ALTERNATIVE FUELS 101: HOW TO CHOOSE THE RIGHT FUELS AND TECHNOLOGY FOR YOUR FLEET

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Green Drive$ 2018
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WHAT ARE ALTERNATIVE FUELS AND TECHNOLOGIES?

Alternative Fuels and technologies are becoming the new normal! Commonly used today include the following:

• Electric
• Hybrid (gas/Diesel electric and hydraulic)
• Ethanol (various blends from E-10 to E-85 commonly)
• Biodiesel (various blends with diesel (from B2 to B20 typically)
• Natural Gas, Compressed (CNG) and Liquifies (LNG)
• Propane (LPL, Autogas)
• Variations of some of the above Bi-Fuel and Dual Fuel
• Anti-Idling Technologies
• Exhaust Retrofits
IF YOU HAVE BEEN INVOLVED WITH ALTERNATIVE FUELS AND TECHNOLOGIES PREVIOUSLY, NOTE THE FORMULAS TO COMPUTE THE REAL COSTS HAVE NOT CHANGED, OVER TIME THE COST OF THE TECHNOLOGY AND FUELS HAVE CHANGED DRAMATICALLY.
WHAT FUELS AND TECHNOLOGIES TO USE TODAY AND INTO THE FUTURE

In 2018 there are more choices than in years past. CNG, LPG, Biodiesel, Ethanol, Hybrid (electric and hydraulic), electric, hydrogen, upcoming fuels as well as new technologies.
FUEL SAVINGS THINGS TO DO

• Electrically operated heating and cooling with the engine off
• Devices that limit acceleration
• Driver training
• Add on generators (larger vehicles)
• Limit unnecessary weight
• Perform maintenance, keep tires inflated
CNG, LPG, BIODIESEL, ETHANOL AND HYBRID ELECTRIC

When we converted the fleet I managed we used many different types of fuels and technologies for all of the different kinds of vehicles the fleet had.

The choices were based on the ROI on specific vehicles. We received government grants and rebates to make it all work.
In addition to the cost of the fuels there is also the “Green Factor” and how that fits into the company or agency culture, in addition there can be great PR value.
HOW TO DECIDE WHAT TO USE

You should calculate the TRUE cost, use formulas taking into account all of the following: cost of the fuel, cost of the infrastructure, cost of infrastructure operation (electricity, maintenance and estimated repairs), cost of labor to fuel the vehicle and the incremental vehicle cost (alternative VS traditional fuel). Search and find incentives, grants and rebates. Then with the amount of fuel and labor used compute the cost savings (or higher cost) and the ROI (if any).
ELECTRIC VEHICLES

*Range in size from small cars, sports cars, to busses and soon Semi Tractors

*Fast charge stations are available and can give a significant charge in as little as 15 minutes.

*Large electric trucks and busses are becoming available from OEM and some conversions
HYBRIDS: ELECTRIC AND HYDRAULIC

*Both technologies add cost but after doing all of the math can save money in the long term
*Electric Hybrids typically use gasoline and electric power, some are plug ins
*Hydraulic Hybrids build up hydraulic pressure and reduce fuel consumption when the use that power.
ETHANOL

Ethanol is readily available and can be used as E-85 in vehicles designated to use it. Ethanol should cost less per gallon than gasoline but has less energy per gallon. Expect to get 15-25% less MPG. Using Ethanol can save money if the price is right. All gasoline in the area is E-10, some places offer custom blends.
BIODIESEL

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BIODIESEL

• Increased Engine Performance
• Decreased Tailpipe Emissions
• Fuel Cost Savings
• No Upfront Investments
REG – AMERICA’S #1 BIODIESEL PRODUCER

13 Biomass-Based Diesel Plants

502 MMGY NAMEPLATE CAPACITY

Multiple Feedstock Capable
- Albert Lea, MN
- Danville, IL
- Emden, Germany
- Gelsom, IA
- Madison, WI
- Mason City, IA
- New Boston, TX
- Newton, IA
- Oeding, Germany
- Seneca, IL

Refined Feedstock
- Grays Harbor, WA
- Houston, TX
- Ralston, IA

Fermentation Facility
- Okeechobee, FL

Feedstock Proc. Facility
- Burla, Germany

Partially Completed or Repairs Required
WHAT IS BIODIESEL?

- Biodiesel is methyl esters made from biological oils and fats (triglycerides by transesterification*)

*Transesterification is the process of swapping one alcohol (i.e. methanol) for another alcohol (i.e. glycerol)
BIODIESEL BENEFITS

• Blends with petrodiesel in any percentage
• Higher Cetane
• Higher Lubricity
• Virtually Zero Sulfur
• Zero Aromatics
• High Flash Point
• Low Emissions
## Biodiesel Benefits

<table>
<thead>
<tr>
<th></th>
<th>Total Hydrocarbons</th>
<th>Particulate Matter (PM)</th>
<th>Carbon Monoxide (CO)</th>
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<tbody>
<tr>
<td>% Reduction from ULSD</td>
<td>70%</td>
<td>70%</td>
<td>25.0%</td>
</tr>
<tr>
<td>% Reduction from ULSD</td>
<td>60%</td>
<td>60%</td>
<td>20.0%</td>
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<td>% Reduction from ULSD</td>
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<td>50%</td>
<td>15.0%</td>
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<td>% Reduction from ULSD</td>
<td>40%</td>
<td>40%</td>
<td>10.0%</td>
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<tr>
<td>% Reduction from ULSD</td>
<td>30%</td>
<td>30%</td>
<td>5.0%</td>
</tr>
<tr>
<td>% Reduction from ULSD</td>
<td>20%</td>
<td>20%</td>
<td>0.0%</td>
</tr>
<tr>
<td>% Reduction from ULSD</td>
<td>10%</td>
<td>10%</td>
<td>0.0%</td>
</tr>
<tr>
<td>% Reduction from ULSD</td>
<td>0%</td>
<td>0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

B20 | B100

Note: All emissions data taken from 2006 Cummins ISM 370 on Federal Test Procedure driving cycle, as reported in Durbin, Thomas D., et al. "CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California “Biodiesel Characterization and NOx Mitigation Study.”" California Air Resources Board: Sacramento, CA (2011). Comparisons with Federal ULSD were conducted based on a linear comparison with CARB ULSD data. All biodiesel data shown is taken as an average of the means of high and low cloud point biodiesel emissions results, where available.
ILLINOIS TAX INCENTIVE

- B1 – B10 Blends: Retailers are exempt from 20 percent of the state’s 6.25 percent sales tax
- B11 or Greater: Full exemption
- $2.00/gallon diesel price = $.125/gallon savings
- A company using 500,000 gallons/month = $62,500 savings/month for using biodiesel blends of B11 or greater
NATURAL GAS AND PROPANE

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Natural Gas

Hydrocarbons, predominantly methane (CH$_4$)

High octane rating

Nontoxic, noncorrosive, and noncarcinogenic

Not a threat to soil, surface water, or groundwater

Extracted from gas and oil wells

Existing pipeline distribution system

The USA has an abundance on natural gas

Can be made from methane from landfills and water reclamation.
Compressed Natural Gas (CNG)
• Stored in onboard tanks under high pressure
• Fuel economy similar to gasoline
• 1 GGE = 5.7 lb CNG

Liquefied Natural Gas (LNG)
• Kept at cold temperatures
• Stored in double-wall, vacuum-insulated pressure vessels
• Heavy-duty vehicles
• 1 GGE = 1.5 gal LNG
• Also known as liquefied petroleum gas (LPG)
• Colorless, odorless liquid (when stored under pressure)
• High octane rating
• Nontoxic
• By-product of natural gas processing and crude oil refining
• Less than 2% of propane used in U.S. used in transportation
• Lower GHG emissions
Propane Vehicle Availability

• Light-duty vehicles available
• Engines and fueling systems for heavy- and medium-duty vehicles
• Conversions
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HYDROGEN

This I believe is the fuel of the future, but will be a long time till it is practical. There is some regional availability now.
EXHAUST RETROFITS

- Diesel oxidation catalysts (DOCs)
- Diesel particulate filters (DPFs)
- Selective catalytic reduction (SCR) systems
- Crankcase ventilation (CCV) filter systems - No fuel savings, no cost recovery – seek grants
- EPA and California ARB verify the efficacy of these devices and require compatibility with legacy engines – verification required to obtain grant funding
SO, WHAT TO DO TODAY

*Driver Training can save a lot of fuel
*Biodiesel and ethanol are easy and readily available
*CNG, LNG and LPG fuel cost is much more stable than diesel and gasoline
*Electric and Hybrid vehicles are readily available. Infrastructure is being built. Personal cars can charge at home or work.
THE BEST PLACE TO LOOK FOR ADVICE AND INFORMATION

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Coordinator, Chicago Area Clean Cities, City of Chicago
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CLEAN CITIES WEB-BASED TOOLS & RESOURCES

- Websites
- Publications
- Technical Assistance
- Toolkits
- News Sources
- Online Tools
• Clean Cities Website
  • Program Overview
  • Goals & Accomplishments
  • Information Resources
  • News.

• Alternative Fuels Data Center
  • Station Locator
  • Laws & Incentives
  • Maps & Data
  • Case Studies
  • Publications
  • Tools & Widgets.

• FuelEconomy.gov

• Spanish Language Resources

• Additional Resources

https://cleancities.energy.gov/
THE BEST DECISION

The best fuel to use in your fleet is...

What works best in your situation and meets your “green” requirements and ROI needs.
<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Unit of Measure</th>
<th>BTUs Per Unit</th>
<th>Gallon Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline, regular unleaded, (typical)</td>
<td>gallon</td>
<td>114,100</td>
<td>1.00 gallon</td>
</tr>
<tr>
<td>Gasoline, RFG, (10% MBTE)</td>
<td>gallon</td>
<td>112,000</td>
<td>1.02 gallons</td>
</tr>
<tr>
<td>Diesel, (typical)</td>
<td>gallon</td>
<td>129,800</td>
<td>0.88 gallons</td>
</tr>
<tr>
<td>Liquid natural gas (LNG), (typical)</td>
<td>gallon</td>
<td>75,000</td>
<td>1.52 gallons</td>
</tr>
<tr>
<td>Compressed natural gas (CNG), (typical)</td>
<td>cubic foot</td>
<td>900</td>
<td>126.67 cu. ft.</td>
</tr>
<tr>
<td>Liquefied petroleum gas (LPG or propane)</td>
<td>gallon</td>
<td>84,300</td>
<td>1.35 gallons</td>
</tr>
<tr>
<td>Methanol (M-100)</td>
<td>gallon</td>
<td>56,800</td>
<td>2.01 gallons</td>
</tr>
<tr>
<td>Methanol (M-85)</td>
<td>gallon</td>
<td>65,400</td>
<td>1.74 gallons</td>
</tr>
<tr>
<td>Ethanol (E-100)</td>
<td>gallon</td>
<td>76,100</td>
<td>1.50 gallons</td>
</tr>
<tr>
<td>Ethanol (E-85)</td>
<td>gallon</td>
<td>81,800</td>
<td>1.40 gallons</td>
</tr>
<tr>
<td>Bio Diesel (B-20)</td>
<td>gallon</td>
<td>129,500</td>
<td>0.88 gallons</td>
</tr>
<tr>
<td>Electricity</td>
<td>kilowatt per hour</td>
<td>3,400</td>
<td>33.53 kwhrs</td>
</tr>
</tbody>
</table>
FOR MORE INFORMATION

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