smog-forming chemical and increases respiratory problems.

Sulfur Dioxide

- The main source of sulfur dioxide is coal-burning power plants and is the main supplier to “acid rain.”
- Sulfur dioxide can cause permanent damage to the lungs if exposed to too much.

Alternative Fuels and Reducing Emissions

Propane produces lower amounts of some harmful pollutants and greenhouse gases, but it depends on the vehicle type, drive cycle and engine calibration. It has been found to emit 26% less greenhouse gases than gasoline. The Alternative Fuels Vehicle Institute compared propane to gasoline and found that the use of propane reduces particulate matter by 40%, nitrogen oxides by 50%, and total hydrocarbon (THC) emissions by 87%. Hydrogen is the cleanest fuel.
available. Hydrogen-powered-fuel-cell vehicles have zero emissions. E-85 is a mixture of 85% ethanol and 15% gasoline. Ethanol-powered vehicles produce less net CO2 than gasoline-powered vehicles per mile traveled. Compressed natural gas is much safer than gasoline. It provides less pollution. Lead and benzene are absent in CNG and emits significantly less air pollutants. Biodiesel is safer and produces less air pollutants than petroleum-based diesel. It reduces carbon dioxide by 15%. Biodiesel from soy oil reduces greenhouse gases on average by 57% compared to petroleum diesel and biodiesel from recycled restaurant greases results in 86% reduction. Lastly, electric vehicles emit no tailpipe pollutants although the companies that produce the electricity may do. Electricity from wind-, hydro-, nuclear-, or solar- powered plants cause no air pollutants.

Public Awareness

Communities need to become aware of alternative fuel vehicles. To ensure that people are willing to commit to converting to alternative fuel vehicles the community needs to be informed on how these vehicles can be cost and health effective to not only them, but their community too. Seminars should be conducted on each USC campus to promote the use of alternative fuel vehicles to the campus staff and employees and community members. The seminars will focus on the positioning, emphasizing lower prices, maintenance, safety, public health, and policy barriers based on the efficiency of converting vehicles to alternative fuels. USC’s department of Vehicle Management and Parking Services proposes to organize an annual event called CAFÉ to promote alternative fuel vehicles to students, staff, community members, etc.

A visit to the senior campus USC-Upstate was made to meet with their personnel in charge of their vehicle fleet. Their vehicle fleet contains forty-two vehicles including 1 B5 bus, 2 propane mowers, 3 LVS and 3 electric vehicles. The main challenges faced by USC campuses are production, availability,
installation, infrastructure and maintenance cost of alternative fuels. USC-upstate recently had three electric golf carts running on their campus, but due to cheap parts and labor they were not able to maintain them. This led to the concern regarding the life cycle of alternative fuel vehicles. However, they would consider converting or purchasing new alternative fuel vehicles provided they have sufficient funds to support the vehicle fleet.

The University of South Carolina- Lancaster vehicle fleet is composed of eight vehicles. They are interested in propane or a CNG vehicle to use for errands around town. They also proposed an innovative idea of converting from the use of conventional oil to synthetic oil in campus vehicles. Synthetic oil can save oil, the life of the engine, and gas mileage and speed. Synthetic oil is energy saving. The challenges they face are similar to that of USC-Upstate with cost and the availability of the alternative fuel. The Lancaster campus is willing to convert if the worth of alternative fuel vehicles can be proven.

**Conclusion**

A detailed review and assessment of the information given in this article is directed to create public awareness on the health, safety and training aspects for alternative fuel vehicles. Genesis 2015 will emerge as the forerunner to achieve its goal to have all campus state vehicles use some form of alternative fuel. The success of Genesis 2015 will lead to future prospects of a petroleum free fleet making USC a cleaner, greener and healthier campus.
References


