




CITY OF HOUSTON
Fleet Management
Alternative Fuel & Emissions Reduction



Transportation, Technology & Infrastructure Committee

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Victor Ayres, Director
 Fleet Management Department

Comparison to Major Metropolitan Cities

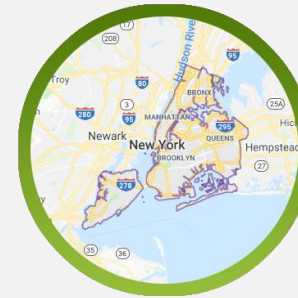
Of the 4-largest cities by population, Houston, at 669 square miles, encompasses a substantially larger geographic footprint than the others.



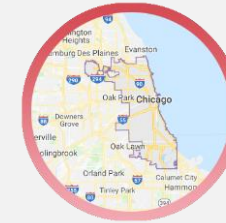
Houston
669 square miles



Los Angeles
503 square miles



New York City
304 square miles

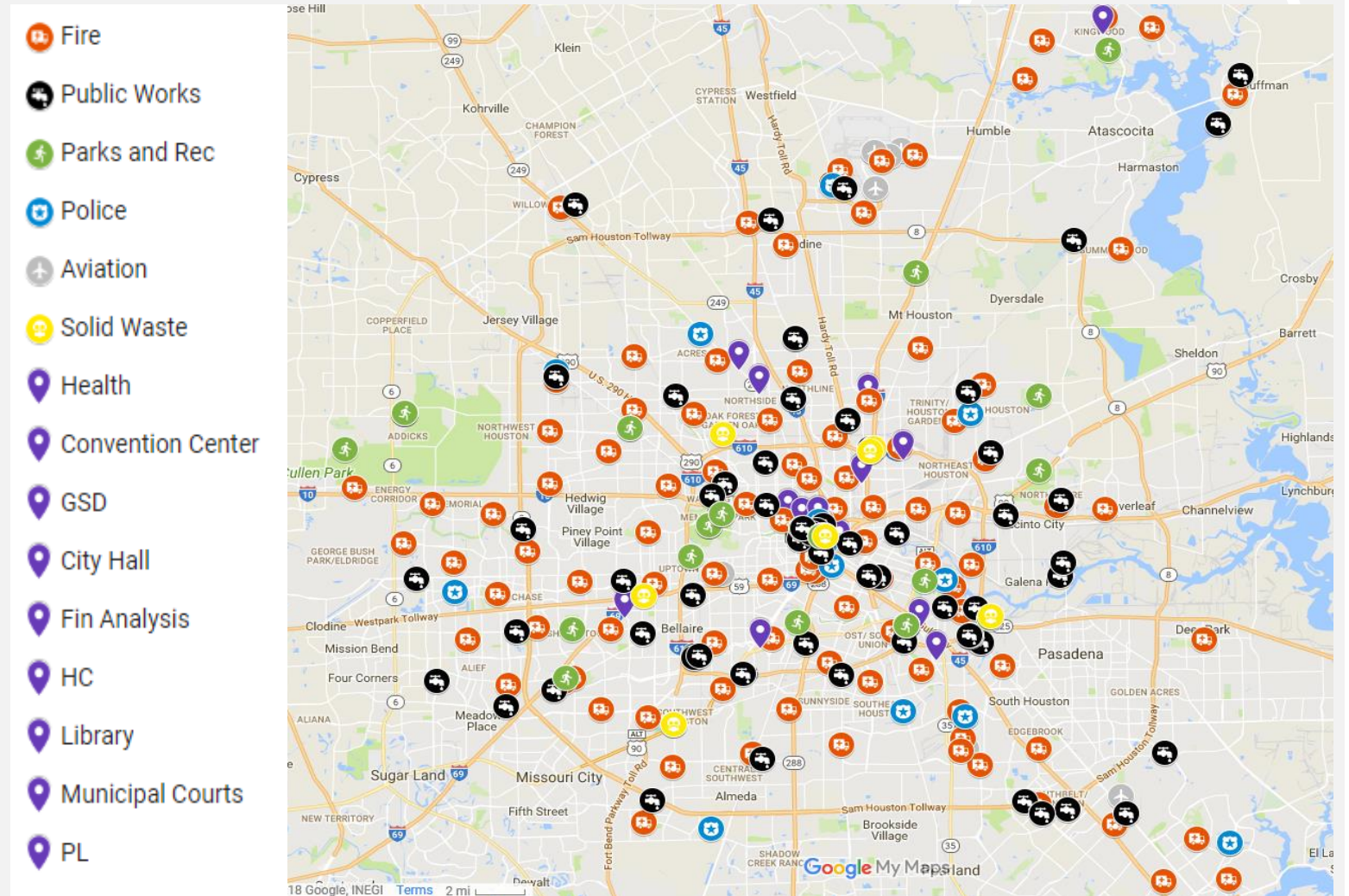


Chicago
234 square miles

Overview of City fleet

Vehicle Parking Locations

- Widely dispersed around city
- A site may contain various equipment types
- A site may have a few to over 100 vehicles



Alternative Fuel Vehicle (AFV) Fleet

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

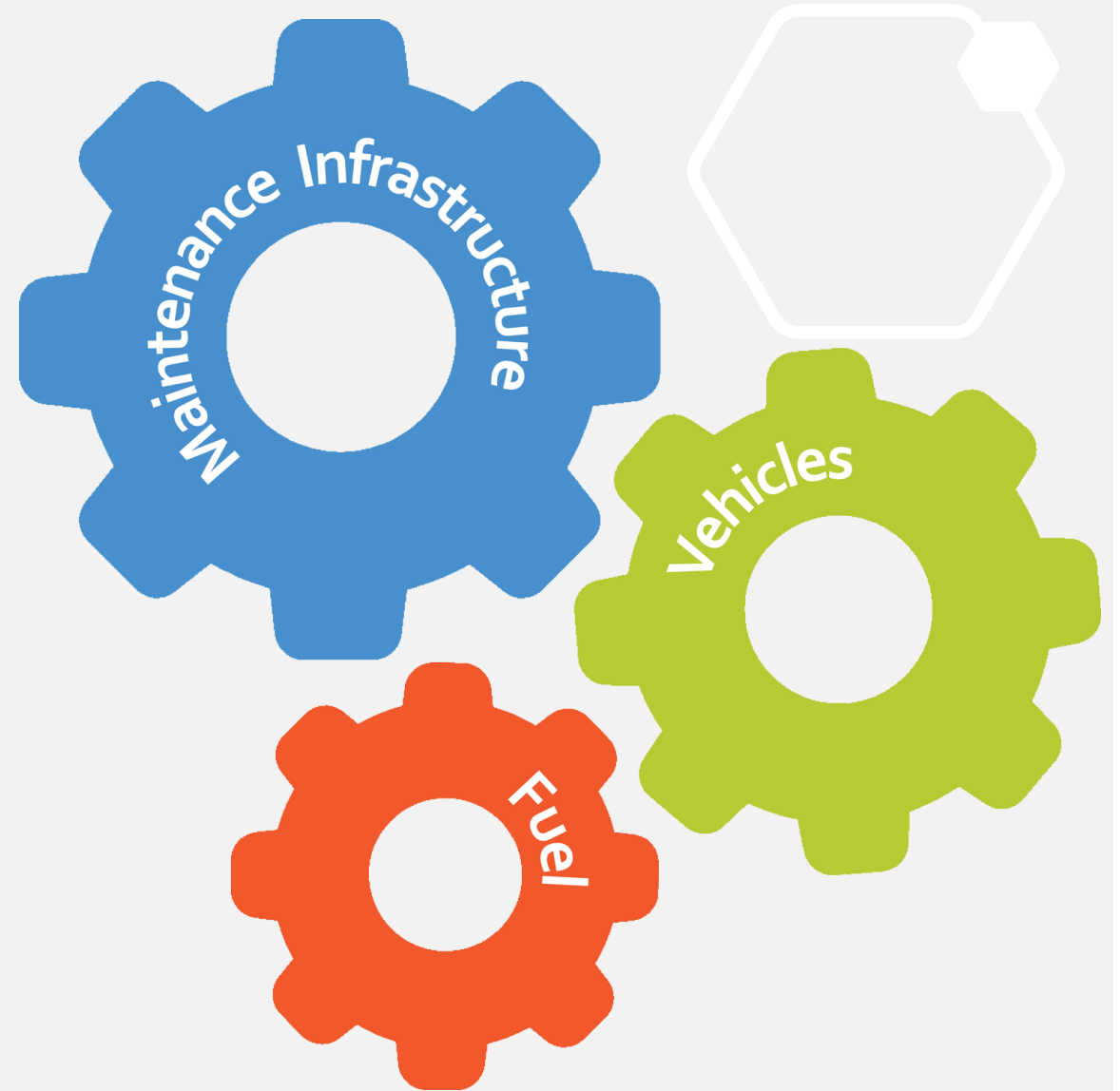
- Little to no infrastructure requirements
- Ease of operator use
- Compatibility with operational needs

City of Houston On-Road Fleet	
TOTAL ON-ROAD FLEET	9,230
ALT. FUEL VEHICLES (AFV'S)	
CNG	1
All-Electric	27
Hybrid-electric	596
Hydraulic Hybrid	12
Propane	4
TOTAL AFV's	640
% 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



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

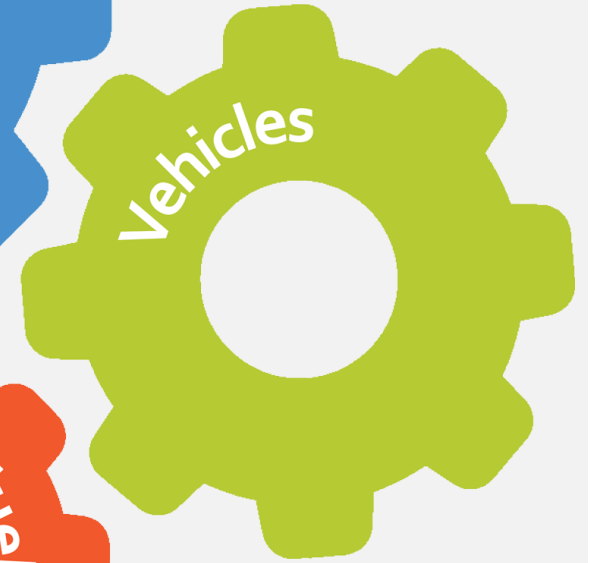
The on-board tank capacity and configuration may impede use of certain fuel types due to range, a critical aspect due to geographic area, and availability of space issues.

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



Fuel



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



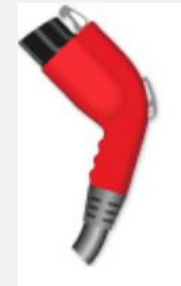
Hydrogen

- 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.

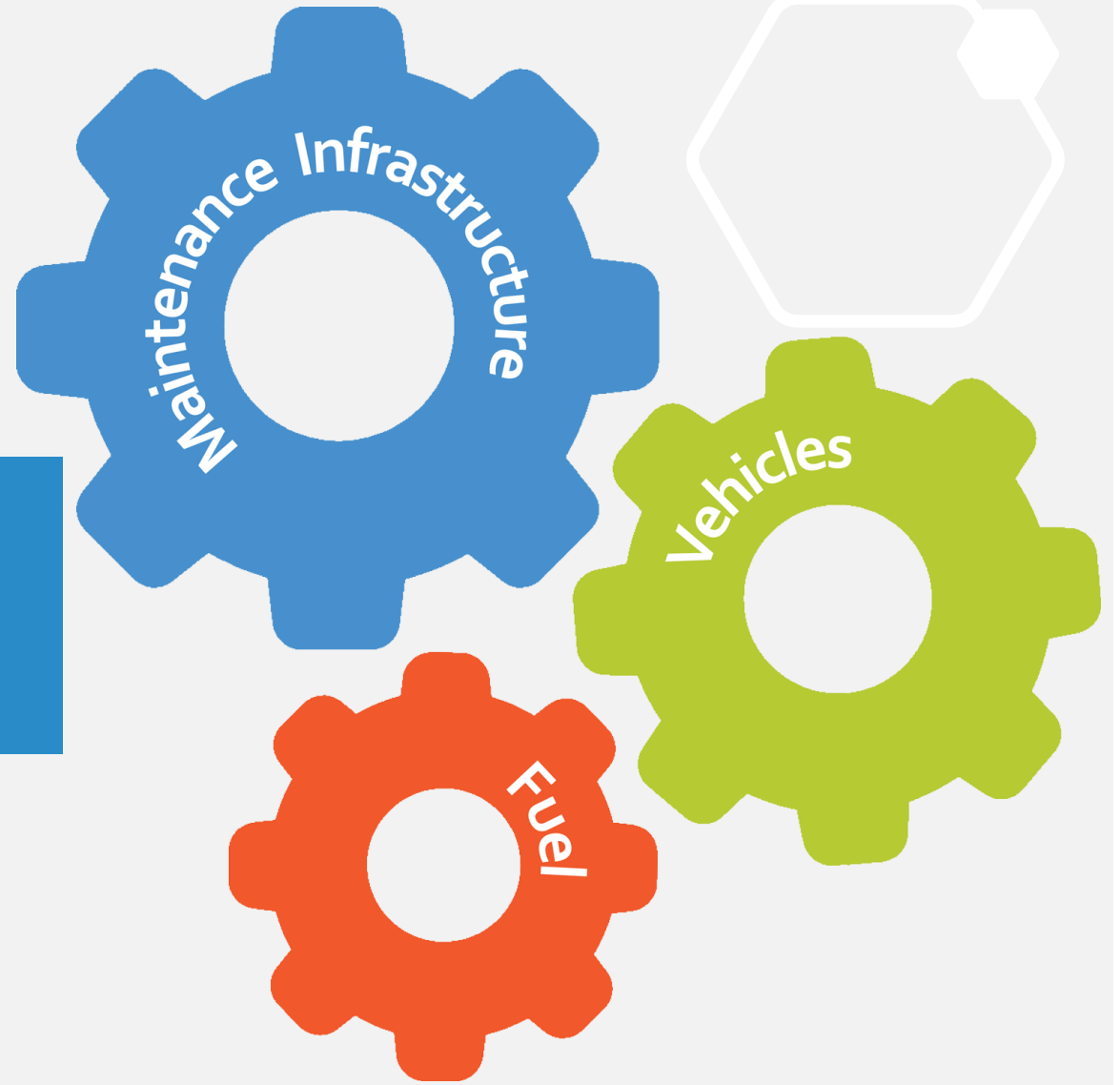
When comparing fuels, the equivalent energy content available must be considered

Lower Heating Values	
Fuel	Lower Heating Value
Gasoline (E0)	115,400 BTU/gal
Gasoline (E10)	114,300 BTU/gal
Diesel	128,700 BTU/gal
Biodiesel (B100)	117,100 BTU/gal
Compressed Natural Gas (CNG)	114,300 BTU/GGE
Ethanol (E100)	75,700 BTU/gal
Propane	83,500 BTU/gal

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

*GGE – Gallon of gasoline equivalent

Fueling and Maintenance Infrastructure



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”.



Source: U.S. Department of Energy, *Compressed Natural Gas Vehicle Maintenance Facility Modification Handbook*, Sept. 2017, pg. 30.



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 storage



Natural Gas compression station for CNG



Electric Vehicle Chargers
(Standalone and wall mounted)

Dispensing and Storage

- 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>

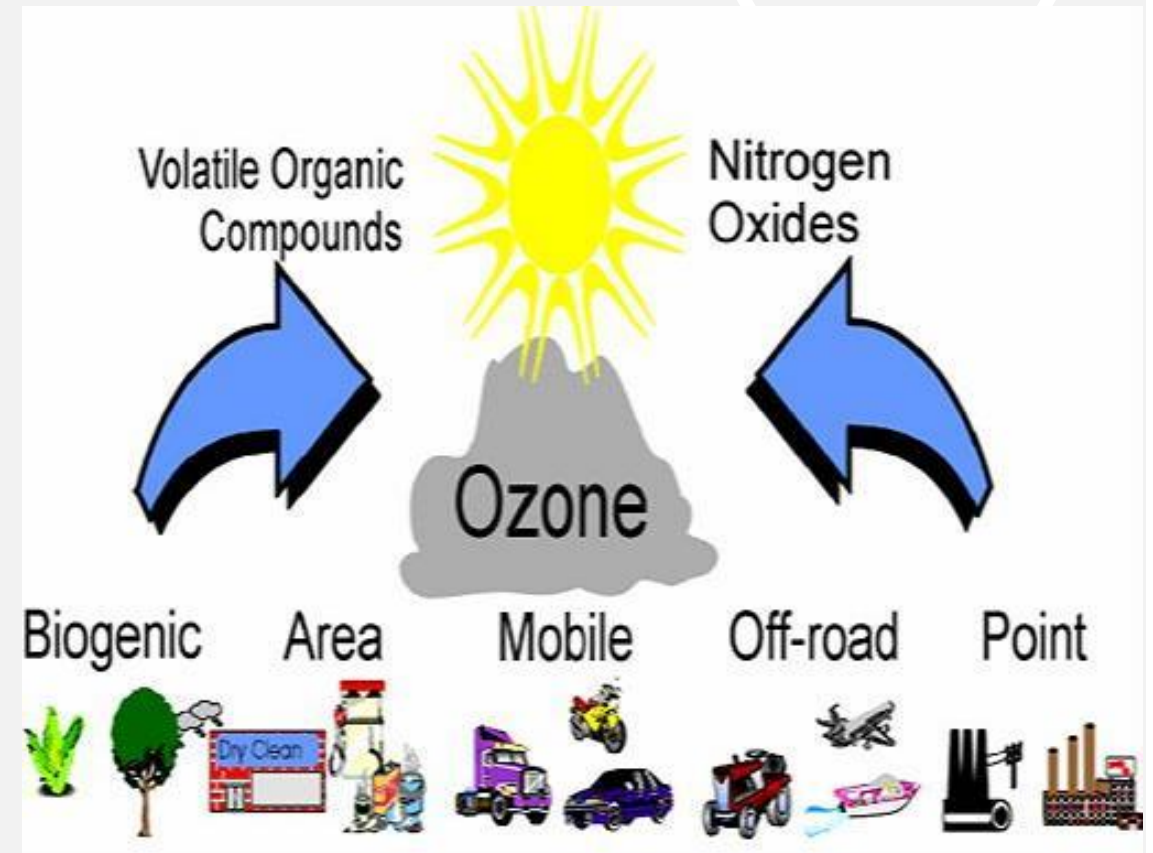


Vehicle Emissions



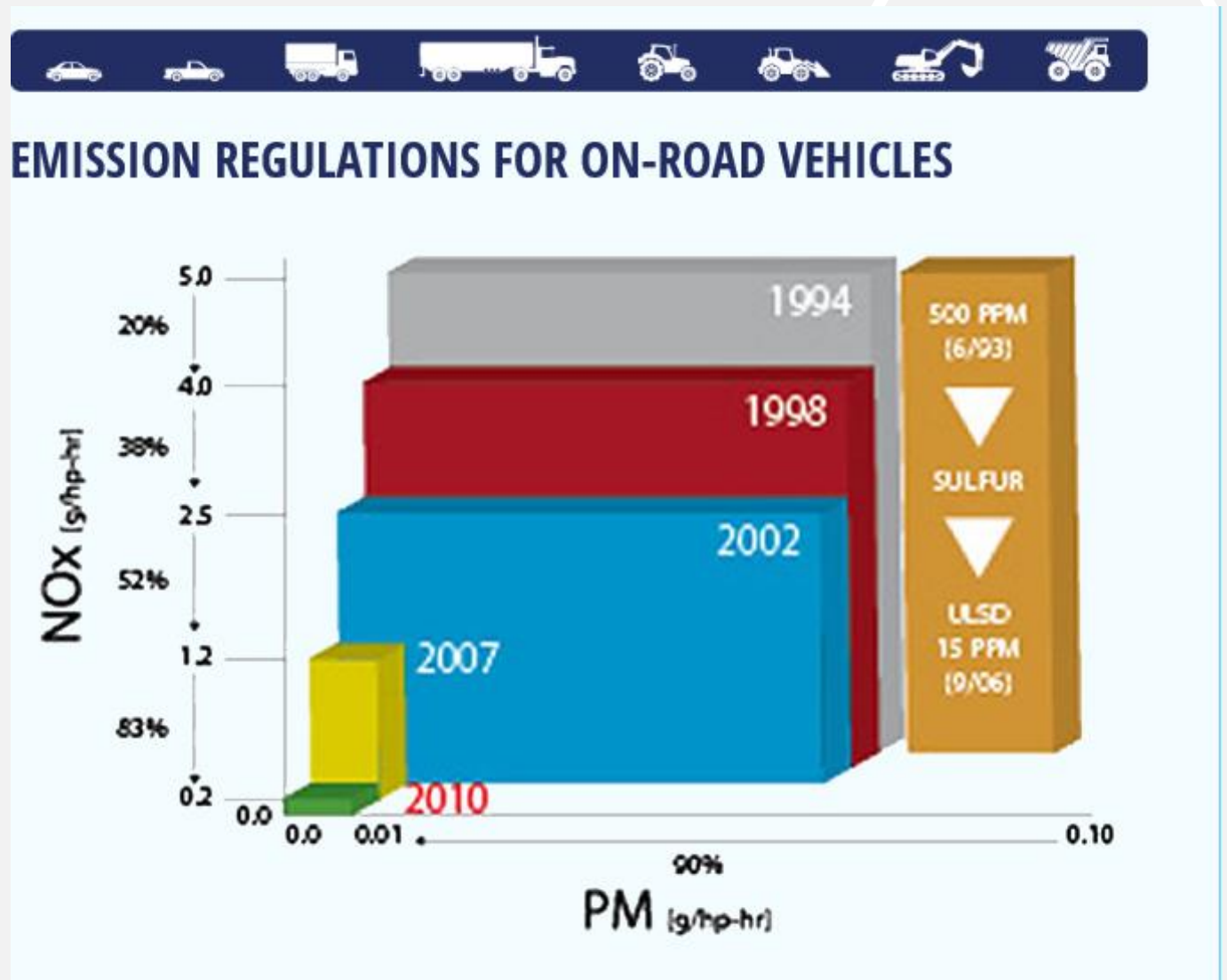
Houston Air Quality

- 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



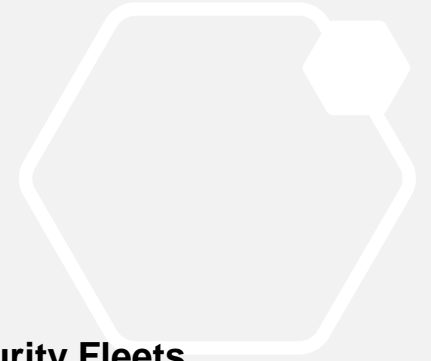
Funding

Vehicle Replacements

- Many agencies have fees and revenues for fleet replacement
- COH has limited funds available which constricts 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

Public Safety and Homeland Security Fleets

Age of Fleet

General Fund - On-Road Vehicles

	Count	Avg. est life (yrs)	Avg age (yrs)	# Units exceeding est. life	% of fleet
FIRE	807	7.8	10.3	566	70%
HEALTH	182	7	8.7	109	60%
PARKS	366	7	11.4	261	71%
POLICE	3,312	5.6	6.4	1,632	49%
SOLID WASTE	496	7	8.8	331	67%
TOTAL	5,163	6.2	7.7	2,899	56%



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?

