AFVs - More Choices than Ever
Work Trucks & Other Vehicle Alt-Fuel Options for Utilities

Jonathan Overly, ETCleanFuels
Utility Fleet Maintenance Assoc. Spring Meeting
Agenda

✓ What is Clean Cities & Who is ETCleanFuels?

Work Truck Options

✓ CNG  ✓ Hybrids – Battery
✓ Propane  ✓ Hybrids – Hydraulic
✓ PHEVs  ✓ Biodiesel

✓ Brief overview of GHGs reductions by alt fuels
What is Clean Cities?

Clean Cities advances the nation's economic, environmental, and energy security by supporting local actions to reduce petroleum consumption in transportation. A national network Clean Cities coalitions bring together stakeholders in the public and private sectors to deploy alternative and renewable fuels, idle-reduction measures, fuel economy improvements, and emerging transportation technologies.

86 teams across the U.S.
Who is ETCleanFuels?

✓ 13-year old nonprofit in East TN, 501(c)3
  • 2 full-time staff, 1 intern
  • Designated member of U.S. DOE Clean Cities Program
  • Contract w/ UTK for staffing & office space

✓ Focused on transportation sector: **Helps Fleets Reduce Petroleum Consumption** (& Save $$ & Improve air quality along the way)

✓ Key metric = # GGEs/year
  (GGE = Gasoline Gallon Equivalents)
What Do ETCleanFuels Members Get?

No one in Tennessee has the knowledge we do to help you evaluate any of the alternative fuels, and the connections to get you industry & fleet user insights.

✓ Review w/you different alt fuels or advanced tech. vehicles; ROI analysis; loaner AFVs for you to test drive; outside entity promoting you as GREEN (suggest for TN or regional awards)

✓ **Writing grants – We have won over $2 million in funding in last 5 yrs**

✓ Associate with other fleet managers & industry leaders via coalition meetings, events & webinars

✓ **Access to our network of alt-fuel professionals from across U.S.**
The Gaseous Fuels

Natural Gas
- CNG = compressed NG
- LNG = liquefied NG (not for utility fleet applications)

Propane / LPG
- “AutoGas” the term used world-wide for propane as autofuel
- 3rd most used trans. fuel on Earth

Higher mileage or higher fuel use vehicles are where the payback is!!
--- 10k, 20k, 30k+ mi/yr vehicles ---
Gaseous Fuel Vehicle Types

Dedicated Vehicles
✓ Run on alt fuel (NG or propane) only
✓ In some cases, better performance
✓ Lower emissions – run solely on alt fuel

Bi-fuel Vehicles
✓ Two fueling systems: gasoline & (LPG or NG)
✓ No range, distance limitations
✓ Fueling flexibility

Dual fuel Vehicles
✓ Run on diesel & alt together; HD only
TN NGVs Task Force...

A State-wide Collaboration for NGVs

- Partnership of TN Clean Cities coalitions, TN Gas Association & other organizations to advance NG as transportation fuel in the state
- Working on assisting fleets and helping build public stations throughout the state to make this a more viable alternative for Tennesseans
CNG Options

- Dedicated, Bi-fuel & Dual Fuel Vehicles
- Mach Fuels is Tennessee installer!

- OEM Options = Ford, Chevy, Ram
- QVMs = Impco, Landi Renzo, Westport, Venchurs, Altech-Eco
  (*Ship-thru & aftermarket*)
- Installers = Mach Fuels, Leggett & Platt, Knapheide, Green Alt. Systems, others
CNG Vehicles - OEM

- Ford Westport WiNG, QVMs, gaseous prep
- Ram 2500 bi-fuel CNG
- Chevy bi-Fuel CNG Silverado/Sierra 2500/3500HD
CNG Vehicles – QVM - Westport

<table>
<thead>
<tr>
<th>FORD MODEL</th>
<th>FUEL TYPE</th>
<th>TANK LOCATION</th>
<th>TANK SIZES</th>
<th>GGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PICKUP TRUCKS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-250</td>
<td>CNG / Bi-Fuel</td>
<td>In-bed</td>
<td>18 x 60</td>
<td>17</td>
</tr>
<tr>
<td>F-350</td>
<td>CNG</td>
<td>Under-body²</td>
<td>(2) 14 x 52</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Bi-Fuel</td>
<td>Under-body (aft-axle)</td>
<td>(1) 12 x 72</td>
<td>30</td>
</tr>
<tr>
<td><strong>CHASSIS CAB</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-350</td>
<td>CNG</td>
<td>IBOX²</td>
<td>21</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Bi-Fuel</td>
<td>Inside service body²</td>
<td>17</td>
<td>23</td>
</tr>
<tr>
<td>F-450</td>
<td>CNG</td>
<td>Short tank-pack</td>
<td>21</td>
<td>42</td>
</tr>
<tr>
<td>F-550</td>
<td>Bi-Fuel</td>
<td>IBOX²</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>F-650</td>
<td>CNG</td>
<td>Saddle-mount</td>
<td>32</td>
<td>42</td>
</tr>
<tr>
<td><strong>BED DELETE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-250</td>
<td>Bi-Fuel / CNG</td>
<td></td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td>F-350</td>
<td>CNG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CUTAWAY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-450</td>
<td>CNG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>STRIP CHASSIS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-59</td>
<td>CNG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CARGO VAN</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td><strong>PASSENGER WAGON</strong></td>
<td></td>
<td></td>
<td>42</td>
<td></td>
</tr>
</tbody>
</table>
CNG Vehicles – QVM - Westport
CNG Vehicles – QVM - IMPCO

We will view IMPCO’s line up on another slide because it includes CNG and propane options...
Propane Options

✓ Dedicated & Bi-fuel Vehicles
✓ Vapor & Liquid-injection Systems
✓ Mach Fuels in Chattanooga can do conversions

✓ ROUSH CleanTech
✓ Icom North America
✓ IMPCO Technologies
✓ CleanFUEL USA
✓ Mach Fuels
✓ Alliance Autogas (Blossman)
Propane Vehicles - ROUSH

<table>
<thead>
<tr>
<th>TRUCKS</th>
<th>VANS/WAGONS</th>
<th>CUTAWAYS</th>
<th>CHASSIS CAB</th>
<th>STRIP CHASSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ford F-250</td>
<td>Ford E-150</td>
<td>Ford E-450 DRW</td>
<td>Ford F-450 / F-550</td>
<td>Ford F-59</td>
</tr>
<tr>
<td>Ford F-350</td>
<td>Ford E-250</td>
<td></td>
<td>Ford F-650</td>
<td>Ford F-53</td>
</tr>
<tr>
<td></td>
<td>Ford E-350</td>
<td></td>
<td></td>
<td>Ford E-450</td>
</tr>
</tbody>
</table>

ETCleanFuels.org
Reducing foreign oil dependence one fleet at a time.
Propane Vehicles - ICOM

Technocarb (older), Impco, Icom, Altech-Eco, M-tech Solutions, Powerfuel CNG, Have liquid-injection systems but also vapor-injection through partner Imega.
Propane Vehicles - ICOM

Dedicated (Monofuel) Vehicles

- 2011 to 2014 F150 3.7L Pickups
- 2011 to 2015 F250/350 6.2L Pickups
- 2009 to 2015 F450/550/650 6.8L Work Trucks
- 2009 to 2015 F53/F59 6.8L (box trucks)
- 2009 to 2015 E450 + F550 6.8L Shuttle Buses
- Projected late June 2015: Ford Transit 3.7L
Propane Vehicles - CFUSA & ICOM

- Trucks utilize CFUSA Liquid Propane Injection (LPI) system (dedicated propane fuel)
- EPA certified
- Van packages available summer 2015

**Highlights**

<table>
<thead>
<tr>
<th>Engine</th>
<th>6.0 V8 (L96)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horsepower</td>
<td>346 hp</td>
</tr>
<tr>
<td>Torque</td>
<td>373 lb-ft</td>
</tr>
<tr>
<td>Tank Size</td>
<td>60 gallons (in bed tank)</td>
</tr>
<tr>
<td>Range</td>
<td>700 miles*</td>
</tr>
<tr>
<td>Warranty</td>
<td>3 year/36,000 miles (Provided by CFUSA)</td>
</tr>
</tbody>
</table>
Vehicles - IMPCO

**Make - Model**

- Ford 6.2L - F250/350
- Ford 6.2L - F250/350
- Ford 6.2L - F250/350
- Ford 6.8L - F450/550
- Ford 6.8L - F650
- Ford 6.8L - E450
- Isuzu 6.0L - NPR HD
- Isuzu 6.0L - NPR HD
- GM 1.4L - Cruze
- GM 5.3L - 1500 Silverado/Sierra
- GM 5.3L - Tahoe, Yukon, Suburban
- GM 6.0L - 2500/3500HD - Silverado/Sierra
- GM 6.0L - 2500/3500HD Silverado/Sierra
- GM 6.0L - 2500/3500HD Silverado/Sierra
- GM 6.0L - 4500 Cutaway Express
- GM 6.0L - 2500/3500HD Express

**Fuel Delivery**

- Bi-Fuel CNG
- Dedicated CNG
- Bi-Fuel LPG
- Dedicated CNG
- Dedicated CNG
- Dedicated CNG
- Bi-Fuel CNG
- Dedicated CNG
- Bi-Fuel CNG
- Bi-Fuel CNG
- Bi-Fuel CNG
- Dedicated CNG
- Bi-Fuel CNG
- Bi-Fuel LPG
- Dedicated CNG
- Dedicated CNG

EAST TENNESSEE CLEAN FUELS
ETCleanFuels.org
Reducing foreign oil dependence one fleet at a time.
Propane in Kingsport
Propane Vehicles – Mowers
Propane Vehicles – Mowers
PHEVs – Plug-in Hybrid Trucks

VIA Motors. A Better Way to Go.
Pictures of EVSE - Level 2

- Pedestal / Wall mount
- Cost
- “Dumb” vs. “Smart”
Hybrid Technology

- Battery electric hybrids
- Hydraulic hybrids
Hybrid Technology

- Mercedes Benz
- Freightliner
- Chevrolet
- Volvo
- Ford – Examples: F-350XT, F-450XT, F-550XT 164 inch wheelbase + greater
Hybrid Technology

The Simple Hybrid Solution

Cargo Vans & Passenger Wagons
- Chevy Express 2500/3500
- GMC Savana 2500/3500
- Ford E-150/E-250/E-350

Shuttle Buses
- Ford E-350 Cutaway
- Ford E-450 Cutaway
- Ford E-450 Strip Chassis
- Coming September, 2015 - GM 3500/4500 Cutaway

Box Trucks
- Ford E-350 Cutaway
- Ford E-450 Cutaway
- Ford E-450 Strip Chassis

Reach Walk-In Commercial Van
- From Isuzu and Utilimaster
- 2,500 payload capacity with XL3 system

Download Specs

✓ Low cost
✓ 15-20% reduction in fuel consumption in urban driving

XL Hybrids has pioneered a hybrid electric powertrain that is revolutionary in its simplicity.
Biodiesel Basics

✓ **B20 most common blend** – can be used in ANY DIESEL vehicle
✓ Will **clean residue out of diesel tank** – good cleaning agent
✓ **B20 fuel economy same**; just need effectively priced B20!
✓ **Cleaner burning**; reduces emissions & black smoke, smell, noise
✓ **Can help extend life** of a diesel engine; **reduced maintenance**
✓ Puts $$$ back in U.S. versus Iraq, Saudi Arabia, Venezuela, Iran, Nigeria...
✓ Renewable, and helps farming sector
✓ **Nontoxic and biodegradable** ; 10x < toxic than table salt!
✓ Higher cetane number that petro-diesel (^40’s to 70’s)
✓ **BEST SUGGESTION:** IMPLEMENT QUIETLY, THEN TELL STAFF 6 MO.S LATER
## GHG/CO2 Emissions Reductions

<table>
<thead>
<tr>
<th>Alt Fuel</th>
<th>GHG</th>
<th>Other Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Biodiesel as B20</td>
<td>- 15%</td>
<td>B100 = 75%</td>
</tr>
<tr>
<td>✓ Electric Vehicles **</td>
<td>- 45% (Leaf)</td>
<td>- 10-80%</td>
</tr>
<tr>
<td>✓ Ethanol Flex Fuel – E85</td>
<td>- 52%</td>
<td>IDLU issue</td>
</tr>
<tr>
<td>✓ (Cellulosic ethanol ends up with over 100% reductions!)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Natural gas as CNG</td>
<td>- 6-11%</td>
<td>20-30% (Old Std.)</td>
</tr>
<tr>
<td>✓ Propane Autogas</td>
<td>- 8-9%</td>
<td></td>
</tr>
<tr>
<td>✓ Hybrid Truck (e.g., 30% ^ fuel econ.)</td>
<td>- 30%</td>
<td>30% red. fuel $$</td>
</tr>
</tbody>
</table>

* Very dependent upon the area electric grid and mix of upstream resources used – heavily coal will reduce the savings; heavily hydro, nuclear, or renewable will increase them.
Calculating Payback – Bi-fuel Propane Sedan

**CAPITAL COST** *(incremental)*

$6,000

**OPERATING COSTS (fuel)**

<table>
<thead>
<tr>
<th></th>
<th>Gasoline</th>
<th>Propane</th>
<th>Gasoline</th>
<th>Propane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example #1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total vehicle life - miles</td>
<td>75,000</td>
<td>9.1</td>
<td>150,000</td>
<td>9.1</td>
</tr>
<tr>
<td>(assumptions)</td>
<td>(15k mi/yr, 5 yrs)</td>
<td></td>
<td>(15k mi/yr, 10 yrs)</td>
<td></td>
</tr>
<tr>
<td>Average miles/gallon (17.5% red.)</td>
<td>11.0</td>
<td>9.1</td>
<td>11.0</td>
<td>9.1</td>
</tr>
<tr>
<td>Gallons of fuel used over life</td>
<td>6,818</td>
<td>8,264</td>
<td>13,636</td>
<td>16,529</td>
</tr>
<tr>
<td>Fuel price/gallon</td>
<td>$3.50</td>
<td>$2.00</td>
<td>$3.50</td>
<td>$2.00</td>
</tr>
<tr>
<td>Fed. fuel excise tax credit</td>
<td></td>
<td>$0.50</td>
<td></td>
<td>$0.50</td>
</tr>
<tr>
<td>Adjusted fuel price</td>
<td>$3.50</td>
<td>$1.50</td>
<td>$3.50</td>
<td>$1.50</td>
</tr>
<tr>
<td><strong>Total Fuel Savings/Cost over Life</strong></td>
<td><strong>$11,466.94</strong></td>
<td><strong>$22,933.88</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Example #2       |          |         |          |         |
| Total vehicle life - miles | 150,000  | 9.1     | 150,000  | 9.1     |
| (assumptions)    | (15k mi/yr, 10 yrs) |        | (15k mi/yr, 10 yrs) |        |
| Average miles/gallon (17.5% red.) | 11.0     | 9.1     | 11.0     | 9.1     |
| Gallons of fuel used over life | 13,636   | 16,529  | 13,636   | 16,529  |
| Fuel price/gallon | $3.50    | $2.00   | $3.50    | $2.00   |
| Fed. fuel excise tax credit |          | $0.50   |          | $0.50   |
| Adjusted fuel price | $3.50    | $1.50   | $3.50    | $1.50   |
| **Total Fuel Savings/Cost over Life** | **$11,466.94** | **$22,933.88** |

**OPERATING COSTS (maintenance)**

<table>
<thead>
<tr>
<th></th>
<th>Gasoline</th>
<th>Propane</th>
<th>Gasoline</th>
<th>Propane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maint. rate per mile</td>
<td>0.030</td>
<td>0.015</td>
<td>0.030</td>
<td>0.015</td>
</tr>
<tr>
<td>Maintenance costs</td>
<td>$2,250.00</td>
<td>$1,125.00</td>
<td>$4,500.00</td>
<td>$2,250.00</td>
</tr>
<tr>
<td><strong>Total Maint. Savings/Cost over Life</strong></td>
<td><strong>$1,125.00</strong></td>
<td><strong>$2,250.00</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Gross Vehicle Lifetime Savings

$12,592

Net Vehicle Lifetime Savings

$6,592

✓ Capital cost includes installation

✓ Propane systems CAN be transferred from one vehicle to another, lasting through several cars

✓ Assumed 17.5% reduction in fuel economy due to energy density difference

✓ Assumed 50% reduction in maintenance costs

✓ $12,592 life savings = 1.9 yrs $6,000 cost
Thank you

Questions?

Jonathan Overly
✓ www.ETCleanFuels.org
✓ jonathan@etcleanfuels.org
✓ 865-974-3625

Follow us on Twitter, Facebook, YouTube or Instagram – “ETCleanFuels”