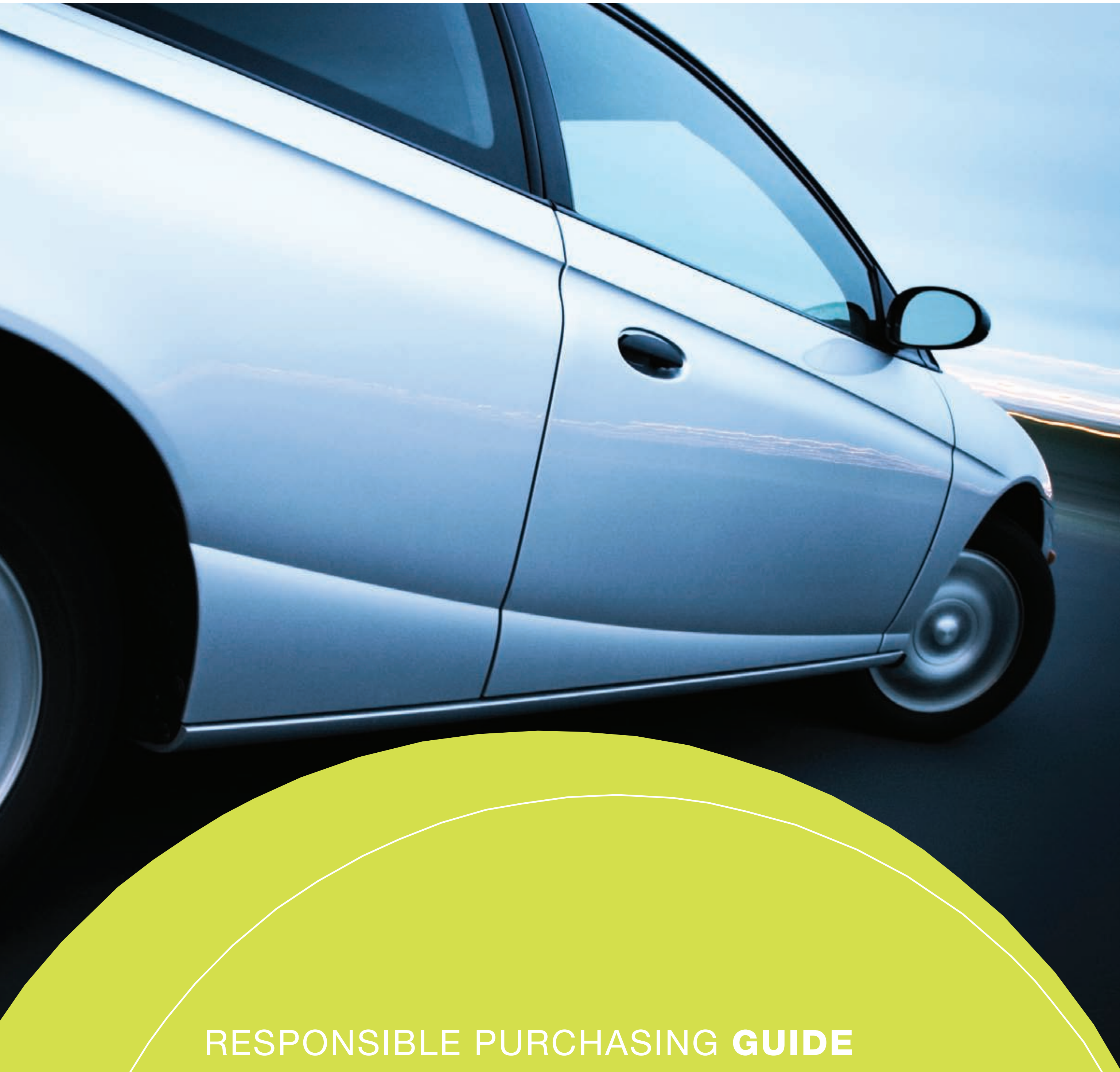

RESPONSIBLE PURCHASING **GUIDE**

light-duty fleet vehicles

RPN
Responsible Purchasing Network
Center for a New American Dream

About the Guide

The Responsible Purchasing Guide for Light-Duty Fleet Vehicles is published by the Responsible Purchasing Network in print, as a PDF file, and on the web. Print and PDF copies are available to the public for purchase. The online edition includes additional resources available to members of the Responsible Purchasing Network, including: searchable product listings, multiple policy and specification samples, comparisons of standards, and related documents. Visit www.ResponsiblePurchasing.org to purchase a copy or to access the members-only web-based edition of the Guide.

About the Responsible Purchasing Network

The Responsible Purchasing Network (RPN) was founded in 2005 as the first national network of procurement-related professionals dedicated to socially and environmentally responsible purchasing.

RPN is a program of the Center for a New American Dream (www.newdream.org) and guided by a volunteer Steering Committee of leading procurement stakeholders from government, industry, educational institutions, standards setting organizations, and non-profit advocacy organizations.

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Overview

Welcome to the Responsible Purchasing Guide for Light-Duty Fleet Vehicles. This guide covers vehicles and fuels that operate efficiently, reduce greenhouse gas emissions, improve air quality, and increase energy security. The Guide includes the following sections:

Social and Environmental Issues
Motor vehicles are a significant source of air pollutants that cause smog and unhealthy air conditions. This air pollution causes asthma, cancer, heart disease, birth defects, and brain damage. In addition, these vehicles produce close to one-third of the country's total annual carbon dioxide emissions. By consuming vast amounts of petroleum, motor vehicles reduce U.S. energy security. These problems are compounded by poor urban planning and sprawl, both of which can increase fleet vehicle miles.

Best Practices
Fleet managers can reduce the negative human and environmental impacts of vehicles through trip planning and reduction, improved maintenance and operation of conventional vehicles, use of fuel-efficient vehicles, and replacement of gasoline and diesel with clean, low-carbon alternatives. Practices such as maintaining proper tire pressure and changing oil and filters are standard and should occur on a regular basis. Other practices, such as purchasing vehicles painted in light rather than dark colors to reduce air conditioning needs in summertime, are one-time decisions that require forward planning.

Cost, Quality, and Supply
After implementing trip planning and vehicle efficiency measures, fleet purchasers can look for new vehicles and fuels to add to the fleet. There are a range of cost, quality, and supply issues that should be considered when making vehicle and fuel procurement decisions. The vehicle market is dominated by traditional gasoline and diesel-powered vehicles and there is usually substantial variation in environmental performance even between the best and worst conventional vehicles in a class. In addition, a range of technologies (e.g., hybrid-electric vehicles) and fuels (e.g., ethanol, biodiesel, and compressed natural gas) are becoming increasingly available and price competitive.

Policies
Various government agencies, educational institutions, and businesses already have responsible fleet policies detailing the social and environmental benefits gained by switching to responsible vehicles. They typically require the use of particular fuels, such as CNG, E85 and biodiesel; vehicles, such as hybrids and flex-fuel; and maintenance and management practices such as maintaining proper tire pressure, limiting vehicle idling time, and trip-planning to reduce mileage.

Specifications
Flex-fuel cars, trucks, SUVs, and vans are now being specified in large quantities, especially by federal and state government agencies required to do so by EPAct 2005. Similarly, over 200 fleets now have contracts with specifications for hybrid vehicles. In recognition of the fuel economy and emissions benefits of compressed natural gas (CNG), many centrally-fueled fleets are also specifying for CNG vehicles in their purchase contracts.

Standards

Several standards can be used to improve the social and environmental profile of a vehicle fleet. Emissions from most vehicles are determined by federal government standards. The California Air Resources Board (CARB) emission standard designates gasoline vehicles that have fewer emissions than most vehicles sold with the federal government's standard. Other standards relate to the quality of alternative fuels (e.g., ethanol, biodiesel, natural gas) that a fleet may purchase directly from a fuel producer for dispensing at a central fleet-owned pump.

Social and Environmental Issues

Of the over 240 million motor vehicles on the road in the U.S. today, nearly 10 million are in public and private fleets (BTS, 2006; CTA, 2006a). Over 95 percent of the fuel used in these vehicles is petroleum-based, which causes local air pollution and greenhouse gas emissions (CTA, 2006b). In addition, reliance on foreign sources of petroleum diminishes U.S. energy security.

Highway vehicles are a significant source of the air pollutants that cause smog and unhealthy air conditions – one reason why nearly half of Americans live in areas with unhealthy air quality (STPP, 2003). Studies have linked the vehicular pollution to a number of serious health issues, including asthma, cancer, heart disease, birth defects, and brain damage.

Highway vehicles in the U.S. emit more carbon dioxide, the principal global warming pollutant, than the total national emissions from any country other than China and Russia (EPA, 2006d; Marland, 2006). They are also a major contributor of nitrogen oxides associated with global warming, human health problems, and acid rain, which destroys forests and damages other terrestrial and aquatic ecosystems (EPA, 2005).

Conventional urban planning in American cities has increased vehicle miles traveled, contributing to human health problems, reducing quality of life, increasing greenhouse gas emissions, and adding capital expenses and operating costs for fleets. Sprawl, the spread of cities into rural land, also adds to these social and environmental costs.

There are a variety of ways for fleet managers to reduce the negative human and environmental impacts of their vehicles. Options include trip planning and reduction, improved maintenance of conventional vehicles, anti-idling policies, and procurement of fuel-efficient and/or alternative fuel vehicles. Throughout the country, well-managed fleet programs are already reducing vehicle emissions and saving money.

Human Health Impacts

Internal combustion engines produce a variety of pollutants harmful to human health. The three most prevalent local air pollutants from vehicles are carbon monoxide, nitrogen oxides, and particulate matter. Vehicles also emit volatile organic compounds, sulfur dioxide, and carbon dioxide.

Carbon Monoxide (CO) is an odorless and colorless gas with high toxicity. Combustion of gasoline in vehicle engines is a primary source of CO in most cities (ALA, 2000). CO is a human health concern in the outdoor environment where individuals can be exposed over prolonged periods of time. CO is also notorious for its lethal indoor effects, typically in the winter season due to leaking furnaces/ovens and improper indoor ventilation. In the last twenty years, CO emissions in the U.S. have dropped by over fifty percent due to engine improvements such as catalytic converters, which convert CO into carbon dioxide (CO2). Nevertheless, road vehicles are still responsible for nearly half of the CO emissions in the U.S. each year (EPA, 2005).

When inhaled, CO inhibits the bloodstream from carrying oxygen to the body’s cells. In extreme cases, such as those in poorly ventilated indoor environments, CO exposure can quickly cause death. Low concentrations of CO can cause fatigue, dizziness, headaches, and nausea. Long term exposure to CO can lead to permanent lung and heart problems, birth defects, and premature death. According to the Center for Disease Control, from 2001 to 2003 there were 15,200 hospital visits due to CO exposure in the U.S. and 480 associated deaths (CDC, 2005).

Particulate Matter (PM) includes a range of small particles and liquid droplets that result from fuel combustion and a range of industrial activities such as electricity generation, construction, and the production and use of chemicals (EPA, 2003). Road vehicles are responsible for around four percent of particulate emissions in the U.S. Of these emissions, over half are from heavy-duty diesel vehicles (EPA, 2005). Since 2002, PM emissions from heavy-duty diesel vehicles have declined by over fifty percent due to cleaner engines and fuels as well as particulate filters on exhaust pipes. PM emissions from light duty vehicles have remained constant over the past decade. In total, road vehicles emit 204,000 tons of PM per year.

Particulate matter can consist of metals, acids, organic chemicals, and dust. The health impact of PM is related to the size of the particle; with small particles (less than 2.5 micrometers in diameter) having greater health risks since they are able to penetrate deeply into lung tissue and in some cases enter the bloodstream (EPA, 2006a). Smaller particles typically result from combustion, including diesel and gasoline burned in vehicle engines. Immediate effects of PM exposure include shortness of breath, coughing, and wheezing. Larger particles (2.5 to 10 micrometers in diameter) are usually stirred up from the ground by roadway traffic and construction and industrial activities. Peer-reviewed studies link prolonged PM exposure to respiratory disease (e.g., lung cancer, tuberculosis), heart disease, and birth defects (HEI, 2003). Around 64,000 premature deaths per year can be connected to PM (NRDC, 2006).

Nitrogen Oxides (NOx) are a highly reactive class of gases that form when nitrogen and oxygen bind together during fuel combustion. Motor vehicles are responsible for over one-third of NOx emissions in the U.S. and have a particularly detrimental impact in metropolitan areas with high population densities. Improved engine technologies (e.g., catalytic converters) and fuel blends (EPA, 1994) have helped to lower NOx emissions from light-duty cars by over one-third in the past decade. However, light-duty gas trucks and heavy-duty diesel vehicles emitted constant levels of NOx during the same time period (EPA, 2005). Road vehicles emit over seven million tons of NOx per year.

Ground level ozone, commonly referred to as “smog,” is created when NOx and volatile organic compounds (VOCs) are released into the air and exposed to intense sunlight. NOx can also react with materials in the air to produce nitric acid, causing acid rain. In some cases NOx combines with airborne particulate matter (PM), leading to acidification of these already harmful particulates. NOx is also a component in a range of other toxic pollutants in the air and water and impacts human health in a variety of ways (EPA, 2006b). For example, exposure to ground level ozone (i.e., smog) reduces lung function (especially in asthma sufferers) and leads to long-term respiratory system damage. Individuals exposed to acid rain risk inhaling fine acidic particles that harm the respiratory system (EPA, 2006c). Health risks caused by PM exposure are discussed above. Since NOx problems are most frequent in heavily populated areas, millions of Americans suffer ill effects every year.

Environmental Impacts

Internal combustion engines in road vehicles have detrimental environmental impacts both locally and globally. Locally, NOx and SO2 emissions cause acid rain that impedes the growth of vegetation and disrupts water ecosystems. Globally, road vehicles are a key cause of global warming.

Acid Rain occurs when acidic compounds, primarily SO2 and NOx, collect in the atmosphere, are absorbed by clouds, and fall to earth as acidic precipitation. Coal-fired power plants are the largest source of SO2 emissions in the U.S. and motor vehicles are the largest source of NOx, contributing about one-third of the U.S. total (EPA, 2005). Environmental impacts of acid rain occur on a local and regional scale and include acidification of lakes, streams, and soil, damage to vegetation including trees and crops, and disruption of exposed ecosystems and food chains. Acid rain also degrades human structures such as buildings and statues.

Water Pollution occurs when detergents, toxics, acid rain, and other residual materials contaminate waterways. Vehicles-related water pollution includes: cleaning detergents that wash into sewers; carelessly disposed or leaking engine fluids; residual oil, gasoline, and wiper fluids washed from roadways; and vehicular air pollutants that are absorbed by rain droplets. Environmental impacts of water pollution, from vehicles and a range of other point and non-point sources, include algae blooms that reduce oxygen supplies in water and lead to fish kills, outbreaks of pathogens and other pests in degraded water, and contamination of drinking water supplies. In some cases, water bodies can become too contaminated to support any life.

Global Warming is caused by greenhouse gases (GHGs) released into the atmosphere, preventing Earth's surplus heat from radiating into space. The most common GHG is carbon dioxide (CO2), released when fossil fuel is burned. Since the industrial revolution, human activities have raised the amount of CO2 in the atmosphere to higher levels than the Earth is likely to have experienced in at least the last 650,000 years (Siegenthaler et all, 2005). In the U.S., highway vehicles emit close to one-third of the country's total annual CO2 emissions (DOE, 2006b). Environmental impacts of a warmer atmosphere include erratic and extreme weather conditions such as more intense hurricanes and dramatically shifting rainfall patterns; rising sea levels; migrating disease vectors such as malaria and West Nile virus; coral reef bleaching; and species extinction. These changes are likely to affect agriculture lands and fisheries; increase the number and severity of weather-related disasters such as floods and droughts; and lead to the displacement of hundreds of millions of people around the world.

Best Practices

There are a variety of established best practices available to guide the development of a responsible vehicle fleet. These include forming a stakeholder team responsible for developing and executing the plan, establishing baseline inventory and impacts, setting goals, adopting policy, reviewing standards and specifications, and improving practices.

Form a Responsible Fleet Team

Form a task force of stakeholders concerned with the procurement and maintenance of fleet vehicles, including fleet management personnel, elected officials, procurement directors, transportation engineers, drivers, and environmental health and safety staff. The team should cooperate with key decision-makers and departmental staff and it's duties can include: collecting baseline inventory and environmental impact data; assessing current policies; establishing or tracking budget requirements; developing recommendations and setting goals; and reporting on findings and progress.

Inventory and Impact

Compile a comprehensive fleet inventory that includes the make, model year, and number of all vehicles in the fleet, as well as type and amount of fuels used by each vehicle in order to assess current impacts and develop targets. Record the VIN numbers of each vehicle for easy reference. Record the life-cycle financial costs and pollution outputs associated with these vehicles and plan to report them on a regular basis. Life-cycle financial costs should include purchase price and depreciation, fuel and maintenance, staff, insurance, and disposal/resale. Key pollution outputs are carbon monoxide, nitrogen oxides, particulate matter, and carbon dioxide. Update the fleet inventory on a regular basis and recalculate impacts.

Establish baseline year or years (e.g. the previous, current, and/or following fiscal year) using the complete fleet inventory. Calculate and report key indicators, such as actual fuel economy achieved, average cost per gallon and/or per mile, estimated carbon dioxide emissions per mile, and proportion of alternative-fueled vehicles in the fleet. These data allow for multi-year comparisons of, for instance, miles per gallon averages of gasoline versus hybrids for the entire fleet, serving as verifiable data points for fleet policy recommendations.

Set Goals

<u>Emissions</u>. Establish air pollutant and greenhouse gas emission reduction goals for the fleet. Air pollutants include nitrogen dioxide, carbon monoxide, volatile organic compounds, sulfur dioxide, and particulates. Carbon dioxide is the primary fleet vehicular greenhouse gas emission to track. Although reduction objectives may be covered in other institutional policies, it is important to specify the role of fleet management in achieving overall institutional carbon dioxide reduction goals. Set emission standards for new and old vehicles in the fleet and specify preferences for alternative fuels and/or fuel efficient vehicle types. Offer estimates for the fleet's potential to reduce emissions and announce reduction targets for key pollutants. These estimates could be developed by analyzing costs and benefits of various approaches to achieving emissions goals.

<u>Costs.</u> Establish cost saving targets that can be achieved in relation to improved environmental performance, such as fuel cost reductions resulting from hybrid vehicles and smaller fleet size due to improved trip planning. See Financial Plan below for additional details.

Fleet Composition. Set targets for fleet performance (e.g., reduced GHG emissions, reduced fuel consumption, etc.) and determine strategies for meeting them by improving the proportion of hybrid and alternative fuel vehicles in the fleet, opting for more fuel efficient conventional vehicles, and optimizing the fleet size. Establish an annual timeline of vehicle purchases, retirements and changes. Goals and timelines should be regularly reviewed and updated as new technologies and practices become available.

Adopt or Improve Policy
Develop and adopt a Responsible Fleet Policy that establishes the overall goals and commitments of the organization as well as strategies to implement changes. Policy should clearly state short-term and long-term objectives and priorities; define key terms; address the purpose and goals of the new approach; list expected outcomes; project financial impacts; outline management and staff responsibilities; schedule key deadlines; and establish reporting, tracking and evaluation methods.

Improve Current Practices
Fuel Economy. Establish fuel efficiency targets, including miles per gallon (or gallon equivalent) and target dates. Classify the targets per vehicle, department, and the entire fleet. Revise the fuel economy targets as newer and more fuel efficient vehicles hit the market. Frame fuel economy requirements in terms of reduced pollutant output, reduced petroleum use, and vehicle and fuel cost savings. When replacing vehicles or expanding the fleet, purchase vehicles with the best available fuel economy and mileage per pound of CO_2 emissions. Many of the following best practices have a direct impact on fuel economy. Be sure to consider them all when developing a responsible fleet.

Fleet Size. Optimize vehicle utilization by matching vehicle class with appropriate tasks, and eliminating under-utilized vehicles. Use the most up-to-date fleet inventory data to make recommendations for fleet size changes and to identify vehicles for permanent retirement (e.g., those with low fuel economy or low annual mileage). Scaling back a fleet will eliminate unnecessary operational, maintenance, and depreciation costs. Alternative modes of transportation, such as local public transit and car-sharing services (e.g., **www.flexcar.com**, **www.zipcar.com**), are available to many jurisdictions and can reduce fleet maintenance costs. An optimally-sized fleet means fewer pollutants and lower operating costs.

Mode of Travel and Trip Reduction. Require alternative modes of travel when possible. Cut back on driving miles, improve fuel economy, and save money. Encourage employees to use public transit, ride bicycles, or walk. Set trip reduction targets and carefully plan routes for delivery vans or waste hauling. Centralize meeting places and encourage teleconferencing. Locate fleet vehicles near transit nodes and in close proximity to destinations.

Efficient Driving Practices. Require fleet vehicle drivers to adhere to prescribed driving practices that improve fuel efficiency. Significant fuel and time can be saved by planning trips during lower traffic periods and by combining trips (i.e., taking care of multiple tasks in one trip). Remove excess loads (e.g., heavy equipment or baggage in the trunk of the vehicle) to reduce weight and improve fuel economy. During vehicle operation, avoid aggressive acceleration and deceleration, follow speed limits, use cruise control when practical, coast down hills and up to stoplights when practical, and refrain from using air conditioning unless necessary.

Anti-Idling. Engine idling, i.e. leaving the engine on while a vehicle is not in use, increases pollution, wastes fuel, and causes engine wear and tear. When idling, engines run at sub-optimal temperatures, resulting in incomplete combustion which creates soot and deposits that cause engine damage. The effects of idling are magnified in larger vehicles like buses and trucks. Idling can be banned entirely or regulated according to explicit time limits and vehicle types, e.g., no more than five minutes idling unless necessary for work performance (Roanoke, 2004). Due to concerns over student health, many school bus fleets have recently adopted no-idling policies in order to reduce exposure to bus exhaust. For safety reasons, some vehicles, such as those used by emergency responders, might be considered for exemption from anti-idling restrictions.

<u>Maintenance</u>. Attentive maintenance can reduce fleet cost and prevent pollution:

1. Retrofit diesel vehicles with particulate traps, reducing these serious pollutants in local air.
2. Replace missing, leaking or otherwise faulty gas caps. This prevents volatile organic compounds, a contributor to ground-level ozone, from leaking into the air, and conserves fuel.
3. Conduct regular inspections and tune-ups for fluids, air filters, and tire-pressure, improving vehicle fuel economy.
4. Use socially and environmentally preferable products, such as bio-based fluids, re-refined engine oil, and retread tires.

Financial Plan

Develop a financial plan addressing costs and savings, describing how new costs will be covered, whether grants or other financial assistance is needed/available, and where savings will be reallocated. Institutions looking to build a responsible fleet might want to set up a special fund for the project. Supplemental funding can often be obtained through federal, state or other governmental assistance. The financial plan should explicitly include total lifecycle costs of current vehicles and comparative options. Since responsible, more efficient fleets can ultimately save money, stipulate how savings should be reallocated toward further fleet improvements and broader organization-wide environmental improvements.

Measure Progress

Publish an annual report mapping fleet progress. Include updated inventory comparisons to baseline data and assess compliance with declared policy and goals. Present a report summary to appropriate decision-making bodies. Successes as well as failures and challenges should be included in the report. Use the report, and the feedback it generates, to promptly revise and update goals in order to ensure continued success.

Cost, Quality, and Supply

The primary goals of socially and environmentally responsible fleet management are to maximize vehicle efficiency and minimize emissions. The simplest and most cost-effective way to get started is to follow maintenance practices recommended by manufacturers and fleet experts. Some practices, such as maintaining proper tire pressure and regularly changing oil and filters, are standard and should occur on a regular basis. Other practices, such as purchasing vehicles painted in light rather than dark colors to reduce air conditioning in the summertime, are one-time decisions that require forward planning.

Although the vehicle market is dominated by traditional gasoline- and diesel-powered vehicles, a range of technologies (e.g., hybrid-electric vehicles) and fuels (e.g., ethanol, biodiesel, compressed natural gas) are available and cost-competitive. There is significant variation between the best-in-class and worst-in-class models for fuel economy, even when considering only conventional gasoline vehicles. For federal and state government fleets, fleet composition is governed by the EPAct regulations requiring at least 75 percent of fleet vehicles to be capable of running on alternative fuels. As of December 2006, EPAct does not apply to local and private fleets. See **http://www1.eere.energy.gov/vehiclesandfuels/epact/** for information on EPAct.

In the text below, cost, quality, and supply considerations are reviewed for six vehicle/fuel types – gasoline, hybrid-electric, plug-in hybrid, ethanol, biodiesel, and natural gas. Not reviewed are propane, fuel cells, and straight vegetable oil. Propane is excluded because no vehicles are currently produced with propane engines, although numerous applications can be found at **http://www.propanecouncil.org/**. Fuel cells are excluded since they also are not readily available. Straight vegetable oil, as distinguished below from biodiesel, is excluded due to more limited applicability compared to biodiesel.

PHH GreenFleet, a climate-neutral service from PHH Arval – the second largest fleet management services provider in the United States and Canada - demonstrates the viability of environmentally-responsible fleet management. This program, developed in partnership with Environmental Defense, is designed to help fleet managers reduce operating costs, decrease global warming pollution, and meet other environmental goals. The program includes: in-depth analysis and recommendations to improve efficiency and reduce greenhouse gas emissions through improved vehicle selection, use, and maintenance; regular measurements and reporting of emissions; and resources to offset remaining emissions. Additional information is available online at: **www.environmentaldefense.org/go/greenfleet**.

GASOLINE

Gasoline is the fuel used in standard internal combustion engines that power over 240 million vehicles in the United States. The current vehicle fueling infrastructure is set up primarily to service these vehicles with over 170,000 stations nationwide. The vast majority of vehicle maintenance and repair services are devoted to gasoline vehicles.

There are a broad range of gasoline vehicles available to fleets, ranging from small cars to SUVs to heavy-duty service vehicles. Fuel economy, emissions standards, and greenhouse gas emissions per mile are the best metrics for identifying the most environmentally and socially responsible vehicles powered by gasoline.

Cost: The purchase price of gasoline vehicles varies by vehicle class, manufacturer, and features. Average purchase prices for 2007 model year gasoline vehicles for common classes are: Small cars - $15,800, Medium cars - $21,200, Large cars - $24,800, Pickup trucks - $24,900, and Sport utility vehicles - $30,300 (purchase prices were obtained from the HEV Calculator at **http://www.responsiblepurchasing.org/calculator**).

After purchase price, fuel is the second biggest cost. Gasoline prices vary geographically and are typically highest in metropolitan areas like New York City, Los Angeles, and Chicago, where a greater number of drivers demand fuel and local governments levy fees on gasoline sales. Prices are typically lowest in the Gulf Coast region where much of the U.S. production occurs. Prices are sensitive to natural disasters and geopolitical instabilities that disrupt or threaten production and/or distribution. For daily gasoline prices, see: **www.eia.doe.gov/oil_gas/petroleum/data_publications/wrgp/mogas_home_page.html**.

Fuel efficiency is a key way to reduce total fleet fuel consumption and costs. Efficiency varies greatly by vehicle class and engine type, and even varies significantly within classes. In general, fuel economy gains are realized by choosing manual over automatic transmission, two-wheel drive over four-wheel drive, and smaller engines (e.g., a 4-cylinder over a 6-cylinder engine).

Fuel Economy for 2007 Model Year Conventional Gasoline Vehicles

Vehicle Class	Avg. mpg city/hwy	Most Efficient	Least Efficient	Annual Fuel Use (gallons of gasoline)*
Small Car	25/33	34/40 Toyota Yaris manual, 4 cyl	19/25 Subaru Impreza AWD manual, 4 cyl	Avg. Small Car – 530 Yaris – 480 Imprezza – 700
Medium Car	22/30	28/36 Hyundai Elantra automatic, 4 cyl	17/24 Pontiac G6 automatic, 6 cyl	Avg. Medium Car - 600 Elantra – 430 G6 – 770
Large Car	18/26	22/31 Toyota Avalon automatic, 6 cyl	14/20 Dodge Charger automatic, 8 cyl	Avg. Large Car – 720 Avalon – 590 Charger – 930
Pickup	16/21	24/29 Ford Ranger 2WD manual, 4 cyl	13/18 Nissan Titan 4WD automatic, 8 cyl	Avg. Pickup – 840 Ranger – 580 Titan – 930
SUV	17/23	26/30 Jeep Compass 2WD manual, 4 cyl	12/15 Jeep Grand Cherokee 4WD automatic, 8 cyl	Avg. SUV – 780 Compass – 540 Grand Cherokee – 1140

*Calculation assumes 15,000 miles / year, with 55% city and 45% highway.
Note: figures for Pickups and SUVs do not distinguish between heavy, medium, and light-duty vehicles.

In many cases, fuel efficient gasoline vehicles cost less than inefficient vehicles, delivering cost savings at both the point of purchase and during the lifetime of the vehicle. For instance, both the Hyudai Elantra and the Pontiac G6 are classified as mid-sized sedans with purchase prices of $14,500 and $15,500 respectively. The Elantra costs $1,000 less than the G6, and also has significant fuel economy advantages, which can save around $500 in fuel costs / year.

Vehicles with lower than average purchase prices in class often deliver better fuel economy than more expensive vehicles in that class. For instance, Small Cars in the 2007 model year that sell for less than the class-average price (less than $15,800) achieve, on average, 17 percent better fuel economy in the city and 16 percent better fuel economy on the highway compared to small cars with above average sales prices (>$15,800). The equivalent numbers for the other four major vehicle classes are:

- Medium cars: less-than-average sales price vehicles achieve 10 percent better city fuel economy and 7 percent better on the highway than above-average sales price vehicles,

- Large cars: 6 percent better in the city and 8 percent better on the highway,
- Pickups: 23 percent better in the city and 17 percent better on the highway,
- Sport utility vehicles: 27 percent better in the city and 20 percent better on the highway

Maintenance and driving practices can also reduce vehicle and fuel costs, including: maintaining proper tire pressure; performing regular engine maintenance (e.g., fluid, filter, and spark plug changes); conducting trip planning to reduce the total number of miles traveled; establishing an anti-idling policy; and promoting smooth acceleration and braking practices. These practices are applicable to gasoline as well as alternative-fuel vehicles.

There are no direct government incentives provided to fleet purchases for purchasing efficient gasoline vehicles. However, gasoline and gasoline vehicles receive significant government subsidies that lower costs for consumers. In a report to the Pentagon, the Rocky Mountain Institute found several billion dollars per year in direct federal subsidies to the oil industry (Lovins et all, 2004).

Quality: Gasoline vehicles are the benchmark for comparing light duty vehicle performance. Performance features are promoted by manufacturers, reviewed by leading automotive authorities, and tested in the real world by millions of drivers. For a typical fleet vehicle, selecting a more efficient vehicle over a less efficient vehicle of comparable size and engine will have little impact on overall vehicle performance and can save significant money at the point of purchase as well as at the pump. One efficiency option available to fleets, choosing manual over automatic transmissions, does impact performance and could require employee training.

Maintaining vehicles according to regular schedules is one of the easiest and most cost effective ways to ensure optimal performance. Technician training and diagnostic tools help realize optimal performance. Extend vehicle life and reduce operating costs by maintaining tire pressure, conducting regular oil, fluid, and filter changes, and completing other manufacturer recommended maintenance activities. Manufacturer recommended maintenance is also the best way to ensure that repair and replacement are covered by vehicle warranty, though these vary by manufacturer and vehicle.

Gasoline quality is regulated by government and industry standards. Gasoline sold at licensed fueling stations must meet required regional fuel standards. In addition, government vehicle emissions standards dictate the types of vehicles that can be sold in particular regions.

All vehicles sold in the U.S. must meet certain government and industry standards addressing the performance and safety of gasoline vehicles. In addition, each vehicle has an emission standard based on its engine type. The current national emissions standards are the Tier II standards managed by the EPA. Through the Tier II standards, vehicles are placed into Bins numbered 1 through 10, with higher numbers assigned to dirtier vehicles and lower numbers for cleaner vehicles.

Among the cleanest gasoline vehicles in terms of air emissions are those built to meet the California Air Resources Board (CARB) emissions standards. These standards apply to vehicles sold in all of the states that have adopted the CARB standards: California, Massachusetts, Maine, New York, and Vermont. These low-emission vehicles may also be sold in these CARB-border states: Arizona, Connecticut, New Hampshire, New Jersey, Nevada, Pennsylvania, and Rhode Island.

Gasoline vehicles are major sources of local air pollutants including carbon monoxide (CO), nitrogen oxides (NOx), non-methane organic compounds (NMOC), and particulate matter (PM). Emission rates vary by vehicle and can be determined based on the EPA and/or CARB emission standards for each vehicle (see ACEEE's Green Book for 2007 model year vehicle emissions **http://www.greenercars.com/indexplus.html**). Gasoline vehicles are also a major source of the principal global warming pollutant, carbon dioxide (CO2). Each gallon of gasoline burned releases enough carbon to create 19.4 pounds of carbon dioxide.

Supply: There over 240 million light-duty gasoline vehicles on the road in the U.S., together consuming over 400 million gallons of fuel every day. About 55 percent of these vehicles are registered as cars and 40 percent are registered as pick-up trucks and SUVs.

In the 2007 model year, fifteen models of gasoline-based small cars are available, along with fourteen types of medium car, ten types of large car, nineteen types of pickup truck, and forty-two types of SUV. For each model, a range of configurations are typically available (two or four-wheel drive, manual or automatic transmission, four or six cylinder engine, two or four doors, etc.). The 2007 Chevrolet Colorado pickup truck, for example, is available with thirty-three different configurations. Certain engine types are only available in states that have adopted the California Air Resources Board (CARB) emissions standards (see the U.S. Environmental Protection Agency's Green Fleet Guide at **http://www.epa.gov/greenvehicles/** for information on vehicles with and without CARB emissions standards).

There is a vast gasoline fueling infrastructure in place with over 170,000 fueling stations nation-wide. Gasoline is produced from crude oil, a by-product of petroleum. The volume of petroleum produced domestically has steadily declined after peaking in the 1970s. Currently, the U.S. imports more than 60 percent of domestically- consumed petroleum (EIA, 2007a). Over half of these imports come from four countries: Canada, Mexico, Saudi Arabia, and Nigeria. Fifty percent of U.S. oil imports are from countries in the Western Hemisphere, while 19 percent comes from Africa and 17 percent from the Persian Gulf. Around 25 percent of oil consumed in the U.S. is produced in OPEC countries (EIA, 2007b).

Over 25 percent of domestic crude oil production takes place in the Gulf of Mexico, placing U.S. oil production platforms at risk from hurricanes. Large volumes of crude oil are also extracted from deposits in ecologically sensitive regions of Alaska. The top crude oil producing states are Texas, Alaska, California, Louisiana, and New Mexico (EIA, 2007c).

Reliance on this global commodity, coupled with control over a large percentage of this natural resource by national oil companies in the Persian Gulf and other regions, makes U.S. gasoline consumers vulnerable to international market pressure (e.g., surging demand for oil in rapidly developing countries like China and India) and geopolitical instability (e.g., problematic or unstable regimes in major producer countries and regions). In the short run, this leads to price volatility at the pump and, in the long run, dependence on foreign oil could lead to major supply disruptions.

HYBRID ELECTRIC

In recent years, hybrid-electric vehicles (HEVs) have become competitive fuel-efficient alternatives to conventional gasoline-powered vehicles. Advanced HEVs achieve high fuel-efficiency by combining an internal combustion engine with a battery-powered electric motor. The electric motor and battery in advanced HEVs allow the gasoline engine to spend more time operating near peak efficiency, to shut down during idling, and recover and reuse energy from braking.

Some vehicles, such as the Chevrolet Silverado, are marketed as hybrids but do not include the standard features associated with what this Guide calls advanced hybrids, such as electric motors and regenerative breaking (for a list of these so-called "hollow-hybrids," see **http://www.hybridcenter.org/hybrid-timeline.html**). Unless noted, the term HEV in this Guide refers to advanced hybrids.

Also, this Guide pertains mainly to light-duty vehicles, only peripherally addressing heavy-duty hybrid vehicles such as buses. For a detailed economic and environmental comparison of diesel, hybrid, and natural gas buses in New York City and King County, WA, see reports from the National Renewable Energy Laboratory (Barnitt, 2006; Chandler, 2006), which can be accessed via links in the Endnotes of this Guide.

Cost: HEV purchase prices are 20-50 percent higher than the base models of comparative gasoline vehicles. For instance, the 2007 Toyota Camry hybrid costs 45 percent more than the base model of a conventional Camry. However, HEVs are typically sold with features and options that do not come standard on base models of comparative vehicles (e.g., GPS). Accounting for these features reduces the HEV price premium (see **www.hybridcenter.org** for details). HEVs require gasoline and are subject to the same fuel price considerations as discussed for gasoline vehicles. However, HEVs use gasoline more efficiently than conventional vehicles for every vehicle class in which they are offered except for pick-up trucks, for which no advanced hybrids are currently available.

Fuel Economy Comparison for 2007 Model Year Gas versus Hybrid Electric Vehicles

Vehicle Class	Gas vehicle avg. mpg city/hwy	Most Efficient Gas	Most Efficient HEV	Annual Fuel Use (gallons of gasoline)*
Small Car	25/33	34/40 Toyota Yaris manual, 4 cyl	49/51 Honda Civic automatic, 4 cyl	Avg. Small Car – 530 Yaris – 480 Civic Hybrid – 300
Medium Car	22/30	28/36 Hyundai Elantra automatic, 4 cyl	60/51 Toyota Prius automatic, 4 cyl	Avg. Medium Car – 600 Elantra – 480 Prius – 270
Large Car	18/26	22/31 Toyota Avalon automatic, 6 cyl	n/a	Avg. Large Car – 720 Avalon – 590
Pickup**	16/21	24/29 Ford Ranger 2WD manual, 4 cyl	18/21 Chevrolet Silverado 2WD automatic, 8 cyl*** 18/21 GMC Sierra 2WD, automatic, 8 cyl***	Avg. Pickup – 840 Ranger – 580 Silverado/Sierra 2WD Hybrid – 780
SUV**	17/23	26/30 Jeep Compass 2WD manual, 4 cyl	36/31 Ford Escape automatic, 4 cyl	Avg. SUV – 780 Compass – 540 Escape Hybrid – 450

*Calculation assumes 15,000 miles driven per year, with 55% of the driving in the city and 45% of the driving on the highway.
**No distinction made between light, medium, and heavy duty vehicles in this class.
***Marketed as hybrids but lack the standard features associated with other hybrids, see above for details on these so-called "hollow-hybrids."

Fuel Economy for 2007 Model year Hybrid Electric Vehicles

Vehicle Class	Avg. mpg city/hwy	Most Efficient HEV	Least Efficient HEV	Annual Fuel Use (gallons of gasoline)*
Small Car	49/51	49/51 Honda Civic automatic, 4 cyl	n/a	Avg. Small Car Hybrid – 300 Civic Hybrid – 300
Medium Car	43/41	60/51 Toyota Prius automatic, 4 cyl	28/35 Honda Accord automatic, 6 cyl	Avg. Medium Car Hybrid – 360 Prius – 270 Accord Hybrid – 490
Large Car	n/a	n/a	n/a	n/a
Pickup**	18/20	18/21 Chevrolet Silverado 2WD automatic, 8 cyl*** 18/21 GMC Sierra 2WD automatic, 8 cyl	17/19 Chevrolet Silverado 4WD automatic, 8 cyl*** 17/19 GMC Sierra 4WD automatic, 8 cyl***	Avg. Pickup Hybrid – 800 Silverado/Sierra 2WD Hybrid – 780 Silverado/Sierra 4WD Hybrid – 840
SUV**	32/29	36/31 Ford Escape 2WD automatic, 4 cyl***	27/32 Saturn VUE 2WD automatic, 4 cyl***	Avg. SUV Hybrid – 490 Escape Hybrid – 450 VUE Hybrid – 520

*Calculation assumes 15,000 miles driven per year, with 55% of the driving in the city and 45% of the driving on the highway.
**No distinction made between light, medium, and heavy duty vehicles in this class.
***Marketed as hybrids but lack the standard features associated with other hybrids, see above for details on these so-called "hollow-hybrids."

Purchase Price for 2007 Model Year Gas versus Hybrid Electric Vehicles

Vehicle Class	Gas vehicle avg. price purchase	Most Efficient Gas	Most Efficient HEV
Small Car	$15,800	$11,000 Toyota Yaris manual, 4 cyl	$22,000 Honda Civic automatic, 4 cyl
Medium Car	$21,200	$14,100 Hyundai Elantra automatic, 4 cyl	$25,000 Toyota Prius automatic, 4 cyl
Large Car	$24,800	$24,300 Toyota Avalon automatic, 6 cyl	n/a
Pickup*	$24,900	$13,500 Ford Ranger 2WD manual, 4 cyl	$25,500 Chevrolet Silverado 2WD automatic, 8 cyl** $25,500 GMC Sierra 2WD automatic, 8 cyl**
SUV*	$30,300	$15,000 Jeep Compass 2WD manual, 4 cyl	$26,200 Ford Escape automatic, 4 cyl

*No distinction made between light, medium, and heavy duty vehicles in this class.
**Marketed as hybrids but lack the standard features associated with other hybrids, see above for details on these so-called "hollow-hybrids."

In best case scenarios, the purchase price premiums for hybrid vehicles can be recovered through fuel cost savings over the life of the vehicle. For example, compare the most popular hybrid vehicle, Toyota Prius, to the Ford Crown Victoria, a popular taxi fleet vehicle, (the Prius has been employed as a taxi vehicle; other vehicle comparisons can be made using the **HEV Calculator**). The 2007 Prius sells for around $25,000 and the 2007 Crown Victoria sells for $20,800 – a $4,200 price premium for the Prius. With a city fuel economy rating of 60 mpg and

51 mpg on the highway, the Prius is far more efficient than the Crown Victoria's 17 mpg in the city and 25 mpg on the highway. If both vehicles travel 15,000 miles/year with 55 percent city driving, the Prius saves over $1,000 annually in fuel costs compared to the Crown Victoria when gasoline costs $2.20 per gallon. During the fifth year of service, the Prius fully recoups it's price premium and begins registering net savings. However, the Prius/Crown Victoria comparison represents a best case scenario, and other HEVs may not recover their price premiums through fuel savings during the operational life span of the vehicle.

The HEV Calculator (**www.ResponsiblePurchasing.org/calculator**) compares costs and emissions of hybrids and conventional gasoline vehicles.

HEVs maintenance costs are another common concern with fleet managers, but Fleet data show maintenance costs for light-duty HEVs are comparable to conventional vehicles. This is due in part to the fact that HEVs typically require the same maintenance as conventional vehicles while enjoying extended manufacturer warranties on advanced engine components. In addition, HEVs with electric drive capabilities, such as the Prius, enjoy maintenance cost savings since they operate in the gas mode less often. Most components of an HEV can be maintained by fleet maintenance staff while more advanced components may need to be serviced by authorized technicians at dealerships.

In recognition of the benefits delivered by HEVs, federal and state governments provide tax credits for the purchase of hybrid vehicles. Although these credits are typically applicable to tax paying entities, in some cases they are available to venders selling light-duty and heavy-duty hybrid vehicles to tax-exempt entities. In such cases, the tax-exempt buyer can recover some of the value of the credit through a reduced sales price. Through EPAct 2005, the federal government offers a tax exemption for sellers of both light and heavy-duty HEVs to tax-exempt entities, but as of December 2006 the IRS had failed to issue necessary tax guidance. For state and federal hybrids incentives, visit **http://www.eere.energy.gov/fleetguide/incen_laws.html**.

Quality: HEV quality is ensured by the same government and industry standards that ensure quality gasoline vehicles, and HEVs use gasoline governed by conventional standards.

In addition to using fuel more efficiently than conventional counterparts, many hybrid vehicles produce significantly lower emissions. For instance, a Ford Escape Hybrid emits 1,300 fewer pounds of carbon monoxide (CO), 56 fewer pounds of nitrogen oxide (NOx), 31 fewer pounds of hydrocarbons (HC), and 37,000 fewer pounds of carbon dioxide (CO2) than a conventional Ford Escape over seven years of typical operation at 15,000 miles/year (see: www.responsiblepurchasing.org/calculator).

HEVs perform similarly to conventional vehicles in terms of acceleration, torque, and horsepower. Some drivers note that HEVs provide more responsive acceleration than conventional vehicles and accelerate more smoothly due to variable drive transmissions. Both Toyota and Ford report HEVs that have operated for over 100,000 miles and in one documented case, a Toyota Prius was driven over 200,000 miles in two years by a Vancouver, B.C. taxi driver (Sainsbury, 2005).

Advanced HEVs are able to operate in gas or electric mode, or a combination of both. This gas/electric drive system can be disruptive to new drivers for two reasons. First, when HEVs switch from gasoline to electric mode, drivers may notice a slight and momentary change in vehicle responsiveness. Second, when an HEV is in all-electric mode (e.g., when waiting at a stop light), the electric engine is silent, which may confuse some new drivers. Both issues are quickly overcome as drivers gain experience.

Basic maintenance, like changing oil and brake pads and rotating tires, is the same as for conventional cars. For more complex engine components, maintenance may need to be done by the dealer. Most components have long warranties. For instance, Toyota guarantees the hybrid-specific components of the Prius for 8 years/100,000 miles; Ford guarantees hybrid components of the Escape for 8 years or 100,000 miles; and Honda guarantees the battery pack for the hybrid Civic for 8 years or 80,000 miles. Fleet managers should maintain careful maintenance records for warranty purposes.

Nickel-metal hydride (NiMH) batteries used in hybrids are safer for the environment than the lead-acid batteries used in conventional vehicles, but both effective recycling programs exist for both types. NiMH batteries are designed to last for the normal life of the HEV and most have warranties of eight to ten years. Toyota and Honda place decals on the batteries with phone numbers to call for information about recycling. Toyota even offers $200 for returned batteries. Automakers are working toward the goal of introducing more benign lithium-ion batteries that will reduce potential environmental impact even more than NiMH batteries.

Supply: There are over 500,000 HEVs on the road in the U.S. today, over half of which are Toyota's Prius. Despite strong public awareness, HEVs currently represent less than one percent of vehicles on the road. Nevertheless, auto companies are increasingly interested in HEVs. Toyota has set a goal of increasing its HEV sales by 40 percent in 2007 (Reuters, 2007). HEV sales in the U.S. were 25 percent higher in 2006 than in 2005, and industry observers expect another year of strong growth in 2007 (Energy Futures, 2007). As high volume purchasers, fleet buyers can play a significant role in accelerating the market for HEVs.

In the 2007 model year, thirteen different light-duty HEVs are available from Chevrolet, Ford, GMC, Honda, Lexus, Mercury, Nissan, Saturn, and Toyota. HEVs are available in small and mid-sized sedans, SUVs, and pick-up trucks. Some models, particularly in the SUV and pick-up truck class, have drawn criticism for being "hollow-hybrids" because they lack the standard efficiency features common to most HEVs. See above for details.

Due to manufacturing constraints and low profit margins, automakers have at times been reluctant to make some models of HEV, such as the Prius, widely available on a bulk-basis to fleet purchasers. RPN has worked with fleet purchasers and auto companies to broaden the availability of HEVs to fleets, an effort which has helped open the door to greater adoption of HEVs by fleets across the country. HEVs are also now available for heavy duty vehicles such as delivery trucks and transit buses and are being tested for refuse haulers and other specialty vehicles.

HEVs currently use the conventional gasoline fueling infrastructure with over 170,000 filling stations nationwide. In the future, HEVs could become available in flex-fuel format (described below) which would reduce gasoline use even further. For a discussion of gasoline availability and production, see "Gasoline Vehicles" above.

HEVs represent the single greatest improvement in vehicle fuel efficiency in the past two decades. The highest efficiency gains are typically achieved in stop-and-go driving in city environments. In many cases, HEVs save both fuel and money compared to conventional vehicles. However, the most efficient conventional vehicles sometimes have lower total cost of ownership than comparable HEVs.

PLUG-IN HYBRIDS
Plug-in hybrid vehicles (PHEVs) are similar to regular hybrid vehicles in that they use both an internal combustion engine and an electric motor. What makes them different is the use of a larger battery charged by plugging into a standard electrical outlet. The chief benefit is that these batteries store enough energy to power a vehicle for 20-60 miles on 100 percent electricity and the internal combustion engine is used only after the battery charge is depleted. A typical car is driven between 25 and 50 miles per day, so a large portion of daily driving in a PHEV could be powered by the electric battery and a fleet of PHEVs would use significantly less petroleum than conventional vehicles. There are currently no PHEVs in production, although some regular hybrids (e.g., the Toyota Prius) can be converted to PHEVs.

Cost: Compared to regular hybrid vehicles, PHEVs are expected to cost an additional $2,000-$3,000 for a sedan and an additional $5,000 for an SUV when mass production begins, although the actual marginal cost of PHEVs is a subject of considerable disagreement among experts. Currently, costs for converting a hybrid electric vehicle (HEV) into a PHEV are in the $10,000 range.

Based on typical driving patterns, analysts anticipate that PHEVs can achieve fuel economy of over 100 miles per gallon of gasoline equivalency. The actual fuel efficiency of each PHEV will depend on the driving style and distance, with drivers that rely on a greater proportion of electricity achieving the highest fuel efficiency. In addition, PHEVs could be built in a flex-fuel format similar to what is currently used for E85 (a blend of 85 percent ethanol and 15 percent gasoline). In such a case, the fuel efficiency of the PHEV would be affected by the choice of gasoline versus E85. When using E85, PHEVs could achieve upwards of 200 miles per gallon of gasoline.

Since the average national price of electricity is around $1 per gallon of gasoline equivalent, significant cost savings can be realized with PHEVs. For instance, an Electric Power Research Institute study found that PHEVs achieve life-cycle parity with conventional vehicles when the cost of gasoline is $1.75 per gallon (Duvall et al, 2003). When the cost of gasoline is higher than $1.75 per gallon, which it is today and will likely remain, PHEVs have lower total life costs than either conventional gasoline vehicles or HEVs. In regions with lower electricity costs, such as the Pacific Northwest where hydropower provides electricity at prices as low as 45 cents per gallon of gasoline equivalent, even greater savings can be realized.

PHEVs have yet to be tested on the market and maintenance costs are currently unknown. However, using HEVs as a guide suggests that maintenance for conventional components on PHEVs will be similar to conventional vehicles while maintenance for advanced components may need specialized skills. On balance, since electric drive trains have fewer mechanical parts than internal combustion engines, PHEVs, with their larger electric drive train and smaller combustion engine, could deliver lower maintenance costs than conventional vehicles.

As of January 2007, there were no tax credits or other government incentives available for PHEVs. Nevertheless, several government actions, such as the 2007 White House Executive order and 2006 Minnesota legislative bill referenced in the Policies section of this Guide, suggest growing interest in PHEVs by policymakers.

Quality: Since PHEVs have yet to achieve market penetration, there are no official standards governing their performance and safety. Nevertheless, since these vehicles will be very similar to gasoline vehicles and HEVs, they will likely follow general automobile standards.

When driving in electric mode, there are no emissions from the vehicle itself. Emissions resulting from the electricity used to charge the battery depend on the fuel mix of the electric utility (Kleisch, 2006). In a best case scenario, the electricity will be produced by a clean source of power, such as wind, that charges the vehicle's battery with zero emission electricity. A worst case scenario would produce electricity with coal, although emissions benefits could still result compared to a conventional gasoline vehicle. In any case, regulating emissions from a large centralized power plant is much simpler than controlling emissions from millions of vehicle tail pipes. Also, power plants are typically further away from dense human populations, so health benefits can be realized with PHEVs relative to gasoline vehicles even if the electricity comes from a dirty power source such as coal.

Demonstration vehicles have shown no noticeable change in vehicle acceleration or performance. In addition, since most components are similar to conventional vehicles, maintenance costs are expected to be on par with current vehicles.

PHEV conversion kits are available for some vehicles, e.g. Toyota Prius. It is unclear whether such conversions void vehicle warranties, but legal precedent suggests that warranties are only voided on vehicle components directly affected by the conversion (see **http://www.calcars.org/howtoget.html**).

Batteries in PHEVs are larger and heavier than batteries used in regular hybrids. This increased weight may be offset by the reduced size and weight of the combustion engine, which can be smaller since it does less of the work. Battery costs are still high but are expected to fall with mass production.

Supply: Although PHEVs rely on existing technology and prototypes exist, there are no models available commercially in 2007 and significant technical barriers remain, such as the need for low-cost and light-weight batteries. DaimlerChrysler has tested PHEV prototypes and is converting up to forty commercial passenger vans into PHEVs for testing. General Motors has expressed a commitment to PHEVs and unveiled a prototype at the Detroit Auto Show in January 2007.

Currently, the only available option is to convert an HEV into a PHEV, which is already being done by various entities. The University of California, Davis converted nine sedans and SUVs; the nonprofit organization, California Cars, converted a Toyota Prius; the US Marine Corps converted a HUMVEE; and Long Island, NY converted a city bus and is converting three recycling trucks.

There are at least three companies currently providing PHEV conversion kits. In certain regions, these companies can complete the conversion for their customers. In other cases, the companies will ship components and instructions for customers to complete the conversion. Conversions typically cost around $10,000. These companies offer kits and services:

- EDrive Systems, LLC, Los Angeles, California: **www.edrivesystems.com**
- Hybrids-Plus, Boulder, Colorado: **www.hybrids-plus.com**
- Hymotion, Toronto, Canada: **www.hymotion.com**

When fueling, PHEVs will rely on a mix of electricity and liquid fuel. The electricity will be obtained from a standard three-pronged electrical outlet. The liquid fuel will be obtained from gasoline and/or alternative fuels pumps. PHEVs will typically recharge at night when electricity costs are lower due to less demand. Night is also peak time for wind energy, which can improve the emissions profile of PHEVs. Nearly half of U.S. electrical generating capacity sits idle or is underutilized at night, so tens of millions of PHEVs could be charged without need for additional generating or distribution infrastructure. Electricity is generated from almost exclusively domestic resources.

PHEVs represent a significant opportunity for fleet vehicles parked overnight in central locations. In addition, typical driving ranges for fleet vehicles would allow for a large portion of drive time to be electric-powered. Fleet managers interested in supporting the development of PHEVs should contact the Plug-in Partners Program (**www.pluginpartners.org**), a nonprofit organization working to demonstrate PHEV demand to automakers.

ETHANOL

Ethanol is a clean-burning, high-octane vehicle fuel that can be produced from plant materials such as corn, barley, sugarcane, and a variety of high-cellulose plants such as switchgrass. Nearly all of the ethanol consumed in the United States is produced by fermenting and distilling corn into alcohol. Ethanol is typically sold as a blend with gasoline, with the most common blends being E10 (10 percent ethanol and 90 percent gasoline) and E85 (85 percent ethanol and 15 percent gasoline). E10 can be used in any gasoline engine while E85 should only be used in specially designed engines. Automobiles with engines built to run on E85 are commonly referred to as “flex-fuel” vehicles.

Cost: Any conventional gasoline vehicle can run on E10, so there no purchase price premium associated with E10-compatible vehicles. Flex-fuel vehicles capable of using E85 are sold with special electronic systems that monitor the fuel blend and fuel pumps and hoses that withstand the corrosive effects of high ethanol blends, but these vehicles have little or no price premium.

There are no significant cost differences between E10 and conventional gasoline since E10 is already widely sold at conventional gas pumps across the country. Also, since E10 is generally sold as a result of government mandate, all fueling stations in affected regions sell the same fuel blend and include the cost of ethanol in the pump price. The remaining discussion in this section pertains to E85 and flex-fuel vehicles.

Since ethanol has lower energy content than gasoline (i.e., produces less heat per unit of fuel), the fuel economy of flex-fuel vehicles running on E85 is lower than that of equivalent vehicles running on gasoline. Without exception, the flex-fuel vehicles on the market achieve lower fuel economy when operating on E85 than when operating on pure gasoline, which increases the effective cost of E85 relative to gasoline. The Department of Energy’s Flexible Fuel Vehicle (FFV) Cost Calculator provides estimates of the cost implications of E85 use in flex-fuel vehicles based on state-specific fuel prices:
http://www.eere.energy.gov/fleetguide/cost_anal.php?0/E85*Flex*Fuel/.

A concern with ethanol has been the amount of fuel required to grow and refine the corn used to produce it, but ethanol has now been nearly unanimously shown to deliver net energy gains. Estimates of the fuel benefit range from ten to twenty-five percent, depending on the fuels used in the production process. Nevertheless, ethanol’s lower heat content results in 25-30 percent lower fuel economy for E85. Since flex-fuel vehicles achieve around 30 percent less fuel economy than gasoline vehicles, E85 needs to be around 30 percent less expensive than gasoline in order to compete favorably in the market.

According to the October 2006 edition of the Department of Energy's Alternative Fuels Price Report, the national average price of E85 was $2.11 per gallon, which was eleven cents, or five percent, less than the price of gasoline at that time (DOE, 2006a). However, after adjusting for the lower energy content in E85, the average price of E85 on an energy equivalency basis was $2.98 per gallon – 76 cents, or 34 percent, higher than a gallon of gas. Additionally, the price of E85 varies on a regional level, with the lowest average cost in October 2006 recorded in the Midwest at $1.97 per gallon. The highest prices were found in the Central Atlantic region where E85 cost $3.47 per gallon. For comparison, the average gasoline prices in the Midwest and Central Atlantic were $2.18 and $2.20, respectively.

Fuel Economy Comparison for 2007 Model Year Gas versus Flex-Fuel Vehicles

Vehicle Class	Gas Vehicle avg. mpg city/hwy	Most Efficient Gasoline	Most Efficient Flex-Fuel (E85)	Annual Fuel Use (gallons of gasoline)*
Medium Car	22/30	28/36 Hyundai Elantra automatic, 4 cyl	15/22 Chrysler Sebring automatic, 6 cyl	Avg. Medium Car – 600 Elantra – 300 Sebring Flex-Fuel – 129**
Large Car	18/26	22/31 Toyota Avalon automatic, 6 cyl	16/23 Chevy Impala automatic, 6 cyl	Avg. Large Car – 720 Avalon – 590 Impala Flex-Fuel – 120**
Pickup***	16/21	24/29 Ford Ranger 2WD manual, 4 cyl	12/16 GMC Sierra Classic 1500 2WD automatic, 8 cyl 12/16 Chevrolet Silverado Classic 1500 2WD, 8 cyl	Avg. Pickup – 840 Ranger – 580 Sierra/Silverado Flex-Fuel – 170**
SUV***	17/23	25/29 Jeep Compass 4WD manual, 4 cyl	12/16 Chevrolet C1500 Tahoe 2WD automatic, 8 cyl 12/16 GMC C1500 Yukon 2WD automatic, 8 cyl	Avg. SUV – 780 Compass – 560 Tahoe/Yukon Flex-Fuel – 170**
Van***	14/19	15/20 Chevrolet Van 1500/2500 2WD automatic, 6 cyl	12/16 GMC Savana 1500/2500 2WD (cargo) automatic, 8 cyl 12/16 Chevrolet 1500/2500 2WD automatic, 8 cyl	Avg. Van – 950 1500/2500 – 890 Savana/1500/2500 – 170**

*Calculation assumes 15,000 miles driven per year, with 55% of the driving in the city and 45% of the driving on the highway.

**Calculation assumes that the flex-fuel vehicle uses E85 at all times. No adjustment made for embedded energy in ethanol from fuel stock production.

***No distinction made between light, medium, and heavy duty vehicles in this class.

Fuel Economy Comparison for 2007 Model Year Hybrid Electric versus Flex-Fuel Vehicles

Vehicle Class	HEV avg. city/hwy mpg	Most Efficient HEV	Most Efficient Flex-Fuel (E85)	Annual Fuel Use (gallons of gasoline)*
Small Car	49/51	49/51 Honda Civic automatic, 4 cyl	n/a	Avg. Small Car Hybrid – 300 Civic Hybrid – 300
Medium Car	43/41	60/51 Toyota Prius automatic, 4 cyl	15/22 Chrysler Sebring automatic, 6 cyl	Avg. Medium Car Hybrid – 360 Prius – 270 Sebring Flex-Fuel – 130**
Large Car	n/a	n/a	16/23 Chevy Impala automatic, 6 cyl	Impala Flex-Fuel – 120**
Pickup***	18/20	18/21 Chevrolet Silverado 2WD automatic, 8 cyl**** 18/21 GMC Sierra 2WD automatic, 8 cyl****	12/16 GMC Sierra Classic 1500 2WD automatic, 8 cyl 12/16 Chevrolet Silverado Classic 1500 2WD, 8 cyl	Avg. Pickup Hybrid – 800 Silverado/Sierra 2WD Hybrid – 780**** Sierra/Silverado Classic 1500 Flex-Fuel – 170**
SUV***	32/29	36/31 Ford Escape 2WD automatic, 4 cyl	12/16 Chevrolet C1500 Tahoe 2WD automatic, 8 cyl 12/16 GMC C1500 Yukon 2WD automatic, 8 cyl	Avg. SUV Hybrid – 490 Escape Hybrid – 450 Tahoe/Yukon Flex-Fuel – 170**
Van***	n/a	n/a	12/16 GMC Savana 1500/2500 2WD (cargo) automatic, 8 cyl 12/16 Chevrolet 1500/2500 2WD automatic, 8 cyl	Savana/1500/2500 Flex-Fuel – 170**

*Calculation assumes 15,000 miles driven per year, with 55% of the driving in the city and 45% of the driving on the highway.

**Calculation assumes that the flex-fuel vehicle uses E85 at all times. No adjustment made for embedded energy in ethanol from fuel stock production.

***No distinction made between light, medium, and heavy duty vehicles in this class.
****Marketed as hybrids but lack the standard features associated with other hybrids, see above for details on these so-called “hollow-hybrids.”

Maintenance costs for vehicles running on E10 are identical to vehicles running on pure gasoline. E10 is approved under the maintenance warranties for all gasoline vehicles sold in the U.S. Flex-fuel vehicles running on E85 also have similar maintenance costs to regular vehicles. In fact, a growing body of evidence suggests that maintenance costs for flex-fuel vehicles can actually be lower than conventional vehicles because ethanol is a cleaner burning fuel that causes less wear on engine components.

Fueling stations currently receive a federal tax credit of $.0051 percentage point of ethanol per gallon (i.e., E10 receives $.05 per gallon and E85 receives $.43 per gallon). Without this tax credit, E85 would become less competitive with gasoline. Flex-fuel vehicles count toward EPAct requirements for alternative fueled vehicles in state and federal fleets.

Quality: The main standard for ethanol in the U.S. is ASTM D4806-98, which specifies the chemical composition of ethanol. This standard ensures consistent quality of ethanol-gasoline blends. Flex-fuel vehicles that run on E85 are similar to conventional gasoline vehicles and are governed by the same performance, safety, and emissions standards.

Ethanol is increasingly used because of its role as an oxygenate that reduces emissions from gasoline. Ethanol has significantly lower carbon monoxide and hydrocarbon emissions than older gasoline vehicles, and comparable emissions to newer gasoline models. In addition, studies show a 15-20 percent decrease in carbon dioxide emissions per gallon relative to gasoline on a life-cycle basis.

Ethanol has lower heat content than gasoline and lower fuel economy. On the other hand, this lower heat content may benefit the engine by subjecting it to less heat-related wear and tear than conventional engines. Ethanol is a cleaner burning fuel than gasoline and has been shown to have a less degrading effect on fuel injection systems and filters than gasoline.

Operating tips for flex-fuel vehicles from the Chrysler Group include: 1) Be prepared for the possibility of difficulty starting engine in cold weather; 2) Switch between gasoline and E85 only when the engine gauge is above ¼ full; 3) Always add more than five gallons of the new fuel at each fill-up; and 5) Operate the vehicle for at least five minutes immediately after refueling.

Maintenance for flex-fuel vehicles is very similar to conventional gasoline vehicles. When ordering replacement parts though, special attention should be taken to ensure that replacement parts are for flex-fuel rather than conventional vehicles.

Around 1/3 of all gasoline in the U.S. is E10, which is covered under warranty for all cars sold in the U.S. E85 is covered under warranty for flex-fuel vehicles.

Supply: There are over 5 million flex-fuel cars on the road today. Since 1980, flex-fuel vehicles have logged over 3.5 trillion miles of road experience. In the 2007 model year, flex-fuel vehicles are available from Chevrolet, Chrysler, Dodge, Ford, GMC, Jeep, Lincoln, Mercedes-Benz, Mercury and Nissan. Flex-fuel vehicles are available in the following 2007 model year vehicle classes: medium car, large car, pickup, sport utility vehicle, and van. There are no flex-fuel vehicles in the small car category.

Each year over five billion gallons of ethanol are produced in the United States, the vast majority of which is used in E10 blends. Another four billion gallons of ethanol capacity are in the planning and/or development stage. Eighty percent of ethanol is currently produced in five states: Iowa, Illinois, Minnesota, Nebraska, and South Dakota, with Illinois producing the largest amount due to a large Archer Daniels Midland facility in Peoria producing around 20 percent of total U.S. ethanol as of November 2006.

Of the over 170,000 filling stations in the United States, just over 1,000 sell E85. Roughly half of these E85 stations are located in four Midwestern states: Minnesota, Illinois, Iowa, and Wisconsin. As of January 2007, the four most populous states: California, Texas, New York, and Florida, had only 3, 22, 6, and 11 E85 stations respectively and twelve states had no E85 stations at all. However, the number of E85 stations has been increasing rapidly over the past two years and the pace is likely to continue.

The U.S. is the second largest global producer of ethanol after Brazil. Brazilian ethanol is produced from sugarcane and has a significantly better energy return than corn ethanol. However, Brazilian sugarcane ethanol is not yet available in the U.S. due to significant trade tariffs that raise its price to levels significantly higher than domestically produced corn ethanol.

However, as of March 2007, the U.S. and Brazil have begun cooperating to promote ethanol regionally and around the globe.

Nearly all of the ethanol produced in the U.S. is from corn, which delivers up to twenty-five percent more energy than required to produce the fuel - the comparable number for sugarcane is around 100 percent. Although corn ethanol is cleaner burning than gasoline, there are a number of barriers to this fuel source including the amount of cropland, water, and chemicals needed to grow corn as well as competition between the growth of food versus fuel crops. Researchers are working on new sources of ethanol from less energy intensive plants such as switchgrass. This “cellulosic ethanol” could deliver significantly more energy than corn-based ethanol and would greatly improve the environmental performance of ethanol. However, production costs for cellulosic ethanol are still prohibitively high.

Ethanol is a clean burning domestically produced fuel with the potential to deliver significant environmental and economic benefits. The current fleet of flex-fuel vehicles, although capable of running on E85, is optimized to run on gasoline and thus delivers low fuel economy per unit of ethanol consumed. Nevertheless, some flex-fuel vehicles, such as the Chevrolet Impala and Chevrolet Uplander have fuel economies that compare well with other vehicles in their class.

BIODIESEL

Biodiesel is gaining popularity as a renewable, domestically-produced replacement for conventional petroleum diesel. Biodiesel consists of plant or animal fats processed into liquid fuel. Biodiesel differs from Straight Vegetable Oil (SVO) in several respects and these two fuels are not direct substitutes. SVO can be either virgin oil or waste vegetable oil collected from restaurant fryers, whereas biodiesel is refined according to ASTM standard D 6751-03 and is approved for use in conventional diesel engines. SVO is not addressed in this Guide.

Cost: Conventional diesel engines can run on biodiesel blends up to twenty percent (B20) without modification, so there is no purchase price premium for vehicles running on B20. Owners of diesel vehicles should consult their manuals to ensure that B20 does not void vehicle warranties. Concentrations above B20 can also be used in regular diesel engines with minor modifications, but there is less applied experience with regards to vehicle costs and less knowledge about long-term impacts on the engine. Most authorities on biodiesel recommend against using biodiesel blends above B20. For a detailed discussion of concerns, see *Concerns with Biodiesel Blends above B20* in the Related Documents section below.

Biodiesel in blends of B20 or less have a negligible effect on fuel economy. There is some variability in energy content of biodiesel from different producers, so fuel economy can vary by a few percentage points depending on the supplier. Some fleets report improved fuel economy after using biodiesel blends of B20 or less, but as the proportion of biodiesel in the fuel moves beyond B20 up toward B100, fuel efficiency can drop by up to 10 percent.

The average price of B20 at the pump is similar to the price of regular diesel. In October 2006, the national average price of B20 was $2.66/gallon, compared to $2.62/gallon for regular diesel. The national average price in October 2006 for biodiesel sold in a 99 or 100 percent concentration was $3.31/gallon. When adjusted for energy equivalency compared to regular diesel, the national average price for B20 was $2.71/gallon and for B100 was $3.64/gallon.

There was considerable regional variability in the price of biodiesel at the pump in October 2006: the lowest prices were in the Midwest where B20 cost $2.41/gallon and regular diesel cost $2.57; in New England B20 cost $2.55/gallon and regular diesel cost $2.67. The highest price was in the West Coast region where B20 cost $2.78/gallon and regular diesel cost $2.74. The lowest recorded price for B100 in October 2006 was in the Central Atlantic region where a gallon cost $2.72 and the highest price was on the West Coast where a gallon cost $3.55.

Maintenance costs for vehicles running on B20 are the same as costs for conventional diesel vehicles, with one exception pertaining to fuel filters. During the first few weeks of using B20 on a vehicle that had previously used regular diesel, fuel filters may need to be replaced ahead of the regular maintenance schedule due to debris being dislodged from the engine by the biodiesel. This problem is typically limited to the first few weeks of B20 usage, and then filters can be changed according to the regular maintenance schedule.

According to the **EPAct website**, in January 2001, the Biodiesel Final Rule made it possible for fleets to earn EPAct credits for use of biodiesel blends of at least 20 percent. This rule does not make B20 an alternative fuel but gives one credit per 450 gallons of pure biodiesel used in blends.

There is currently a federal tax credit to sellers of biodiesel of $.01 per gallon percentage point of biodiesel used, i.e. B20 receives a $.20 federal tax credit per gallon.

Quality: The primary standard ensuring biodiesel quality is ASTM D 6751, which was developed by a panel of stakeholders including fuel producers, engine manufacturers, scientists, regulators, and end users. This standard applies to the production of B100 meant to be blended with petroleum diesel at ratios of 20 percent biodiesel or less. Mixtures with larger amounts of biodiesel are recommended to be treated on a case by case basis since there is significantly less field experience on performance of higher blends in vehicles.

Biodiesel is a cleaner burning fuel than conventional petro-diesel. Biodiesel emits around 75 percent less carbon dioxide than petro-diesel, and releases less carbon monoxide, particulate matter, hydrocarbons, and sulfur than petro-diesel. Emissions of nitrogen oxides, however, can be higher than petro-diesel in older engines. For newer engines, nitrogen oxides are comparable with conventional diesel (McCormick, 2005).

Over fifty million miles of driving have been recorded with B20 and no adverse impacts have been noted. In fact, biodiesel delivers benefits by improving the lubricity of diesel fuel, which is used both for driving the pistons and for lubricating the moving metal parts. Studies have shown that even at a two percent biodiesel concentration, the added lubricity delivers significant benefits to the engine (Knothe, 2006).

There are three important things to consider regarding engine durability when using biodiesel. First, older diesel engines may not be compatible with biodiesel because of the materials used in engine gaskets, hoses, and seals – biodiesel can erode these older rubber-based materials and cause major engine damage.

Second, when transitioning from petro-diesel to biodiesel, engine filters should be monitored since the biodiesel will strip petro-diesel resins from the fuel tanks and engine parts and expel it through the exhaust. Over time, all petro-diesel resins will be removed and filters should be maintained according to regular intervals.

Third, as mentioned above, there is a wealth of field experience with the use of biodiesel blends up to B20 but limited experience with higher concentrations. Vehicles using blends up to B20 can be treated similarly to vehicles running on pure petro-diesel. However, vehicles using biodiesel blends over twenty percent should be monitored more closely since engine impacts are less studied.

As with petro-diesel, biodiesel suffers from clouding (i.e., transition from a liquid to a gel-like state that can damage engines) at low temperatures and should be stored at appropriate temperatures based on supplier recommendations. In addition to storing biodiesel at appropriate temperatures during cold months, another approach to remedying the clouding effect is to use lower concentrations of biodiesel in the fuel mix during cold months since petro-diesel has a lower clouding point.

In recognition of the long-established performance record of B20 in the marketplace and the added lubricity benefits of biodiesel, engine manufacturers treat biodiesel favorably in terms of engine warranty. However, use of higher concentrations of biodiesel could void some warranties.

Supply: Biodiesel can be used in regular diesel engines, which are available from a range of manufacturers for a range of light and heavy duty vehicle configurations. As of January 2007, there were over 100 biodiesel production plants in the U.S. with a total annual production capacity of nearly one billion gallons (NBB, 2007). Plants with annual production of at least ten million gallons are operational in 18 states. According to the National Biodiesel Board, the states currently with the most production capacity are: Iowa (140m gallons/year), Texas (120m gallons/year), Tennessee (65m gallons/year), and Minnesota (63m gallons/year). Illinois, Missouri, Ohio, and South Carolina all had state-wide production capacities of over 30 million gallons/year.

As of February 2007, the National Biodiesel Board reported 1000 biodiesel fueling stations nationwide. The only states with no pumps were Alaska, West Virginia, and New Jersey. The five states with the most stations were: Illinois (125), Minnesota (70), Indiana (60), Texas (55), and Michigan (50). The three most populous states, California, Texas, and New York, had 35, 55, and 10 pumps respectively. Visit the National Biodiesel Board website for a complete station list: **http://www.nbb.org/buyingbiodiesel/retailfuelingsites/**.

Biodiesel delivers an array of environmental and economic benefits that suggest a bright future for this fuel. B20 can be used today in regular diesel engines and that percentage may increase as more experience is gained with higher concentrations. The supply of biodiesel is domestic and diverse, helping improve energy security and reduce reliance on petroleum. However, until a greater number of light-duty diesel vehicles become available in the U.S. market, gasoline and gasoline alternatives will likely dominate this market segment.

NATURAL GAS

Natural gas is a versatile and clean burning mixture of hydrocarbons that is obtained by extracting sub-surface deposits, as a by-product of oil production, or as a by-product of human and animal waste. The principle component of natural gas is methane. Natural gas is used for a variety of purposes including electricity and heat production and, because of its clean properties, as a transportation fuel. Most natural gas used in vehicles is in the form of compressed natural gas (CNG), where large volumes of gas are compressed into high pressure tanks. Natural gas can also be stored as liquefied natural gas (LNG), where the gas is cooled to minus 260 degrees (F). LNG requires less space per unit of energy than CNG but needs to be held at extremely low temperatures. The engine technology for natural gas vehicles uses the same basic internal combustion principles used in gasoline and diesel engines.

Cost: The Honda Civic is the only vehicle with a CNG model available, which sells for $10,000 more than the standard gasoline Civic. Heavy-duty Natural Gas Vehicles (NGVs) can cost up to $50,000 more than their conventional counterparts. Kits are also available to retrofit conventional engines.

The NGV version of the Honda Civic has a fuel economy of 28 mpg/city and 39 mpg/hwy on a gasoline equivalency basis. The standard gasoline Civic is rated at 30 mpg city and 40 mpg highway and the Civic hybrid is rated at 49 mpg city and 51 mpg highway. On a fuel cost basis, the natural gas version of the Civic performs better than the gasoline Civic and slightly worse than the hybrid Civic. For heavy-duty NGVs, such as buses, the fuel economy can be significantly lower than diesel. For instance, New York City’s transit agency has reported that their NGV buses are 40 percent less efficient than diesel, leading to additional fuel costs of 16 cents/mile (see the *New York City Clean Fuel Bus Program* report in the Related Documents section below).

CNG is the most common form in which natural gas is used in vehicles. In October 2006, the CNG national average price was $1.77/gallon of gasoline equivalent, compared to $2.22/gallon of gasoline and $2.62/gallon of diesel (DOE, 2006a). The lowest average price for CNG in October 2006 was recorded in the Midwest at $1.24/gallon of gasoline equivalency. The price of gasoline in the Midwest was $2.18/gallon. The highest price for CNG was in New England where a gallon of gasoline equivalency cost $2.49, compared to gasoline at $2.23/gallon.

Price volatility is a concern with natural gas since supply and demand can change dramatically, unpredictably and rapidly. For instance, a hurricane in the Gulf of Mexico can significantly disrupt supply while a sustained blast of cold arctic air in the winter can boost heating fuel demand. Aside from these possible supply disruptions and demand spikes, natural gas proponents argue that the significant price rise over the past decade was a side effect of market controls that made prices artificially low and which discouraged suppliers from expanding investment in new capacity. Advocates claim that prices are now stable since price controls have been lifted and the prices more accurately reflect the market.

Because of the clean, high performance nature of natural gas, NGVs are often said to enjoy maintenance cost savings over gasoline and diesel engines. Some fleets have reportedly realized up to a 40 percent savings in maintenance costs and have been able to extend maintenance intervals by 30,000 to 50,000 additional miles and oil change intervals by 10,000 to 25,000 additional miles. Plus, metal components such as exhaust systems, tend to last longer on NGVs since natural gas is less damaging to the metals. But these findings are not unanimous, as demonstrated by New York City’s findings that NGV buses can be less reliable than diesel buses and actually lead to additional maintenance costs of up to 20 cents/mile.

According to NGV America, a federal tax incentive for CNG and LNG went into effect in October 2006 giving sellers a 50 cent/gallon equivalent tax break for natural gas.

Quality: There are nearly 40 standards for the fuel and components required for NGV vehicles. These standards include guidance on the composition of the fuel, the type of storage tank used, the type of hose and nozzle used for fueling, and safety practices. Standards include SAE J1616 (Recommended Practices for Compressed Natural Gas Vehicle Fuel), and SAE J2406 (Recommended Practices for CNG Powered Medium and Heavy-Duty Trucks).

Natural gas is the cleanest burning of all alternative fuels. Compared to gasoline, natural gas produces 70 percent less CO, 85 percent less NOx, and 20 percent less CO2. Compared to diesel, natural gas produces 90 percent less CO and PM, 50 percent less NOx, and 15 percent less CO2. See page 10 of Natural Gas versus Diesel Bus Emissions Comparison in the Related Documents section below for a comparison of grams/mile.

With over 5 million on the road worldwide, NGVs are able to meet performance requirements for a variety of vehicle applications. In general, NGVs deliver 5-15 percent less power than gasoline and diesel vehicles, which can impact acceleration and responsiveness. Advanced electric components ensure that natural gas is mixed properly to maximize engine performance.

Maintenance for NGVs is more complicated than conventional vehicles for a number of reasons. First, natural gas must be stored in high pressure cylinders that need to be monitored and properly maintained for safety reasons. Second, natural gas fueling infrastructure is complex and consists of specialized tanks, tubes, and gaskets that must be properly maintained to prevent leaks. Third, NGVs contain advanced components and electrical equipment that will require special training for maintenance staff.

Warranties for NGVs are similar to those available for conventional gasoline and diesel vehicles.

Supply: There are over 150,000 natural gas vehicles (NGVs) on the road in the U.S. today. Over 50 manufacturers produce around 150 models of light, medium, and heavy-duty natural gas vehicles and engines (NGVAmerica, 2007). Over 20 percent of transit bus orders are currently for NGVs; and fleets of taxi cabs, refuse haulers, and a range of other medium and heavy-duty vehicles use natural gas.

Natural gas is widely available throughout the U.S. and has a broad distribution network. Less than one-tenth of one percent of the natural gas used in the U.S. is used in NGVs, so supply constraints are not a major issue for vehicles. As of February 1, 2007, the Alternative Fuels Data Center reported that there were 739 CNG fueling stations in the U.S., just under half of which were accessible by the public. California had far more public CNG fueling stations than any other state, with 109. The next closest states were: Oklahoma with 32, New York with 27, and Arizona with 22 public CNG fueling stations. Fourteen states and the District of Columbia had no public CNG fueling pumps.

Although most natural gas is currently obtained from underground deposits and through the production of oil, man-made sources such as landfills, sewage, and animal/crop waste represent another plentiful supply. NGV America estimates that there is enough natural gas produced today from these man-made sources in the U.S. to power all the NGVs currently on the road. The potential production from man-made sources in the U.S. could produce enough natural gas to displace 25 percent of the diesel used by buses and freight trucks in the U.S.

Eighty-five percent of the natural gas consumed in the U.S. is produced domestically, 20 percent of which comes from the Gulf of Mexico. Another 12 percent is imported from Canada.

Related Documents:

Alternative Fueling Stations Counts by State and Fuel Type, Department of Energy, 2006. Lists alternative fuel station counts by state and fuel type as of November 2006.

Alternative Fuels Price Report, Department of Energy, 2006.
Compares conventional and alternative fuels prices by region in October 2006.

Analysis of Electric Drive Technologies for Transit Applications: Battery-Electric, Hybrid-Electric, and Fuel Cells, Callaghan and Lynch, 2005.
Report by the Northeast Advanced Vehicle Consortium comparing emissions and performance of electric drive technology buses with conventional diesel buses.

Combating Urban Air Pollution through Natural Gas Vehicle (NGV) Analysis, Testing, and Demonstration, Argonne National Laboratory, 1994.
An early analysis of natural gas bus performance and emissions characteristics.

King County Metro Transit Hybrid Articulated Buses: Final Evaluation Results, National Renewable Energy Laboratory, December 2006.
Technical report comparing performance of fleets of diesel and hybrid-electric articulated buses in King County, WA in terms of emissions, fuel use, fuel economy, and maintenance costs.

New York City Transit (NYCT) Hybrid (125 Order) and CNG Transit Buses: Final Evaluation Results, National Renewable Energy Laboratory, November 2006.
Technical report comparing performance of fleets of hybrid-electric and CNG buses in New York City in terms of emissions, fuel use, fuel economy, and maintenance costs.

NYCT Clean Fuel Bus Programs, Department of Buses, 2000.
PowerPoint presentation comparing performance and emissions of conventional, hybrid, and natural gas buses in the New York City bus fleet.

Plug-In Hybrids: An Environmental and Economic Performance Outlook, American Council for an Energy Efficient Economy, 2006.
Report comparing environmental and economic attributes of plug-in hybrids with conventional gasoline vehicles and hybrids based on geographically diverse electric generation profiles.

Use of Biodiesel Blends above 20% Biodiesel, National Biodiesel Board, 2005.
Guidance issued in November 2005 regarding concerns with biodiesel blends above 20 percent.

Policies

Many educational institutions, cities, states, counties, and businesses have responsible fleet policies stating the social and environmental benefits gained by switching to responsible vehicles, and typically require the use of particular types of fuels, vehicles, and/or practices.

Model Policy > City of Ann Arbor, MI. Green Fleets Policy, 2004
In 2004, Ann Arbor enacted a Green Fleets Policy covering a range of vehicle and fuel types and setting targets and criteria for fleet management. Ann Arbor's responsible fleet policy has already delivered significant benefits to the City and serves as a model for other jurisdictions.

MORE SAMPLE POLICIES

Federal

White House, Environmental, Energy, and Transportation Management, 2007
Executive Order 13423 outlines conservation and efficiency practices for federal agencies. Section 2, paragraph (g) pertains to fleet petroleum and alternative fuel consumption and addresses plug-in hybrids.

White House, Green Fleet Policy, 2000
Executive Order 13149 instructs federal agencies to switch from petroleum to alternative fuels, to use environmentally preferable lubricants and retread tires, acquire higher fuel economy vehicles, and follow new administrative procedures such as inventory and reporting requirements.

State

Minnesota, Plug-In Hybrid Policy, 2006
Legislative that creates a plug-in hybrids task force, establishes objectives and priorities, and mandates plug-in hybrid specifications for State passenger vehicles solicitations.

Texas, Vehicle Management Plan, 2003
A fleet policy including detailed directions for compiling and reporting on fleet inventory, directions for maintaining proper fleet size and vehicle usage, directions for using alternative fuels, and maintenance requirements.

County

King County, WA, Biodiesel Policy, 2006
This policy contains a preamble listing the attributes of King County's responsible vehicle fleet and includes a mandate for 20 percent biodiesel (B20) in the county's diesel vehicles.

Texas Council of Governments, Clean Fleet Policy, 2004
Policy developed by Dallas-Fort Worth area council of governments that addresses vehicle purchasing, operation, maintenance, and emissions.

City

Chapel Hill, NC, Green Fleet Policy, 2005
Policy establishes procedures for fleet inventory and reporting and efficiency targets for light, medium, and heavy duty vehicles.

Los Angeles, CA, Clean Fuel Program, 2000
Description of the Los Angeles policy for clean vehicles and fuels for use in the city's fleet of heavy-duty refuse collection vehicles.

Portland, OR, Green Fuels Ordinance, 2006
Policy mandates minimum B20 for city-owned diesel vehicles and E85 for flex-fuel vehicles.

Roanoke, VA, Idling Policy, 2004
A concise two paragraph policy limiting idling of city vehicles.

Specifications

Flex-fuel cars, trucks, SUVs, and vans are now being purchased in large quantities, especially by federal and state government agencies required to do so by EPAct 2005. Over 200 fleets now include light duty hybrids. In recognition of the fuel economy and emissions benefits of compressed natural gas (CNG), many fleets remain interested in light duty CNG vehicles.

Model Specification > Commonwealth of Massachusetts. Hybrid Vehicle Specs, 2005
In 2005, the Commonwealth of Massachusetts issued hybrid vehicle specifications for the Commonwealth, county and city governments in the Commonwealth, and neighboring states.

Model Specification > State of New York. Flex Fuel & CNG Specs, 2006
In 2006, the State of New York issued flex-fuel and CNG vehicle specifications for the state.

MORE SAMPLE SPECS

State

Arkansas, Hybrid Vehicle Specs, 2006
Bid request for hybrid sedans, trucks, and SUVs that meet State requirements for emissions and cooperative purchasing.

County

Dane County, WI, Hybrid 4x4 Vehicle Specs, 2005
Bid request for hybrid 4x4 vehicle, including vehicle attributes and dealer attributes.

King County, WA, Hybrid Sedan Specs, 2006
Bid request for hybrid sedans.

King County, WA, Hybrid SUV Specs, 2006
Bid request for hybrid SUV.

San Bernardino County (CA), Hybrid Sedan Specs, 2003
Bid for county wide purchasing contract for hybrid sedans that meet the California Air Resources Board emissions standard.

City

Lincoln, NE, Hybrid Vehicle Specs, 2005
Specifications for purchase of Honda Civic Hybrid, including vehicle components and warranty.

Austin, TX, Plug-In Hybrid Conversion Specs, 2006
Bid specifications for conversion of Toyota Priuses into plug-in hybrids.

Educational Institution

University of Missouri, Flex Fuel Vehicle Specs, 2003
Bid request for flex fuel van, including an equation for calculating life cycle cost of the vehicle as criterion for awarding contract.

Standards

Most government and industry standards for safety and performance of vehicles sold in the U.S. apply universally to vehicles, components, and fuels. A few standards can be used to improve the social and environmental profile of a vehicle fleet. First, the California Air Resource Board (CARB) emission standard designates gasoline vehicles that have fewer emissions than vehicles sold under the federal government's emissions standard. Other standards, described below, relate to the quality of alternative fuels that a fleet may purchase directly from a fuel producer for dispensing at a central fleet-owned pump. Alternative fuel vehicle warranties require the use of fuel meeting these standards.

U.S. Environmental Protection Agency Light Duty Vehicle Emissions Standards
Emission rates for criteria pollutants for different emission standard levels under Federal law.

State of California Light Duty Vehicle Emissions Standards
California, Maine, Massachusetts, New York, and Vermont have adopted CARB emissions standards. In some cases, states bordering these five states can acquire vehicles meeting these CARB standards.

Biodiesel Blend Stock Specification (B100) ASTM D 6751
This standard was developed by a panel of stakeholders including fuel producers, engine manufacturers, scientists, regulators, and end users and applies to the production of B100 for the purpose of blending with petroleum diesel at up to 20 percent biodiesel, i.e. B20.

National Biodiesel Accreditation Program BQ-9000
BQ-9000 is a cooperative, voluntary program for the accreditation of producers and marketers of biodiesel with the goal of ensuring top quality biodiesel with ASTM D 6751 specification. For certification, producers, retailers, and marketers must pass inspection and are subject to audits.

E85 Specifications ASTM D 5798-99
The standard for pure ethanol is ASTM D-4806-98. The standard for ethanol in fuel mixture with gasoline is ASTM D 5798.

Natural Gas Codes, Standards and Advisories Applicable to Natural Gas Vehicles and Infrastructure Natural Gas Vehicles Specifications
There are a range of standards pertaining to natural gas vehicles, including standards for fuel composition, fuel tanks, and fueling infrastructure like pumps and hoses. The Clean Vehicle Education Foundation has compiled a comprehensive list of standards for natural gas vehicles and vehicle fueling infrastructure.

Products

Our website: **www.ResponsiblePurchasing.org** has a searchable list of 2007 model year light duty vehicles including purchase price, engine type, and fuel economy. This database, available only to RPN members, includes:

1. All hybrid vehicles available in 2007
2. All flex-fuel vehicles available in 2007
3. Conventional gasoline versions of hybrid and flex-fuel models
4. Most efficient gasoline vehicle in each vehicle class

Our online **Hybrid Calculator** is a publicly available tool that can be used to compare the lifecycle costs and emissions of hybrid and conventional vehicles. http://www.responsiblepurchasing.org/calculator/

Handy Facts

- There are over 240 million light-duty motor vehicles on the road in the U.S. today, nearly 10 million of which are in public and private fleets (BTS, 2006; CTA, 2006a).
- Cars and light trucks are a significant source of air pollutants that cause smog and unhealthy air conditions, emitting 1/3 of all nitrogen oxides and half of all carbon monoxide released in the U.S. each year (EPA, 2005).
- In 2004, U.S., highway vehicles emitted more carbon dioxide emissions than the total national emissions from any country other than China and Russia (EPA, 2006d; Marland, 2006).
- Over 95% of fuel used by cars and light trucks is petroleum-based (CTA, 2006b).
- Based on current trends, U.S. gasoline consumption could increase by 30% by 2030 (EIA, 2005).
- After seven years of driving, a fleet of twenty Priuses will emit 1.3 million pounds less carbon dioxide, 25,000 pounds less carbon monoxide, and 320 pounds less nitrogen oxides than a fleet of twenty Crown Victorias (HEV Calculator).
- There are over 170,000 gasoline filling stations in the U.S., which dispense over 400 million gallons of fuel each day.
- The U.S. imports more than 60% of the crude oil we consume, with 25% of that coming from OPEC countries (EIA, 2007a; EIA, 2007b).
- There are over 500,000 hybrid electric vehicles (HEVs) on the road in the U.S. today, over half of which are Toyota Prius sedans.
- In the 2007 model year, twelve light duty HEVs are available from Chevrolet, Ford, GMC, Honda, Lexus, Mercury, Saturn, and Toyota, including small and mid-sized cars, sport utility vehicles, and pickup trucks.
- There are over 5 million flex-fuel cars on the road in the U.S. today, capable of running on 85% ethanol (E85) blends.
- There are just over 1,000 E85 filling stations in the U.S., half of which are located in Minnesota, Illinois, Iowa, and Wisconsin.
- Twelve states do not have any E85 filling stations.
- There are over 630 biodiesel fueling stations in the U.S., with Missouri, South and North Carolina, and Texas having the most.
- Only Alaska, North Dakota, Rhode Island, South Dakota, and West Virginia have no biodiesel filling stations.
- There are over 150,000 natural gas vehicles on the road in the U.S. today.
- There are over 730 natural gas fueling stations in the U.S., over half of which are available for public use.

Definitions

Acid rain	acidic compounds caused by pollutants such as sulfur dioxide (SO_2) and nitrogen oxides (NO_x) that collect in the atmosphere, are absorbed by clouds, and create acidic rainfall
Advanced hybrid	a hybrid-electric vehicle (HEV) that uses advanced energy recovery technologies (e.g., regenerative braking) and is capable of driving in all-electric mode, see also hybrid-electric vehicle and hollow hybrid
B20	biofuel composed of 20% biodiesel and 80% gasoline, see also biodiesel
Baseline	basic information gathered before a program begins that is used later to provide a comparison for assessing program impact
Biobased	products composed in whole or in significant part of biological products, forestry materials, or renewable domestic agricultural materials, including plant, animal, or marine materials, generally safer for the environment than petroleum-based counterparts, and usually biodegradable or recyclable
Biodiesel	a substitute for petroleum based diesel fuel that is produced from agricultural crops such as soybeans
Car-sharing	a system providing simple, regular access to vehicles without personal ownership; typically run by a for-profit company such as FlexCar and ZipCar
Cellulosic ethanol	a high-energy yielding ethanol fuel produced from cellulose, a naturally occuring carbohydrate commonly found in plant cell walls; cellulosic ethanol has a better lifecycle energy and emissions profile than corn ethanol but is currently more expensive to produce, see also ethanol
Compressed natural gas (CNG)	natural gas held in gaseous form under high pressure used as a vehicle fuel, see also natural gas vehicle
E85	vehicle fuel type composed of 85% ethanol and 15% gasoline, see also "ethanol" and "flex-fuel"
Environmentally preferable	products and services that have a lesser or reduced effect on human health and the environment when compared to other products and services that serve the same purpose.
Ethanol	fuel type made by fermenting plant sugars; nearly all ethanol produced in the U.S. today is from corn sugars, see also cellulosic ethanol, E85, and flex-fuel
Flex-fuel	passenger vehicle with specially designed engine capable of running on E85 or pure gasoline, see also ethanol and E85
Fuel economy	fuel efficiency; a measure of fuel needed per unit of distance traveled, e.g. miles per gallon

Hazardous substance	1. material posing a threat to human health and/or the environment, that can be toxic, corrosive, ignitable, explosive, or chemically reactive; 2. substance that must be reported to the EPA if released into the environment
HEV	hybrid-electric vehicle, see also hybrid-electric vehicle
Hollow-hybrid	vehicle marketed as an HEV but lacking advanced fuel economy features such as regenerative braking and all-electric drive mode, see also hybrid-electric vehicle and advanced hybrid
Hybrid-electric vehicle	fuel efficient vehicle type that combines an internal combustion engine with a battery-powered electric motor and other energy efficiency features
Idling	leaving the engine on while a vehicle is not in use
Natural gas vehicle (NGV)	vehicle fueled by natural gas, see also compressed natural gas
Plug-in hybrid (PHEV)	vehicle type similar to HEV, but with smaller gasoline engine and larger battery pac that can be charged using a standard electrical outlet and provide an all-electric driving range of between 20 and 60 miles, see also hybrid-electric vehicle
Smog	air pollution formed when sunlight reacts with oxides of nitrogen and hydrocarbons
Toxic substance	a chemical or mixture that may present an unreasonable risk of injury to health or the environment
Volatile organic compound (VOC)	organic compound that typically vaporizes at room temperature and participates in atmospheric photochemical reactions

Tools

Hybrid Vehicle Calculator

Compare cost and emissions for 2007 model year vehicles.

HEV Calculator **www.responsiblepurchasing.org/calculator/**

Alternative Fuels Data Center **www.eere.energy.gov**

The Clean Fleet Guide **www.eere.energy.gov/fleetguide**

Endnotes

ALA, American Lung Association, web content dated April 2000, viewed November 2006, http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=35332

Barnitt, R., Chancler, K., New York City Transit (NYCT) Hybrid (125 Order) and CNG Transit Buses: Final Evaluation Results, National Renewable Energy Laboratory, November 2006, http://www.nrel.gov/vehiclesandfuels/fleettest/pdfs/40125.pdf

BTS, Bureau of Transportation Statistics, National Transportation Statistics – Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances, updated September 2006, viewed February 2007, http://www.bts.gov/publications/national_transportation_statistics/html/table_01_11.html

CDC, Centers for Disease Control, Unintentional Non-Fire-Related Carbon Monoxide, United States, 2001-2003, January 21, 2005 http://www.cdc.gov/MMWR/preview/mmwrhtml/mm5402a2.htm#tab1

Chandler, K., Walkowicz, K., King County Metro Transit Hybrid Articulated Buses: Final Evaluation Results, National Renewable Energy Laboratory, December 2006, http://www.nrel.gov/vehiclesandfuels/fleettest/pdfs/40585.pdf

CTA, 2006a, Center for Transportation Analysis, Oak Ridge National Laboratory, Transportation Energy Data Book, 2006, http://www-cta.ornl.gov/data/tedb25/Edition25_Chapter07.pdf

____, 2006b, Transportation Energy Data Book, 2006, http://cta.ornl.gov/data/chapter2.shtml

DOE, 2006a, Department of Energy, Alternative Fuels Price Report, October 2006

____, 2006b, undated web content viewed on November 2006, http://www.fueleconomy.gov/feg/climate.shtml

Duvall, Mark, et all, Advanced Batteries for Electric-Drive Vehicles – A Technology and Cost-Effectiveness Assessment for Battery Electric, Power Assist Hybrid Electric, and Plug-in Electric Vehicles, Electric Power Research Institute, March 2003

EIA, Energy Information Agency, Annual Energy Outlook 2006 with Projections to 2030, Department of Energy, December 2006, http://www.eia.doe.gov/oiaf/archive/aeo06/gas.html

____, 2007a, Energy Information Agency, International Petroleum Monthly, viewed January 2007. Import data: www.eia.doe.gov/emeu/ipsr/t34.xls, demand data: www.eia.doe.gov/emeu/ipsr/t17.xls

____, 2007b, U.S. Imports by Country of Origin – Total Crude Oil and Products, updated February 1, 2007, viewed February 5, 2007, http://tonto.eia.doe.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbbl_m.htm

____, 2007c, Crude Oil Production – Monthly, Thousand Barrels, updated February 1, 2007, viewed February 5, 2007, http://tonto.eia.doe.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_m.htm

Energy Futures, Inc., U.S. HEV Sales Up 25% in 2006, Hybrid Vehicles – Volume 9, Issue 1, February 2007

EPA, Environmental Protection Agency, Automobile Emissions: An Overview, August 1994, http://www.epa.gov/OMS/consumer/05-autos.pdf

____ Eight-Site Source Apportionment of PM 2.5 Speciation Trends Data, September 24, 2003 http://www.epa.gov/oar/oaqps/pm25/docs/8sitesaspectrendsfinal.pdf

____ National Emissions Inventory (NEI) Air Pollutant Emissions Trends Data and Estimation Procedures, data for 2002 posted online on August 2005 and viewed in November 2006, http://www.epa.gov/ttn/chief/trends/

____ 2006a, Web content updated in November 2006 and viewed on November 2006, http://www.epa.gov/oar/particlepollution/index.html

____ 2006b, Web content updated in November 2006 and viewed on November 2006, http://www.epa.gov/air/urbanair/nox/hlth.html

____ 2006c, Web content updated in October 2006 and viewed on November 2006, http://www.epa.gov/airmarkets/acidrain/effects/health.html

____ 2006d, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004, April 15, 2006, http://www.epa.gov/climatechange/emissions/usinventoryreport.html

HEI, Health Effects Institute, Research on Diesel Exhaust and Other Particles, October 2003, http://www.healtheffects.org/Pubs/DieselProgrSumm2003.pdf

Kleisch, James, Langer, Therese, Plug-In Hybrids: An Environmental and Economic Performance Outlook, American Council for an Energy Efficient Economy, September 2006, http://www.aceee.org/pubs/t061.htm

Knothe, G.H., Research on Biodiesel and Vegetable Oil Fuels – Then and Now, Inform, December 2006, http://www.ars.usda.gov/research/publications/publications.htm?seq_no_115=200812

Lovins, Amory B., et all, Winning the Oil Endgame: Innovation for Profits, Jobs, and Security, Rocky Mountain Institute, 2004, http://www.oilendgame.com/

Marland, G., Boden, T.A., Andres, R.J., Global, Regional, and National Fossil Fuel CO2 Emission: Trends – A Compendium of Data on Global Change, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, 2006, http://cdiac.ornl.gov/trends/emis/em_cont.htm

McCormick, Bob, Effects of Biodiesel on NOx Emissions, National Renewable Energy Laboratory, ARB Biodiesel Workshop, June 2005, http://www.nrel.gov/vehiclesandfuels/npbf/pdfs/38296.pdf

NBB, National Biodiesel Board, Commercial Biodiesel Production Plants, January 2007, http://www.biodiesel.org/buyingbiodiesel/producers_marketers/ProducersMap-Existing.pdf

NGVAmerica, About Natural Gas Vehicles, Natural Gas Vehicle for America, viewed on February 1, 2007, http://www.ngvc.org/mktplace/fact.html

NRDC, Natural Resources Defense Council, undated web content viewed November 2006, http://www.nrdc.org/air/pollution/qbreath.asp

ORNL, Oak Ridge National Laboratory, Transportation Energy Data Book: Edition 25, 2006, http://cta.ornl.gov/data/tedb25/Edition25_Full_Doc.pdf

Reuters, Toyota sees 40 pct jump in ’07 global hybrid sales, January 24, 2007, http://today.reuters.com/news/articleinvesting.aspx?type=companyNews&storyID=2007-01-24T092604Z_01_T104456_RTRIDST_0_TOYOTA-HYBRID-UPDATE-2.XML

Roanoke, City of, Engine and Equipment Idling Policy. 2004. Available at: http://www.responsiblepurchasing.org/UserFiles/File/Fleet/Policy/City_of_Roanoke_VA_Idling_Policy_2004.pdf

Sainsbury, Brendan, Big Mellow Taxi – Meet the world’s first hybrid-cab driver, Grist, August 2005, http://www.grist.org/news/maindish/2005/08/02/sainsbury-cab/

Siegenthaler, Urs, et all, Stable Carbon Cycle-Climate Relationship During the Late Pleistocene, Science Magazine, November 2005, http://www.sciencemag.org/cgi/content/short/310/5752/1313/

STPP, Surface Transportation Policy Project, Clearing the Air – Public Health Threats from Cars and Heavy Duty Vehicles, 2003, http://www.transact.org/library/reports_pdfs/Clean_Air/report.pdf

Addendum I: Model Policy

Model Policy > City of Ann Arbor, MI. Green Fleets Policy, 2004
In 2004, Ann Arbor enacted a Green Fleets Policy covering a range of vehicle and fuel types and setting targets and criteria for fleet management. Ann Arbor's responsible fleet policy has already delivered significant benefits to the City and serves as a model for other jurisdictions.

See attached for complete policy.

Addendum II: Model Specifications

Model Specification > Commonwealth of Massachusetts. Hybrid Vehicle Specs, 2005
In 2005, the Commonwealth of Massachusetts issued hybrid vehicle specifications for the Commonwealth, county and city governments in the Commonwealth, and neighboring states.

Model Specification > State of New York. Flex Fuel & CNG Specs, 2006
In 2006, the State of New York issued flex-fuel and CNG vehicle specifications for the state.

See attached for complete specifications.