Transportation, Technology & Infrastructure Committee
August 20, 2018
Victor Ayres, Director
Fleet Management Department

CITY OF HOUSTON
Fleet Management
Alternative Fuel & Emissions Reduction

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Comparison to Major Metropolitan Cities

Of the 4-largest cities by population, Houston, at 669 square miles, encompasses a substantially larger geographic footprint than the others.
Vehicle Parking Locations

- Widely dispersed around city
- A site may contain various equipment types
- A site may have a few to over 100 vehicles
The city fleet currently has
  • 9,230 on-road vehicles
  • 640 (7%) are alternative fuel

Greatest success with
  • Hybrid-electric sedans
  • All-electric sedans

Due to
  • Little to no infrastructure requirements
  • Ease of operator use
  • Compatibility with operational needs

<table>
<thead>
<tr>
<th>City of Houston On-Road Fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL ON-ROAD FLEET</td>
</tr>
<tr>
<td>ALT. FUEL VEHICLES (AFV’S)</td>
</tr>
<tr>
<td>CNG</td>
</tr>
<tr>
<td>All-Electric</td>
</tr>
<tr>
<td>Hybrid-electric</td>
</tr>
<tr>
<td>Hydraulic Hybrid</td>
</tr>
<tr>
<td>Propane</td>
</tr>
<tr>
<td>TOTAL AFV’s</td>
</tr>
</tbody>
</table>

% of fleet as AFV 7%
Making the Conversion

Transitioning to an alternative fuel requires that 3-major aspects be addressed

1. Vehicles
2. Fuel
3. Fuel and Maintenance Infrastructure
Vehicles
Examples of Various Alternative Fuel Vehicle (AFV) Types......

- Propane
- All Electric (EV)
- Compressed Natural Gas (CNG)
- Hydraulic Launch Assist
- Hybrid Electric
..... and DEVELOPING AFV technologies

• HYDROGEN FUEL CELL

• ALL ELECTRIC HEAVY DUTY
**Challenges:** Configuration of existing vehicles may limit incorporation of AFV technology:

- Fuel tank size/location
- Range
- Operating requirements

**Fuel Storage**

The on-board tank capacity and configuration may impede use of certain fuel types due to range, a critical aspect due to geographic area, and availability of space issues.
AFV Costs

• Costs can be up to 50% more than conventional vehicles

• Incremental costs may be recovered through
  • Greater fuel efficiency
  • Lower operating cost
  • Grants
Baseline Fuels

• Unleaded
• Diesel

Characteristics:
• Continuous development over past 100+ years
• Universally available
• Easily transported
• High energy (BTU) density
• Widespread infrastructure
AFV Transportation Fuels

**Biodiesel**
- Manufactured from vegetable oils, animal fats, and recycled cooking grease
- Liquid/Transportable

**Propane**
- Derived from natural gas
- Liquid/Transportable

**Ethanol**
- Made from corn and other plant based materials
- Typically blended with gasoline to reduce emissions
- Liquid/Transportable

**Hydrogen**
- As a transportation fuel, it is still in the introductory phase
- Gas/Not transportable

**Natural Gas**
- Must be compressed or liquified for use in vehicles
- Gas/Not transportable

**Electricity – two uses**
- All-electric vehicles:
  - Must be plugged into external power source to charge battery
- Hybrid-electric vehicles:
  - Charged by engine and braking system
  - No external plug required
  - Not transportable

Other AFV Transportation Technology
- Hydraulic hybrid

Transportability relates to the ability to move the fuel for vehicle “no fuel” situations.
When comparing fuels, the equivalent energy content available must be considered.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Lower Heating Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline (E0)</td>
<td>115,400 BTU/gal</td>
</tr>
<tr>
<td>Gasoline (E10)</td>
<td>114,300 BTU/gal</td>
</tr>
<tr>
<td>Diesel</td>
<td>128,700 BTU/gal</td>
</tr>
<tr>
<td>Biodiesel (B100)</td>
<td>117,100 BTU/gal</td>
</tr>
<tr>
<td>Compressed Natural Gas (CNG)</td>
<td>114,300 BTU/GGE</td>
</tr>
<tr>
<td>Ethanol (E100)</td>
<td>75,700 BTU/gal</td>
</tr>
<tr>
<td>Propane</td>
<td>83,500 BTU/gal</td>
</tr>
</tbody>
</table>

US Dept. of Energy "Clean Cities Alternative Fuel Price Report"; April, 2018

*GGE – Gallon of gasoline equivalent
Fueling and Maintenance Infrastructure

Characteristics of alternative fuels may require changes to maintenance garages and operational practices

**Building and Facility requirements**

Fuel flammability and dispersion characteristics may require substantial building modifications

**Personnel**

Training for vehicle technicians and vehicle operators is typically required when introducing AFVs into a fleet.

**Parts**

Maintenance and repair parts will need to be sourced and stocked.
Maintenance Infrastructure

Building retrofits for gaseous fuels

According to the DOE: “On average, the cost for modifying a four to five bay garage ranges from $75,000 to $80,000 per bay.” “….. a 10 bay garage ranges from $60,000 to $70,000 per bay”.

Per DOE estimates, this one 8-bay facility would cost from $480,000 - $640,000 to retrofit for CNG fuel vehicles

The cost to modify the City’s 94-heavy duty maintenance bays to accommodate gaseous fuels could be as high as $7.5MM

Fueling Infrastructure

- Propane fuel
  - delivered by truck and stored on-site
  - cost estimate: up to $300,000 per site

- CNG
  - requires sufficient pipeline gas supply
  - must be compressed and stored on-site
  - cost estimate: Up to $3MM per site

- Electric vehicles
  - no on-site storage
  - requires sufficient power from the electric grid
  - cost estimate: From several hundred to thousands of dollars per vehicle

* Fuel site cost estimates are dependent on fuel storage/generation capacity and infrastructure needs

Information available https://www.afdc.energy.gov/uploads/publications
Vehicle Emissions
The EPA rates Houston-Galveston-Brazoria region as “non-attainment” for air quality.

Ground-level Ozone is a health hazard from combining Volatile Organic Compounds (VOC’s) and Nitrogen Oxides (NOx) and exposing them to sunlight.

VOC’s and NOx are emitted by vehicles, industry and other sources.
EPA Vehicle Emissions Regulations

- Standards are significantly more rigid than in the 1990’s.
- Diesel vehicles manufactured after 2009 dramatically reduce emissions
- Replacing old vehicles with new reduce key emissions by up to 95%
NEXT STEPS

Assess AFV technology for practicality and cost effectiveness

• The Kinder Institute has funded a fleet assessment through Rice University

• Grant funding opportunities will continue to be sought
Funding

Vehicle Replacements

- Many agencies have fees and revenues for fleet replacement
- COH has limited funds available which constrains replacements
- Incremental AFV vehicle and infrastructure costs
  - fewer new vehicle purchases
  - continued use of older vehicles
Age of Public Safety and Homeland Security Fleets

• Over 50% of the on-road fleet dedicated to Public Safety exceeds proposed life expectancy

• An aging fleet increases the Total Cost of Ownership for the City

• Aging fleet results in
  • Increased maintenance costs
  • Increased unit downtime
  • Decrease in operating departments service levels

<table>
<thead>
<tr>
<th>Public Safety and Homeland Security Fleets</th>
<th>Age of Fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Fund - On-Road Vehicles</td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>Avg. est life (yrs)</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------</td>
</tr>
<tr>
<td>FIRE</td>
<td>807</td>
</tr>
<tr>
<td>HEALTH</td>
<td>182</td>
</tr>
<tr>
<td>PARKS</td>
<td>366</td>
</tr>
<tr>
<td>POLICE</td>
<td>3,312</td>
</tr>
<tr>
<td>SOLID WASTE</td>
<td>496</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5,163</td>
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Funding Opportunities

• Volkswagen Settlement
  • Draft of State of Texas allocation released
    • Houston-Galveston-Brazoria air quality non-attainment area to receive less funding than cities with less air quality issues
  • Pending finalization and issuance of qualifications and disbursement guidelines

• TCEQ Grants and other outside funding
  • Will continue to monitor for opportunities
Wrap-up

3-major aspects to converting fleet to AFV’s

1. Vehicles
   • may cost – up to 50% more
   • sufficient range issue
   • compatible with operational requirements

2. Fuel
   • cost competitive on BTU basis
   • ease of integration into fleet
   • transportable and availability

3. Infrastructure
   I. Maintenance facilities
      • equipped with proper safety features to accommodate the fuel properties
      • cost as high as $7.5MM
   II. Fuel sites
      • accessible to the fleet
      • cost to install and operate
Wrap-up

Other aspects for converting fleet to AFV’s

4. Emissions
   • EPA regulations substantially reduced emissions of conventional fuels
   • Replacing 2009 and older vehicles dramatically reduces emissions

5. Next Steps
   • Rice Univ. to assess existing fleet AFV fuel feasibility
   • Monitor Volkswagen Settlement and other grant funding opportunities
QUESTIONS?