Benefits and Barriers to Renewable Natural Gas as a Vehicle Fuel

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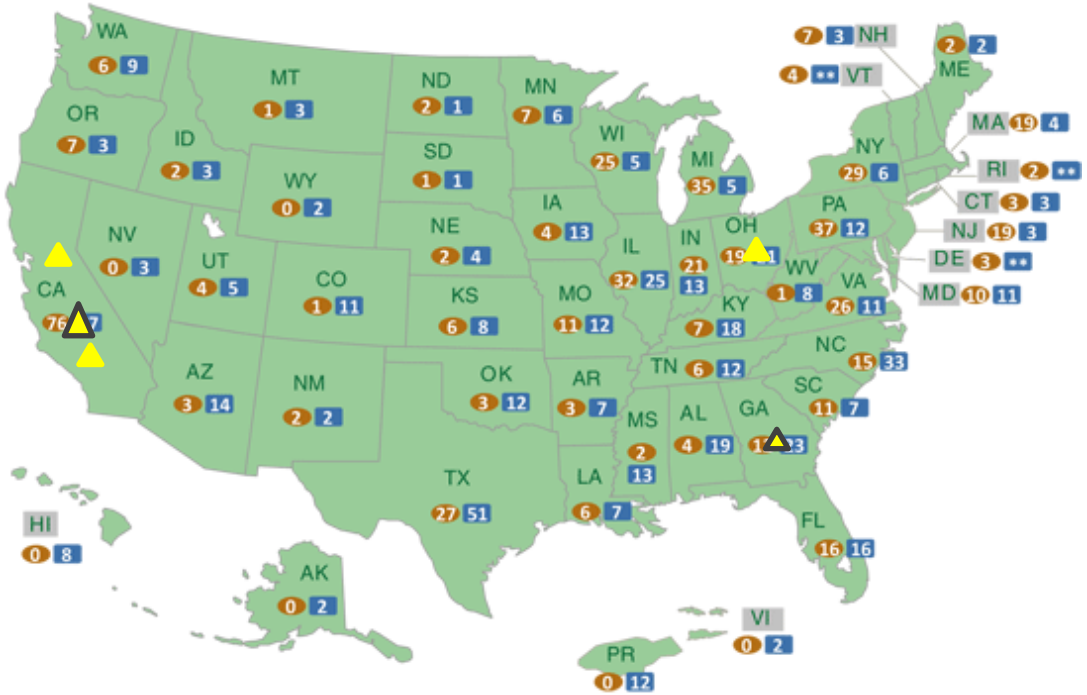
Presentation Overview

On a “well-to-wheels” basis, renewable natural gas (i.e., CNG or LNG from landfill gas or other biomethane sources) has among the lowest GHG emissions of any currently available motor fuel. But few projects convert LFG into RNG, and still fewer sell the RNG into the motor fuel market.

- Currently operating projects and newly funded initiatives to produce RNG for vehicle use
- Analysis of energy and GHG benefits of RNG
- Barriers to RNG penetration into the motor fuel market

Of 541 LFGE Projects Only Three Directly Produce Motor Fuel



Nationwide Summary
541 OPERATIONAL Projects (1,684 MW and 305 mmscfd)
~510 CANDIDATE Landfills (1,160 MW or 580 mmscfd, 13 MMTCE Potential)

OPERATIONAL PROJECTS

CANDIDATE LANDFILLS*

* Landfill is accepting waste or has been closed for 5 years or less has at least 1 mmtons of waste and does not have an operational/under construction LFGE project; or is designated based on actual interest/planning.

These data are from LMOP's database as of December 15, 2010.

** LMOP does not have any information on candidate landfills in this state.

Electricity	481*
Direct Use	138
RNG	24
Vehicle Fuel Livermore, CA Orange Co, CA Franklin Co, OH	3

* All projects producing electricity from LFG. May include multiple projects at the same site, as well as projects involving direct use, RNG and/or vehicle fuel.

Planned/under construction projects producing vehicle fuel:

- Simi Valley, CA
- DeKalb Co, GA
- Sonoma Co, CA?
- Cincinnati, OH?

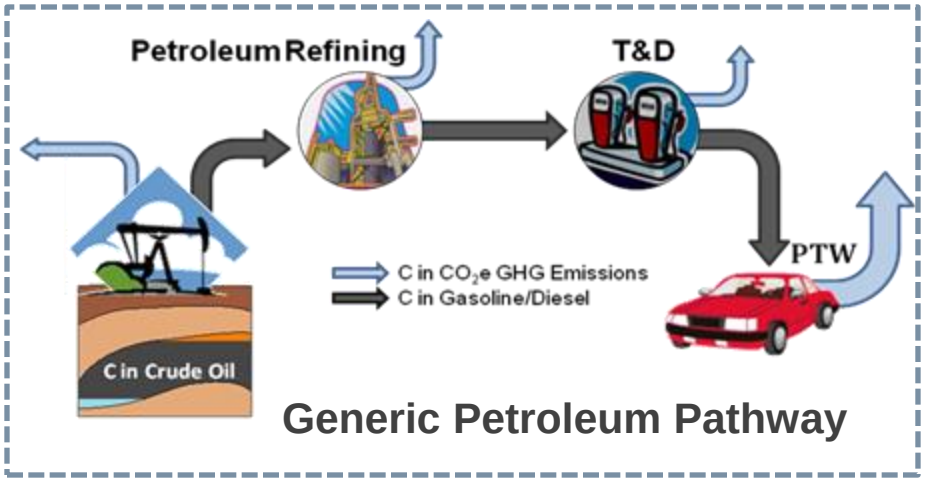
RNG projects indirectly producing vehicle fuel:

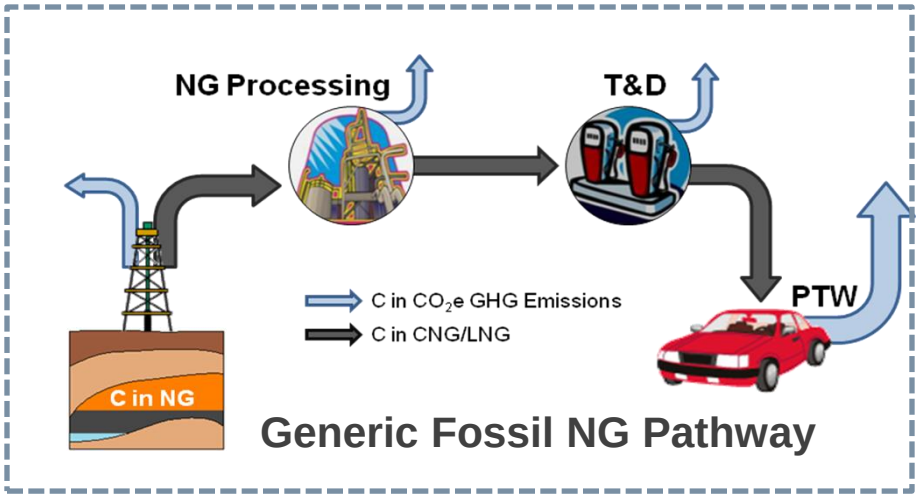
- Cincinnati, OH
- Dallas, TX
- Etc.

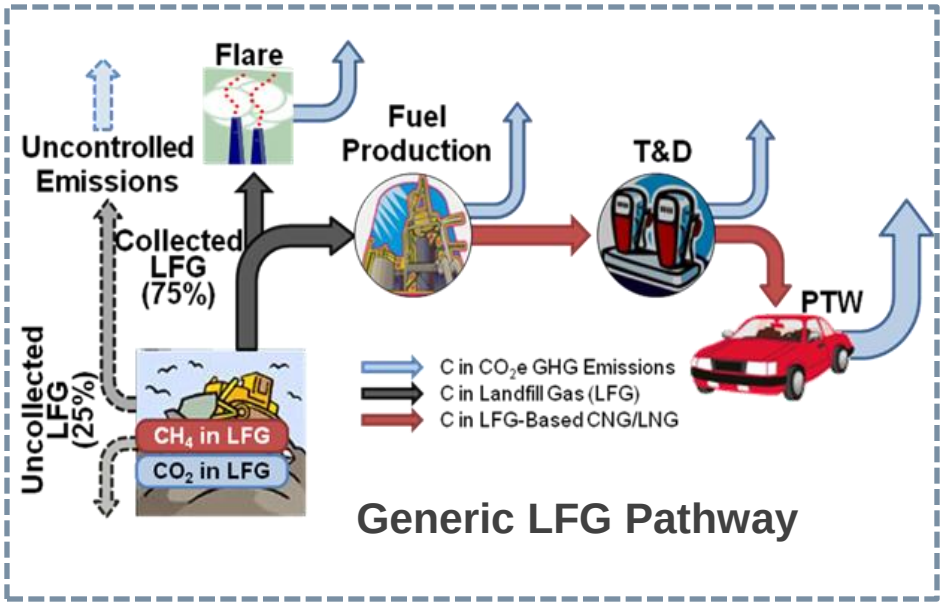
The GREET (Greenhouse gases, Regulated Emissions and Energy use in Transportation) Model

- Estimates emissions of greenhouse gases and criteria pollutants
  - CO_2, CH_4, and N_2O
  - VOC, CO, NO_x, SO_x, PM_{10}, and $PM_{2.5}$
- Separates energy use into:
  - Total and urban
  - All energy sources (fossil and non-fossil)
  - Fossil fuels (petroleum, natural gas, and coal combined)
  - Petroleum
  - Natural gas
  - Coal
- The GREET model and documentation are available at *http://www.transportation.anl.gov/modeling_simulation/GREET*
  - There are more than 14,000 registered GREET users worldwide
- Latest GREET fuel-cycle model (GREET1.8d.1) was released in Sept. 2010

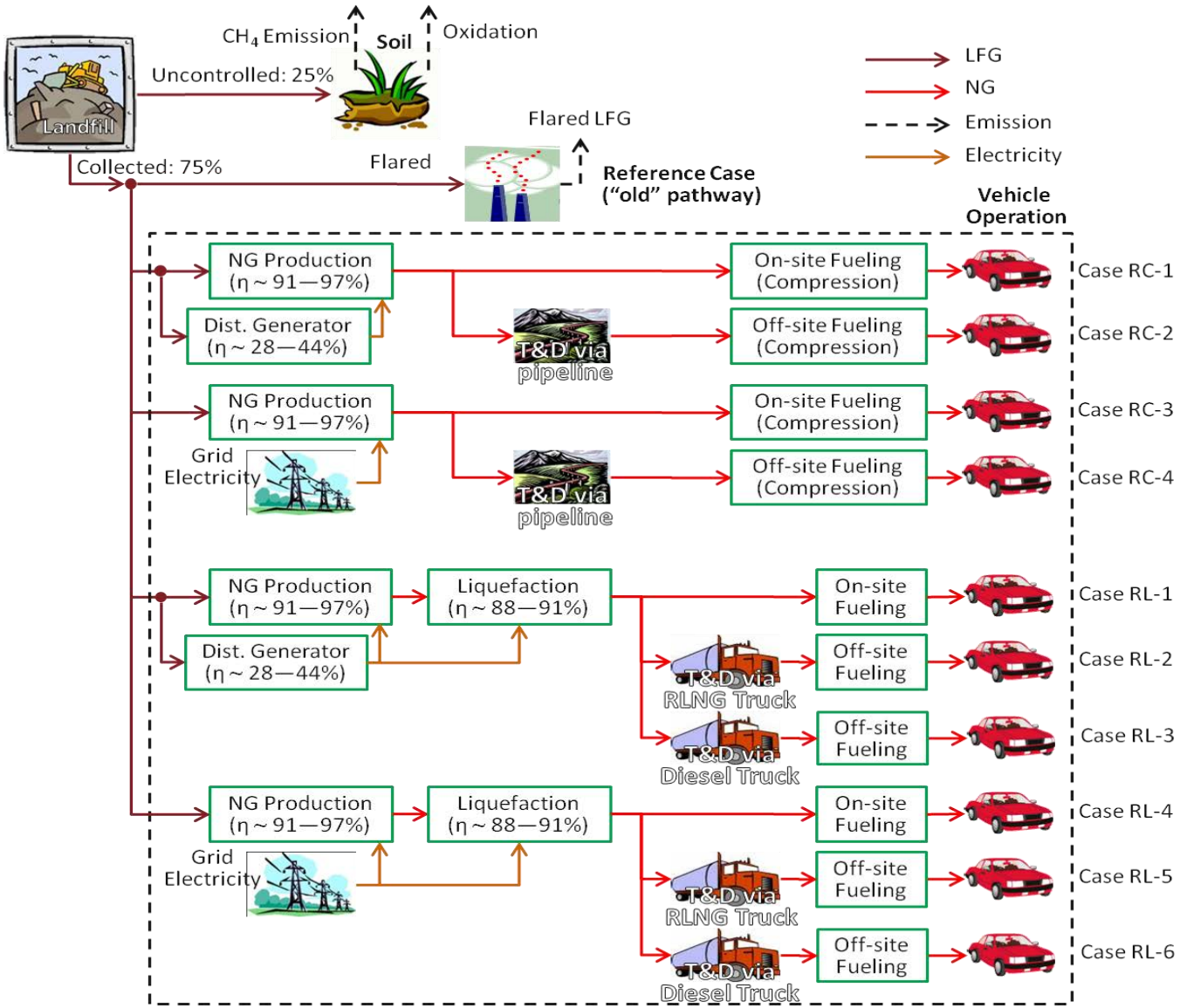
GREET Tracks Carbon in Well-to-Pump (WTP), Pump-to-Wheel (PTW) and Well-to-Wheel (WTW) Pathways







GREET 1.8d.1 Models 4 LFG→CNG & 6 LFG→LNG Pathways



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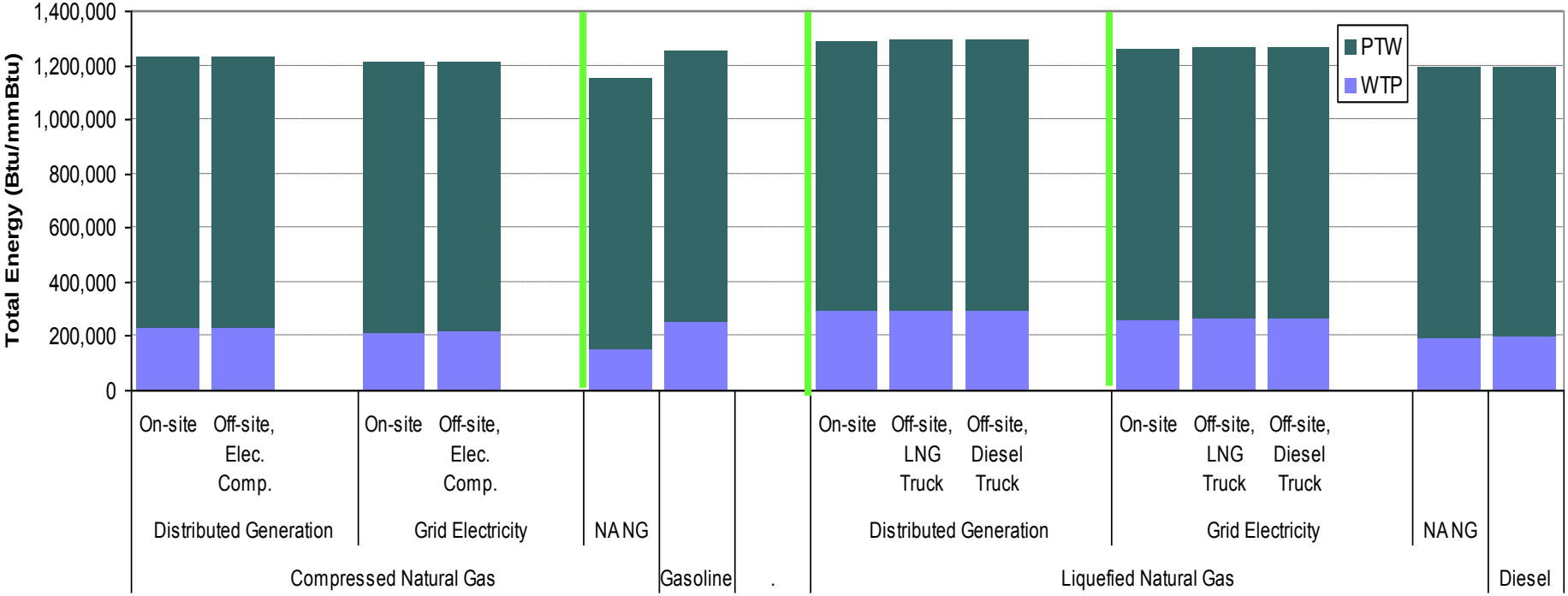
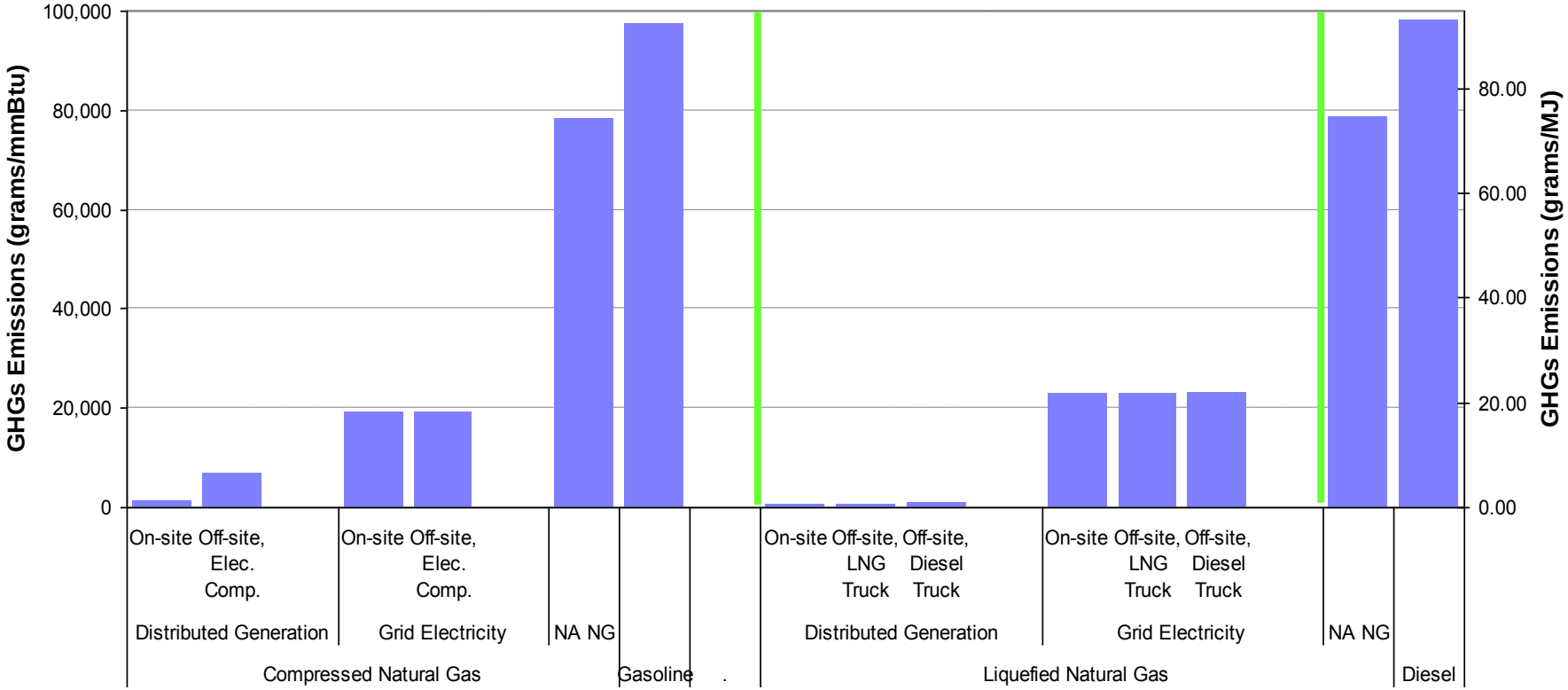
LFG and Fossil NG-Based Pathways Use Comparable Energy



Mintz, M. et al., *Well-to-Wheels Analysis of Landfill Gas-Based Pathways and Their Addition to the GREET Model,* ANL/ESD/10-3, May 2010.

- LFG→CNG and LFG→LNG pathways have similar WTW energy use
- LFG pathways are slightly more energy intensive (smaller scale, cleanup/upgrading processes) than fossil NG pathways

But LFG Pathways Produce Less GHGs, Especially with Self-Generated Power



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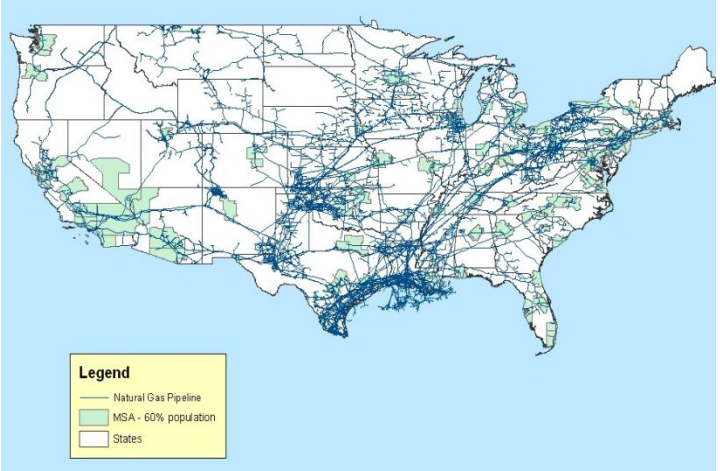
- Grid electricity accounts for most GHGs of LFG-based fuels
- LFG→CNG/LNG cuts GHGs >77% with grid electricity, 90–100% won-site power and refueling
- WTW GHGs drop from ~93 g/MJ for gasoline or diesel to ~74 g/MJ for fossil NA NG, 16–18 g/MJ for RCNG, 21–22 g/MJ for RLNG with grid electricity
- With self-generated power GHGs drop to 2–3 g/MJ for RLNG, 0–7 g/MJ for RCNG

Barriers Are Significant

- Like fossil NG**, lack of vehicles and infrastructure** is main barrier
  - Of 11 million NGVs worldwide, only ~110,000 are in US
  - Of 125,000 fuel stations, only ~1000 dispense NG (half are public; 131 being added from ARRA)



- **Bans against pipeline injection** (LFG, CA)
- **Lack of pipeline acceptance standards** (feed-in tariff) and standard purchase agreements
- Cost and **permitting** of new stationary sources (CA)

Barriers (cont'd)

- **Production cost** exceeds fossil NG, especially at small scale ($5.50–9.00 vs. ~$4.50/MMBtu)
- **Lack of financing**, especially for smaller projects

  American Recovery and Reinvestment Act (ARRA) Section 1603 *Payments for Specified Energy Property in Lieu of Tax Credits* has spurred investment in RNG and other projects

- Difference between electricity and natural gas prices (**spark spread**)
- **Renewable Portfolio Standards** (good, but) encourage investment in biogas electricity over risky/intermittent alternatives; no comparable gas standards
- **Multiple regulatory authorities** (for energy, environment, waste)

Clean Cities Is Raising Visibility of RNG as Motor Fuel and Providing Tools for Coalitions

- Funded two RNG projects under ARRA
- Hosted *Waste-to-Wheels: Planning for Success* workshop for Clean Cities Coordinators and stakeholders
  - Expand awareness of RNG projects and benefits
  - Provide local leaders with project development tools

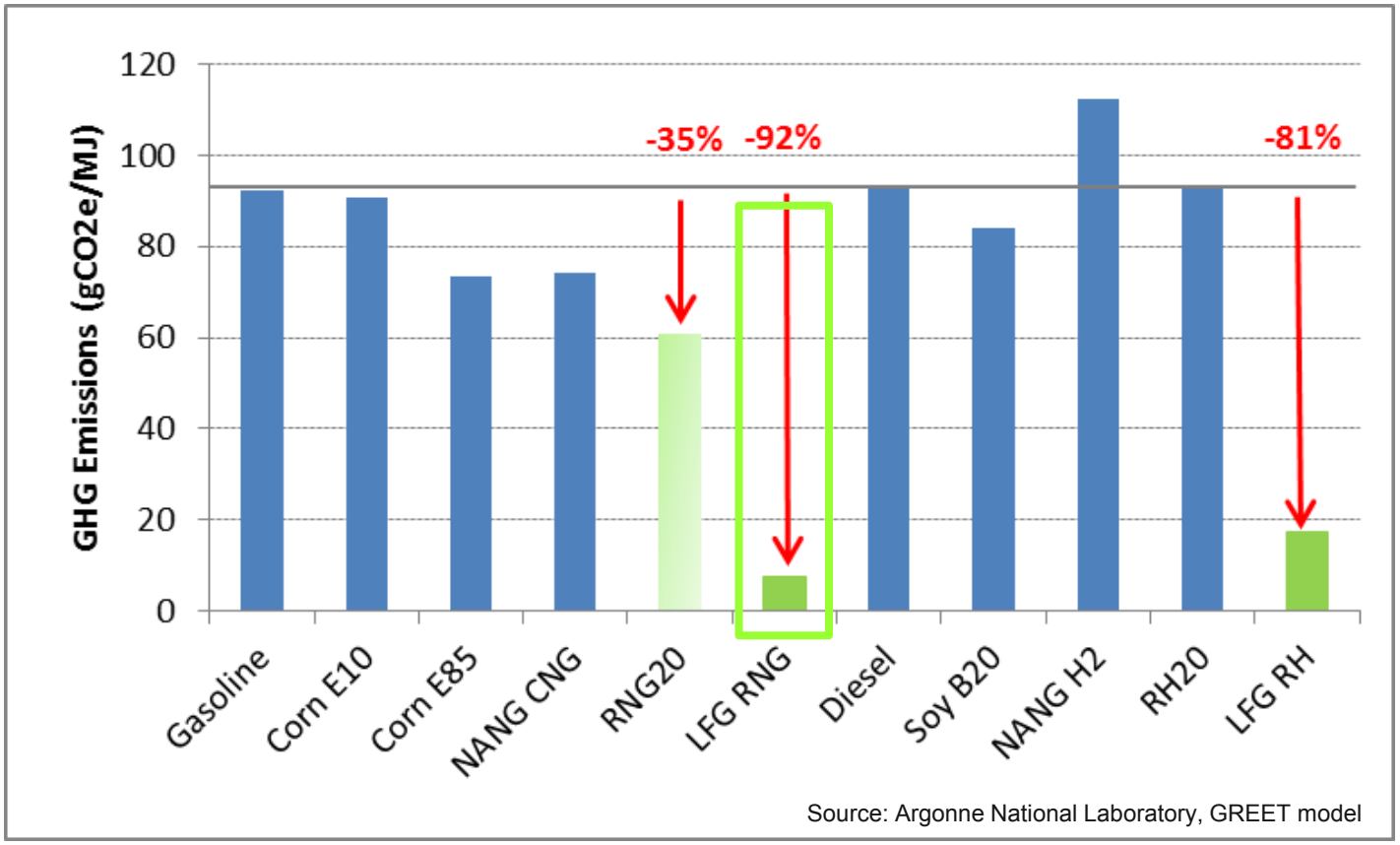
- Added RNG element to Clean Cities strategic plan
- Providing technical data and tools to Clean Cities coordinators, both specific to RNG and as part of natural gas outreach
- Supporting GREET expansion to model GHG and criteria pollutant emissions of RNG production from landfill gas, animal manure and wastewater

Clean Cities Is an Established Network of Local Coalitions

- ~100 coalitions and partnerships
- > 6,500 stakeholders from businesses, city and state governments, transportation industry, community organizations, fuel providers (49% private sector)
- Alabama Clean Cities — Newest Member

Only Renewable Hydrogen Has GHG Emissions Comparable to RNG *(adjusted for efficiency gains)*

Renewable blends also reduce WTW greenhouse gas emissions



- Results shown are WTW per MJ of fuel consumed, unadjusted for PTW efficiency
- LFG-based results for CNG with site-generated power & off-site fueling (RC-2)

Questions/Comments??

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For additional information see

http://www.transportation.anl.gov/pdfs/TA/632.PDF