2015 Clean Cities Strategy

Natural Gas Vehicle Technology Market Trends

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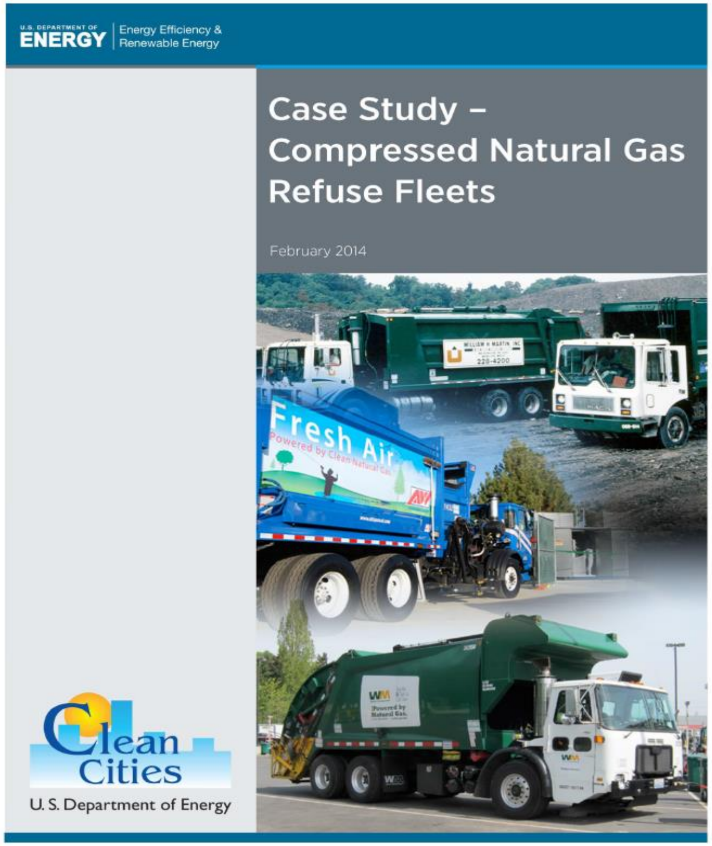
Argonne National Laboratory

Current Clean Cities Activities in NGVs

- **NGVs ~60% of Clean Cities AFV petroleum displacement**
  - Coordinator project development
  - Recovery Act
  - National Clean Fleets Partnership
- **Communication products**
  - AFDC
  - MotorWeek
  - Toolkits
- **Partnerships**
  - Natural Gas Vehicle Technology Forum
  - NCFP


U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Case Study – Compressed Natural Gas Refuse Fleets

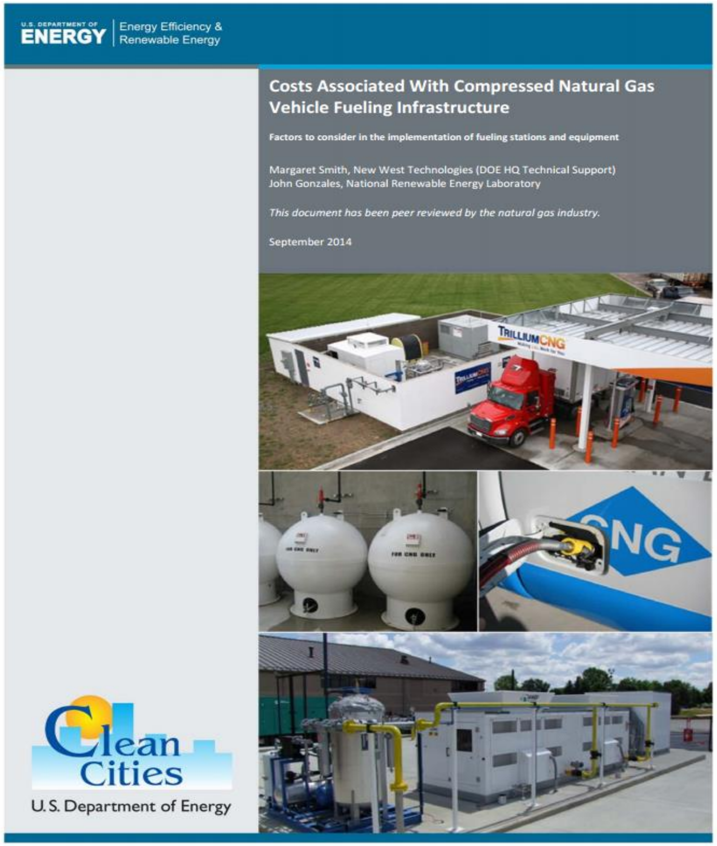
February 2014

Clean Cities

U.S. Department of Energy

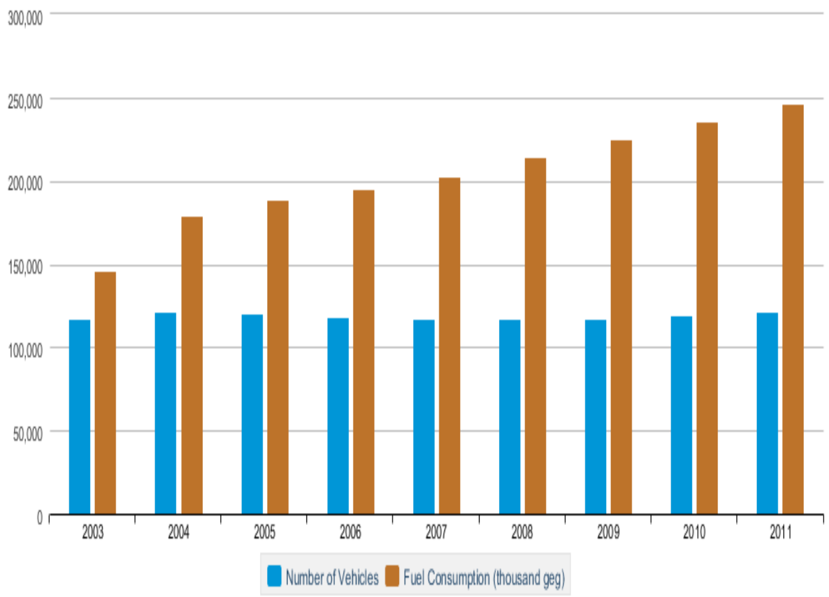
Current Clean Cities Activities in NGVs

- **Technical assistance**
  - Tiger Teams
  - Technical reports
- **Tools**
  - AFDC Station Locator
  - AFLEET Tool
  - VICE Model
  - JOBS NG
  - PREP Tool



Current State of the Market for NGVs

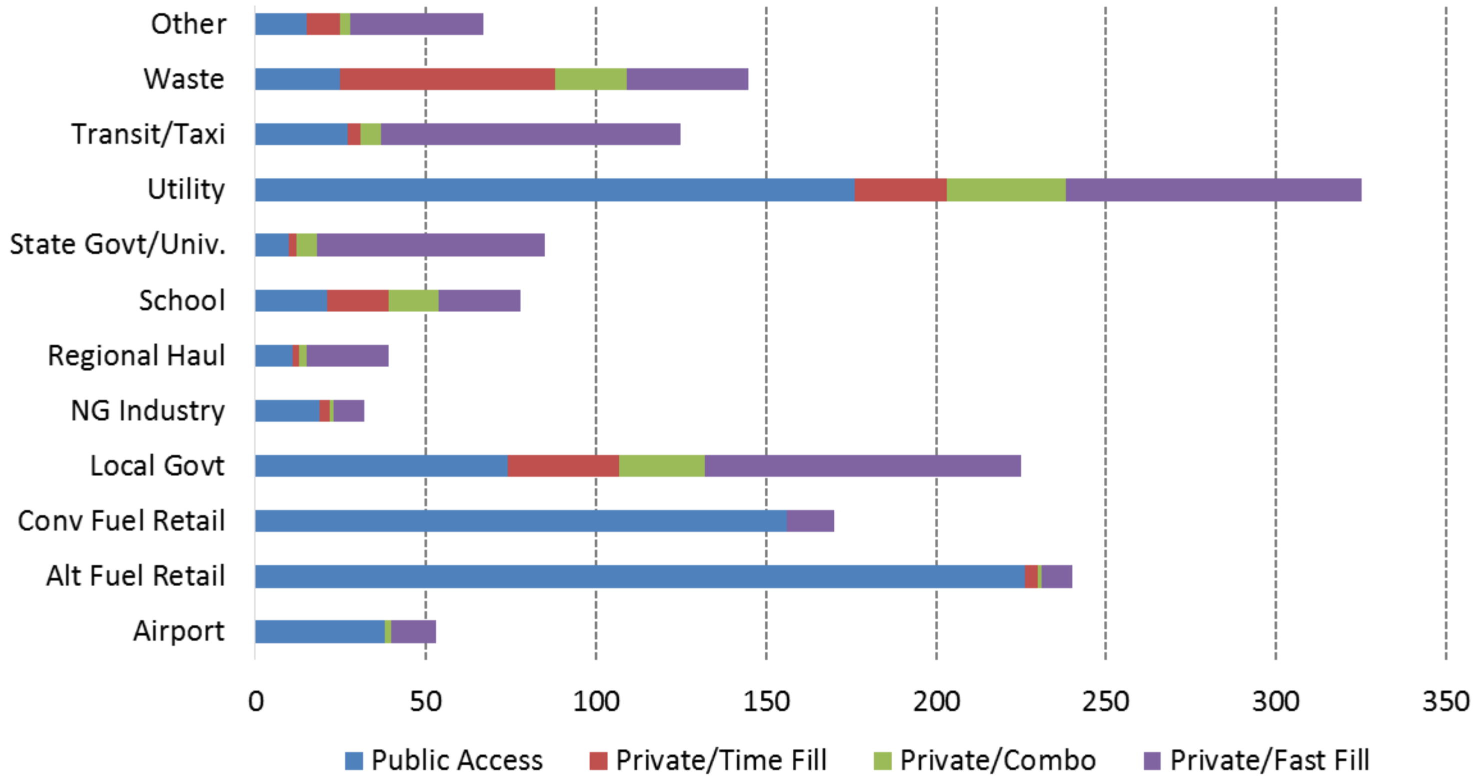
- **120-150K NGVs**
  - 66K LDVs using 22M GGE
  - 23K MDVs using 20M GGE
  - 32K HDVs using 205M GGE
- **Current niche markets**
  - Transit bus
    - 25% of new sales
  - Refuse haulers
    - 50% of new sales



- **Navigant projects growth from today to 2024**
  - From 18K to 24K HDVs sold/yr
  - From 29K to 49K pickups sold/yr

Current State of the Market for NG Infrastructure

- **1,500 CNG & 100 LNG stations**
  - > 50% publicly accessible



Overview of Niche Market Findings

Market Niche	Payback (yr)	10% Mkt **Oil** (bbl/yr)	10% Mkt **GHGs** (tons/yr)
Regional Haul			
100 < x < 200 mi/day range	3	11,700,000	863,000
x < 100 mi/day range	3	6,300,000	465,000
Port Drayage	2	2,700,000	200,000
Concrete Mixers	4	1,200,000	55,000
Paratransit/Shuttles	5	700,000	49,000
School Bus	7	4,100,000	299,000
Utility Service	8	1,100,000	50,000

RNG Feedstock	Suggested Tech.	RNG Production Oil equiv (bbl/yr)	RNG GHGs (tons/yr)
Food Waste (10% Total)	Anaerobic digestion	4,000,000	1,500,000
Landfill Gas (50% Potential)		6,500,000	2,500,000

Regional Haul

- Class 8 combination freight trucks
- Return-to-base
- Private or anchor fleet fast-fill fueling
- 9 & 12 L NG engine
- Fast paybacks

Vehicle type	Pop.	Annual VMT	Annual Fuel (gal)
Regional Haul			
100 < x < 200 mile daily range	410,000	49,000	8,900
x < 100 mile daily range	370,000	30,000	5,400
Port Drayage	80,000	54,000	10,700

Concrete Mixers

- Class 8 vocational trucks
- Return-to-base
- Time-fill fueling
- 9 & 12 L NG engine
- Fast paybacks

Vehicle type	Pop.	Annual VMT	Annual Fuel (gal)
Concrete Mixers	80,000	16,000	5,000

Paratransit/Shuttles

- Class 3 MD vans to Class 7 shuttles
- Return-to-base
- Time- or fast-fill fueling
- SVM conversions and 9 L NG engine
  - Future 6.7 L
- FTA funding for paratransit

Vehicle type	Pop.	Annual VMT	Annual Fuel (gal)
Paratransit	70,000	24,000	2,700

School Bus

- Class 4 Type A to Class 7 Type D
- Return-to-base
- Time- or fast-fill fueling
- SVM conversions and 9 L NG engine
  - Future 6.7 L
- Local incentives

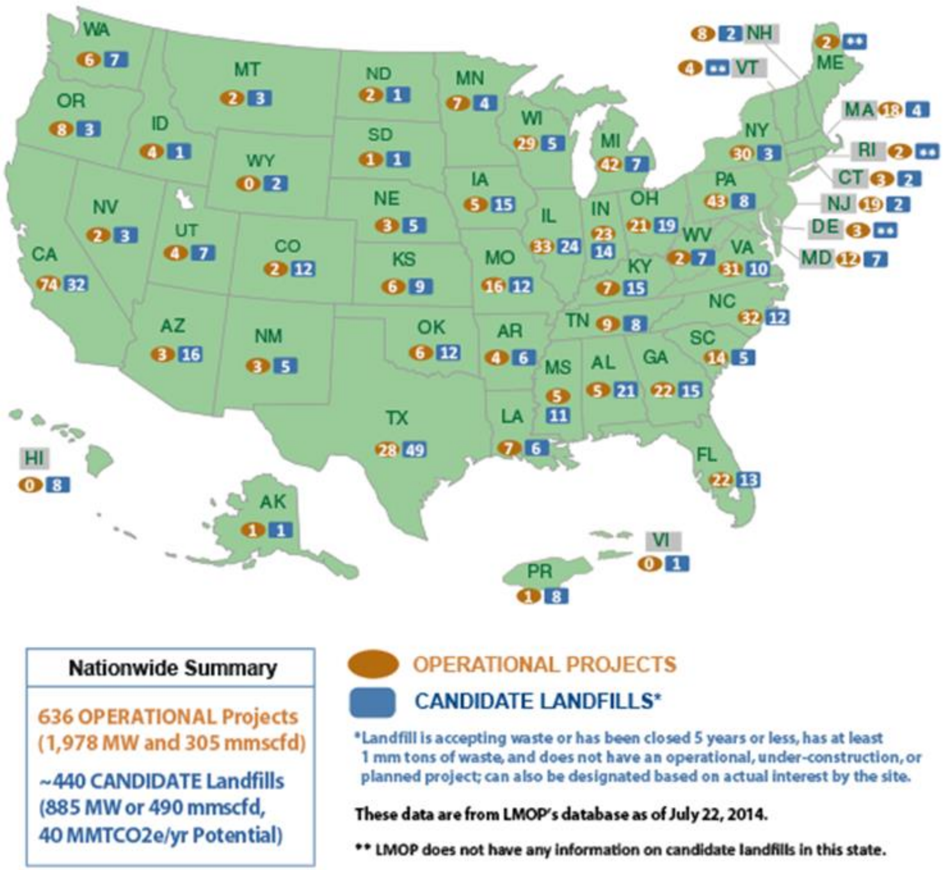
Vehicle type	Pop.	Annual VMT	Annual Fuel (gal)
School Bus	680,000	12,000	1,900

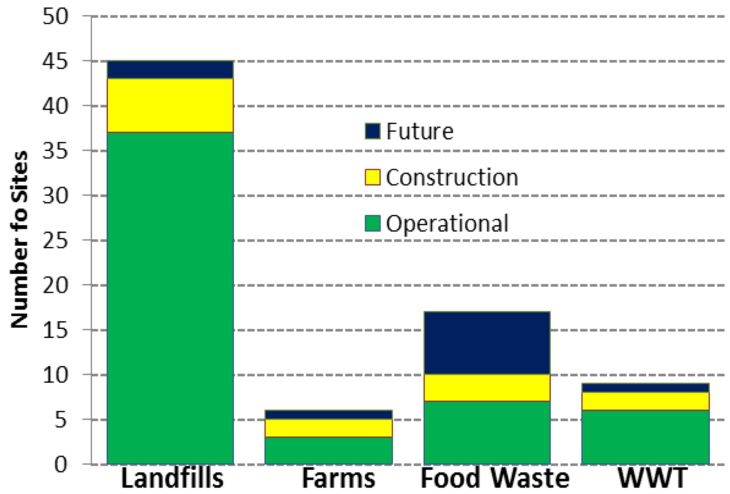
Utility Service

- Class 3 vans to Class 6 vocational trucks
- Return-to-base
- Fast-fill fueling
- SVM conversions and 9 L NG engine
  - Future 6.7 L
- Utility engagement

Vehicle type	Pop.	Annual VMT	Annual Fuel (gal)
Utility Service	260,000	13,000	1,600

Potential Niche Market: RNG from LFG and Food Waste

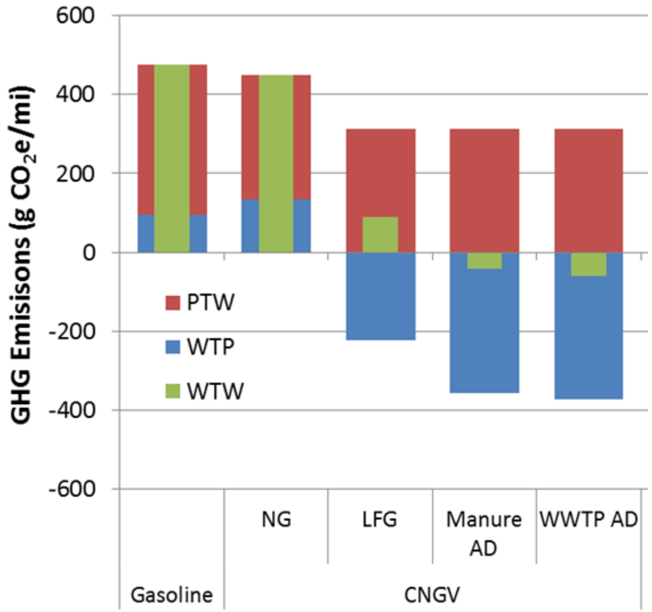


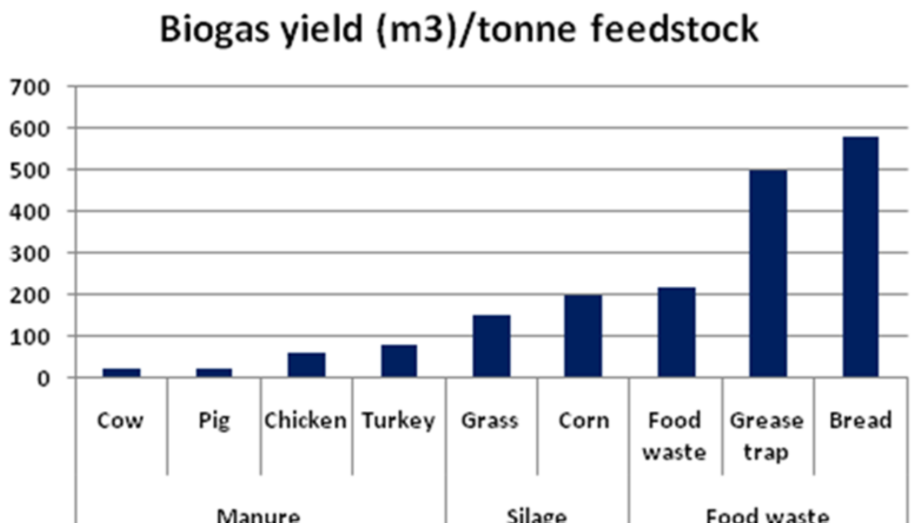


Sources: EPA LMOP, Argonne

- 37 of 636 landfills with WTE projects, produce RNG for pipeline injection or vehicle fuel
- Another 440 candidate landfills are capable of producing 490 mmscfd (540 gge/yr)
- 133 billion lbs (>30% US food supply) is uneaten each year
- Only a handful of WTE projects currently produce RNG utilizing some food waste, but interest is rising
- RNG can be produced from food waste alone or co-digested in stand alone anaerobic digesters or WWTPs

Potential Niche Markets: RNG from LFG and Food Waste





DRIVERS

- Plentiful supply.
- Significant environmental benefits
  - 85-115% GHG reduction
  - Cellulosic biofuel under RFS
  - Qualifies under LCFS which is stackable
- Efficiency. Food wastes boost yield.

BARRIERS

- Cost.
- Complexity. Long lead times, multiple vendors, approvals and partners.
- Temporary and uncertain incentives.
- Financing.
- Utility interconnection costly & difficult (but may be changing).

Clean Cities Strategies Targeting Natural Gas Market Niches

- **Toolkits**
  - Concrete mixers, airport shuttles, RNG, Coalition insights and case studies
  - Tools/calculators (AFLEET, VICE, JOBS, PREP)
  - Links to technical resources (AFDC, NGVA, ABC, NFPA)
- **Financing**
  - Innovative financing (C2ES)
    - Performance contracting
    - “Green” banks
  - Grants (DOE, DOT, USDA, etc.)
  - Third parties (e.g., RIN managers
- **Technical Assistance**
  - Webinars/reports on emerging NGV markets/issues (dual-fuel glider, corridors, HHP applications)
  - Clean Cities University courses
  - Tiger Team troubleshooting

Clean Cities Strategies Targeting Natural Gas Market Niches (cont'd)

- **Liaisons/Connections**
  - Reinforce existing collaborations
    - National Governor's Association (e.g., vehicle/fuel taxation and rate recovery, fuel sales, certification of conversion shops/technicians, vehicle inspection)
    - National Clean Fleets Partnership
  - Build new collaborations
    - Airport administrators/air industry groups (especially for smaller airports)
    - MSW/resource recovery authorities and trade groups
    - Compost facility operators/advocates)
- **AFV Trials/Demos**
  - Local/regional partnerships
  - Web-based support

Thank you!!!

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