Renewable Natural Gas (RNG) and RINs

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

New Rules, New Opportunities

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Renewable Natural Gas: New Rules, New Opportunities

- Overview (Why RNG?)
  - RNG composition and source
  - RNG production
  - Clean Cities and RNG
- Advantages of RNG (Why Now?)
  - Environmental benefits
  - Incentives and other funding sources

What is RNG (biomethane)?

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Parameter	Unit	Tariff Values for Natural Gas	High-BTU Landfill Gas (purified)	Raw Biogas
Htg Value: avg range	Btu/SCF	1050 900-1200	970 930-1010	615 498-697
Wobbe No:	Btu/SCF	1340	1275	644
Methane:	% comp.	not reported	90+	60
Carbon Dioxide:	% comp.	0-3	0-2.2	28.6-40.4
Nitrogen:	% comp.	0-4	0.5-6	0.6-12.7
Oxygen:	% comp.	0-1	0.1-0.9	0.2-2.9
Hydrogen:	% comp.	0-0.1	BDL-0.9	-
Siloxanes:	mg Si/m^3	not reported	BDL-0.4	-
Hydrogen Sulfide:	ppmv	0-15.3	BDL	1480-6570
Total Sulfur:	ppmv	0-338	BDL-5.1	0.3-6580

Source: Gas Technology Institute, 2009 and 2012.

- A renewable source of methane, the primary constituent in natural gas
- Produced from breakdown of organics (MSW, yard/food waste, sewage, manure) in absence of oxygen (anaerobic digestion)
- Biogas (or LFG) is purified to remove contaminants (primarily CO2 and H2S)
- Following purification, RNG contains >90% methane
- RNG is comparable to fossil natural gas. RNG CAN BE USED IN ANY NATURAL GAS-FUELED ENGINE

RNG can close the renewable loop

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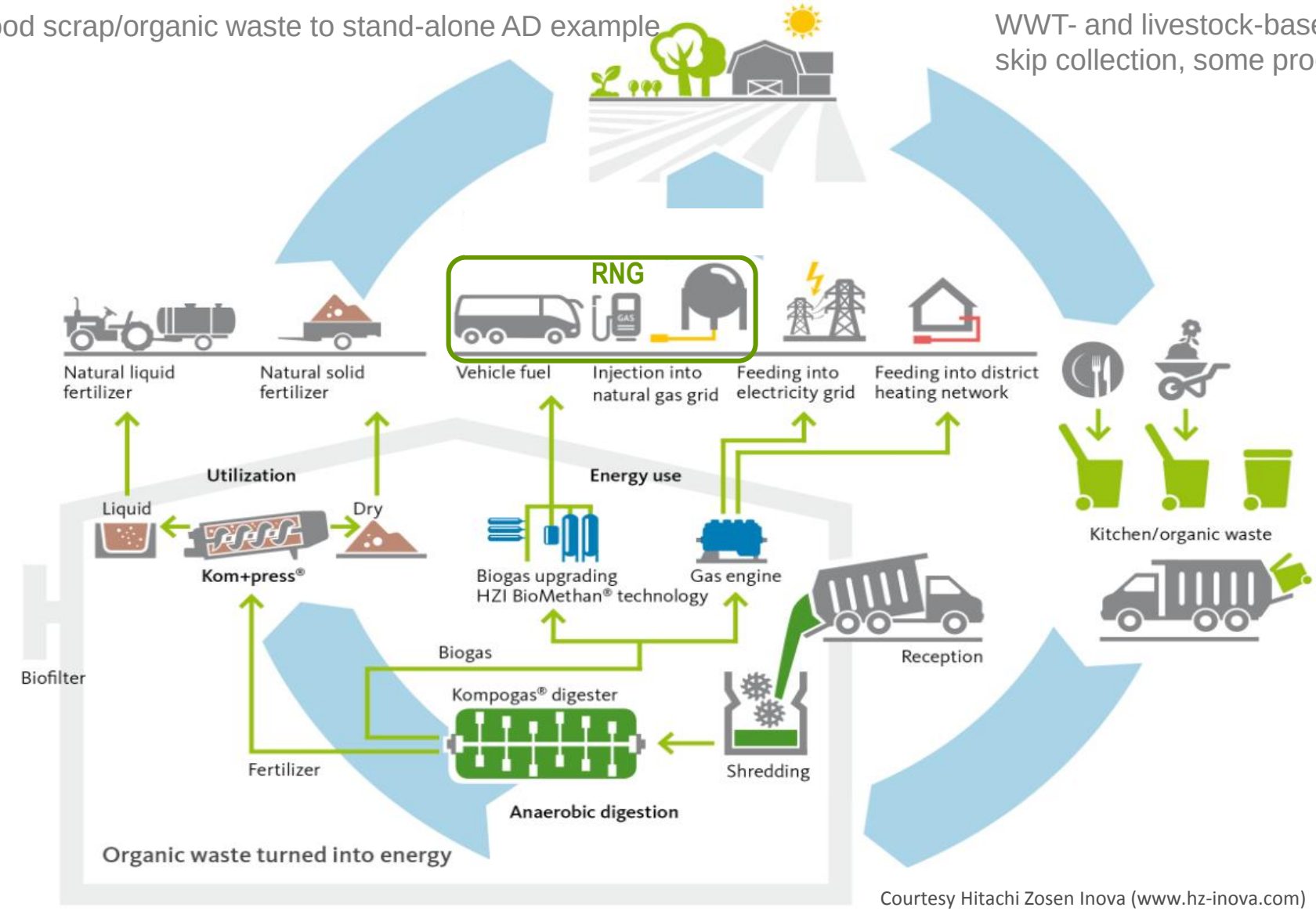
Food scrap/organic waste to stand-alone AD example

WWT- and livestock-based RNG skip collection, some processing



Courtesy Hitachi Zosen Inova (www.hz-inova.com)

RNG projects can be complex

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- Multiple “players”, for example:
  - Waste generators
    - Residences
    - Commercial establishments, institutions
    - Food processors, dairies/CAFOs
  - Waste handlers/collectors (MSW, FOG, etc.)
    - Disposal companies
    - Contract haulers
  - Waste managers
    - Disposal facilities (landfills)
    - Resource reclamation facilities (WWTPs, MRFs, composters)
    - AD operators
  - Offtakers (utilities, RNG/by-product purchasers)
  - 3rd parties
- Multiple regulations/regulatory authorities
- Often long lead times and high capital cost

Courtesy Marion County Environmental Services

Courtesy American Biogas Council

Clean Cities has supported RNG through local coalition efforts

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For example:

- Fair Oaks Dairies (IN)
- Pierce Transit & SEA-TAC Airport (WA)
- Solid Waste Association of Central Ohio
- Quasar Energy (OH)
- Waste Management/ Altamont Landfill (CA)
- Atlas Disposal/South Transfer Station (CA)
- Etc.……

As well as nationally-led efforts

- DeKalb Co. Sanitation Dept./Seminole Rd Landfill (GA, ARRA)
  https://www.youtube.com/watch?v=DRRz7Fl4ZBg
- Clean Cities Strategic Planning (2009)
  - Renewable Natural Gas: Current Status, Challenges and Issues
    http://www1.eere.energy.gov/cleancities/pdfs/renewable_natural_gas.pdf
- Waste-to-Wheels: Building for Success (2012)
  http://www1.eere.energy.gov/cleancities/waste_to_wheels.html
- NGV Technology Forum (2014)
  http://www1.eere.energy.gov/cleancities/natural_gas_forum_meeting_jan2014.html
- Clean Cities Strategic Planning (2015)
  - Status and Issues for Natural Gas in the United States
    http://www1.eere.energy.gov/cleancities/pdfs/2015_strategic_planning_natural_gas.pdf
  - RNG toolkit (under development)
  - Case studies (under development)
  - RNG project data base (Sept. 2015)
- Alternative Fuels Data Center: Emerging Alternative Fuels
  http://www.afdc.energy.gov/fuels/emerging_biogas.html
- State, national and international stakeholder outreach

Why is RNG important now?

- "Greens" the natural gas grid
- Enables continued natural gas uptake (and petroleum displacement) in transportation
- Furthers environmental initiatives and mandates

Courtesy American Biogas Council

RNG can "green" fossil natural gas

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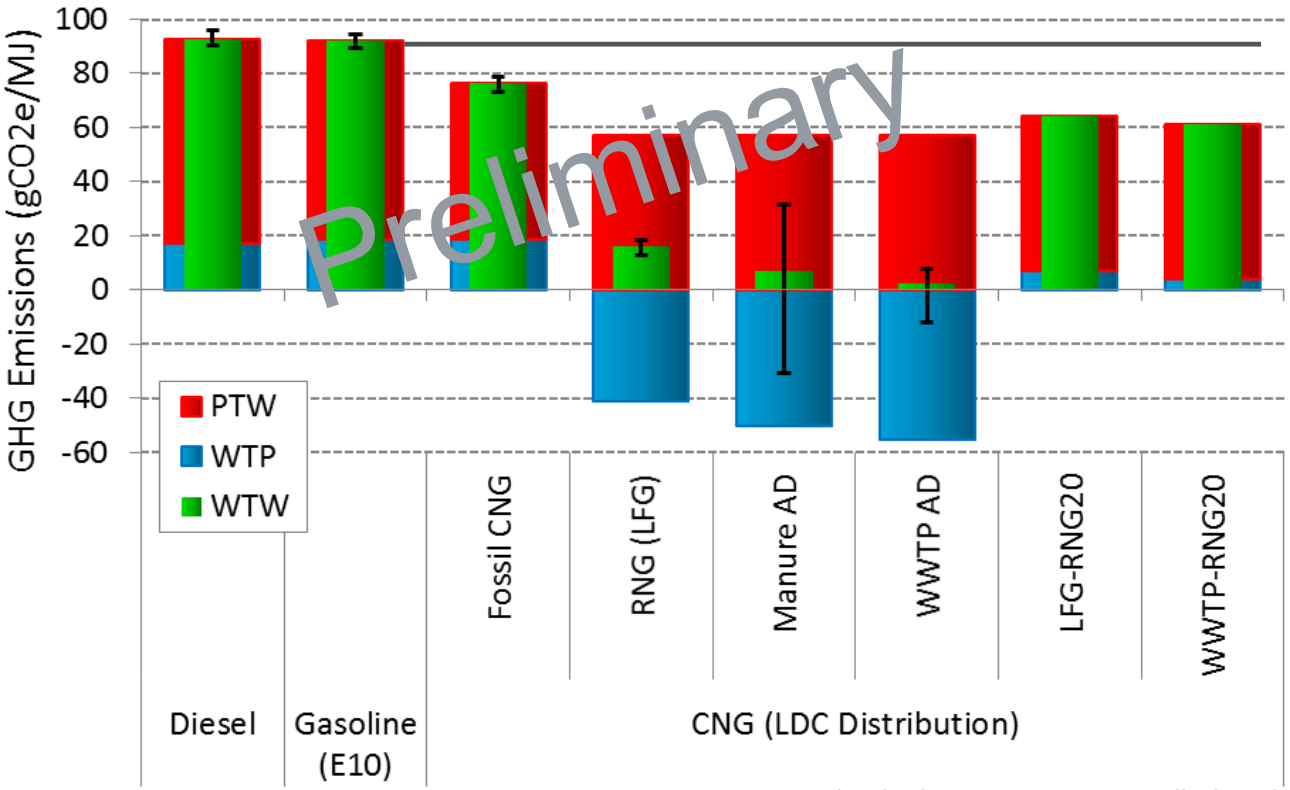
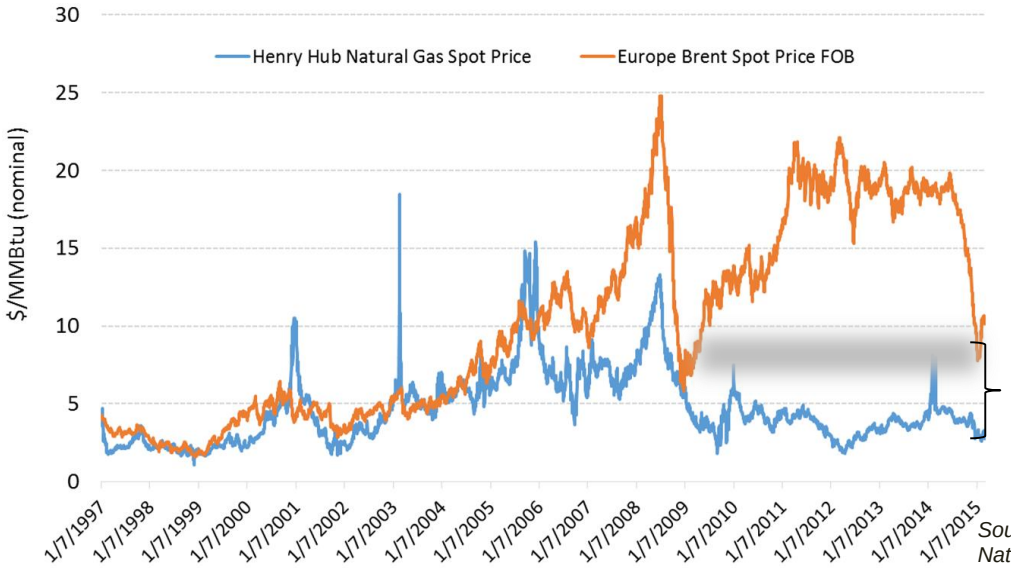
- RNG can achieve 83–98% GHG reductions over gasoline, though results vary with climate, technology, pathway (especially distribution) and reference assumption
- An 80/20 blend reduces GHGs by 30–33%: a 90/10 blend by 19–25%
- GREET 2015 will update methane leakage, petroleum composition, RNG pathways

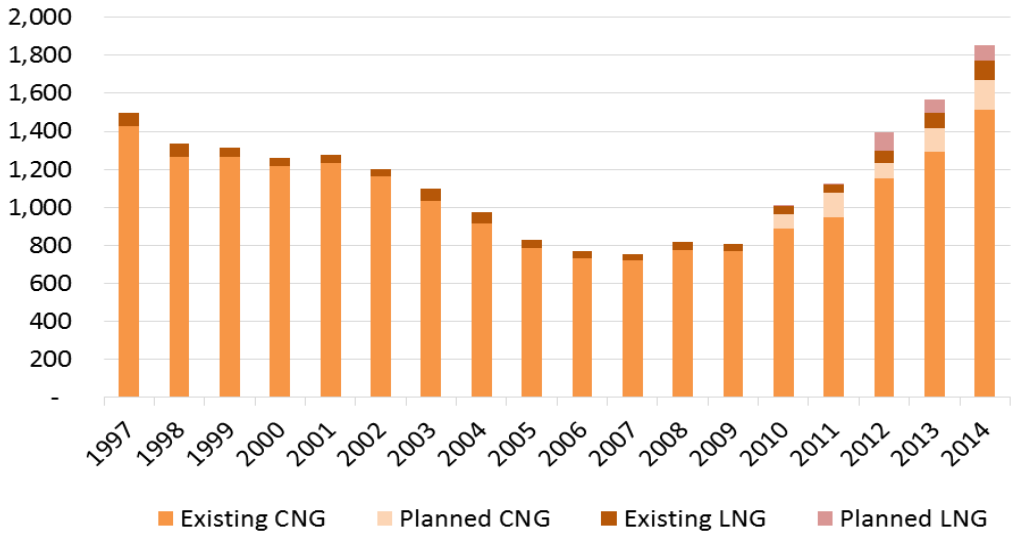


Source: J. Han, Argonne National Laboratory, GREET 2015 (forthcoming).

RNG can enable natural gas uptake



Source: Argonne National Laboratory, based on EIA data.

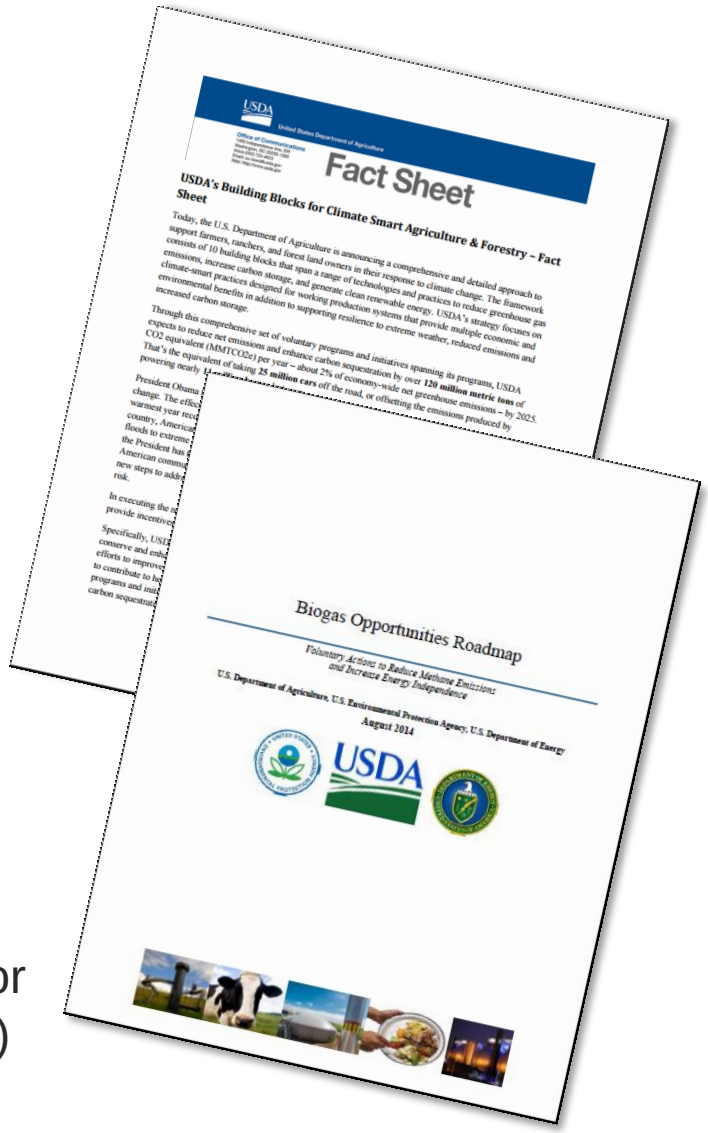


Source: Argonne National Laboratory, based on AFDC and NGVA data.

- Historically, natural gas & oil prices were “coupled”
- Price & new technology spurred exploration, production & new supply
- Shale gas “revolution” (2006-09) uncoupled prices
- In past 5 years, ARRA & price advantage spurred NG penetration and doubled number of stations
- Now, price advantage is less & station additions down (20-30 to 10-20/mo)

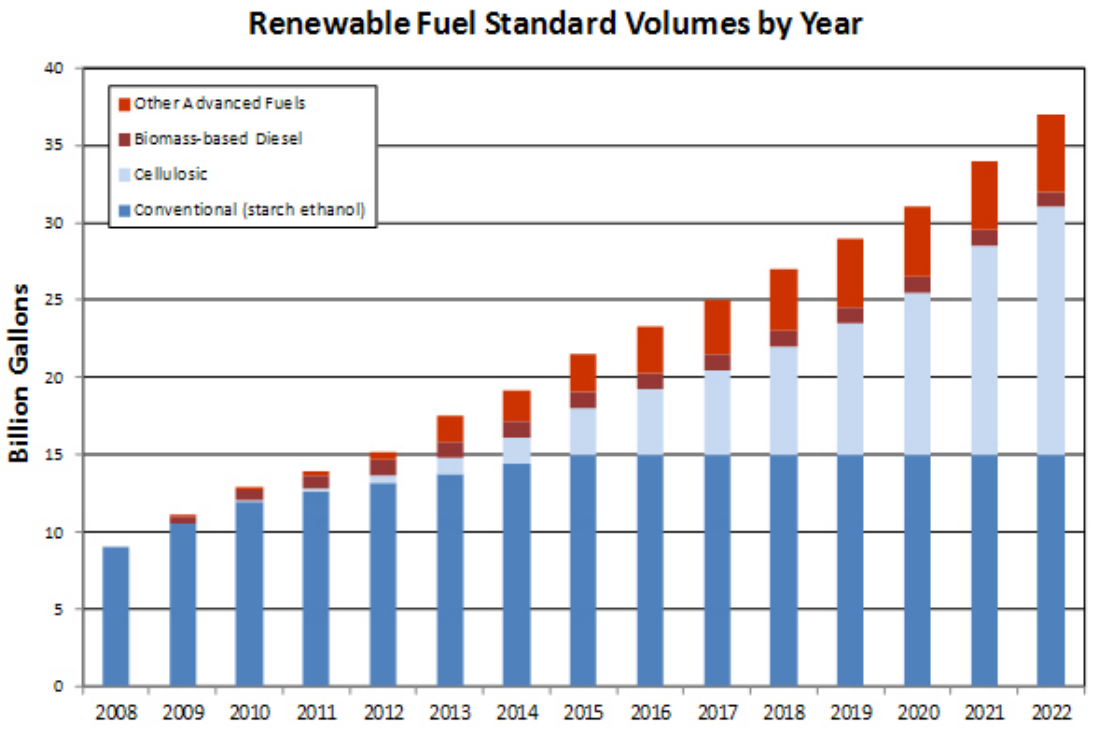
RNG supports climate/environment initiatives and qualifies for incentives

- USDA/EPA/DOE Biogas Opportunities Roadmap
- USDA grants & loan guarantees
  - Biorefinery assistance
  - Building Blocks for Climate Action
    - Livestock partnerships: 500 digesters by 2025
    - Energy generation and efficiency: REAP
- CA Low Carbon Fuel Standard (LCFS)
  - Fossil natural gas may not qualify as LCF
    - Revised leakage estimates
    - Methane's climate-forcing effect greater than prior estimates, especially in near term
- Renewable Fuel Standard (RFS)
  - RNG qualifies as cellulosic biofuel, eligible for associated renewable identification no. (RIN)



Though few projects currently produce RNG, interest is growing

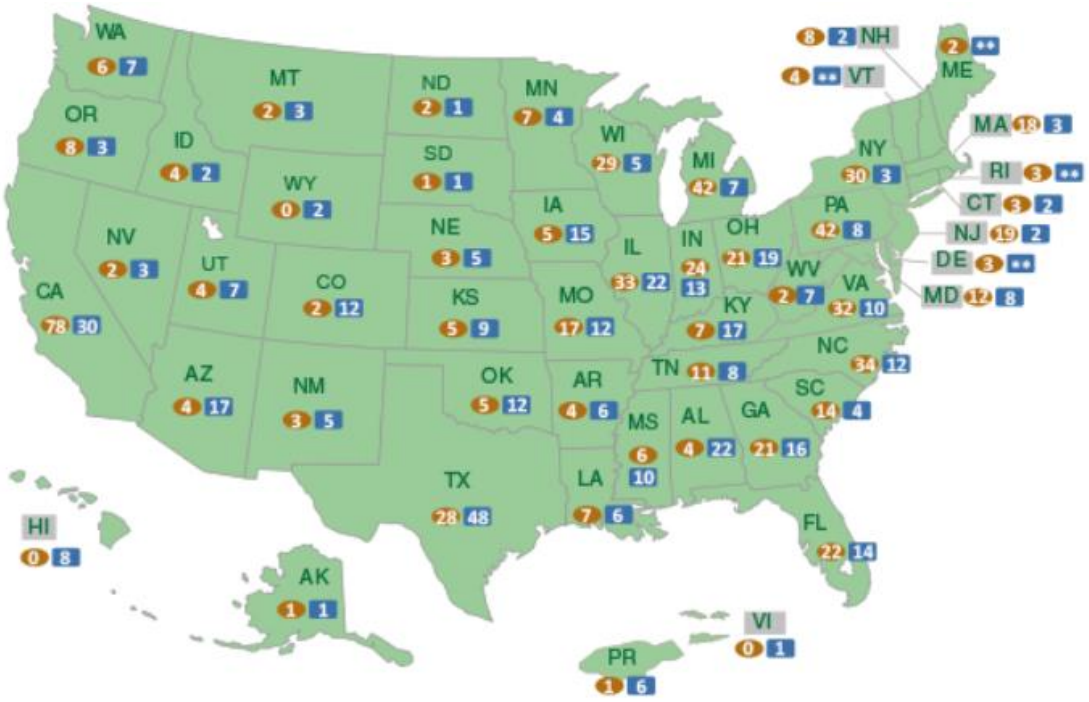
- <40 landfills converting WTE currently produce RNG
- As a "cellulosic biofuel" RNG production is eligible for higher value RFS incentives (D 3 RIN ~ $0.80/dge in 2014) and expected to experience increasing demand



Source: Alternative Fuels Data Center, www.afdc.energy.gov.

- RNG = 98% of 2014 cellulosic biofuel RINS
- RINs make RNG more competitive with fossil NG & petroleum
- State & local bans of organic waste from landfills
- Potential state renewable gas standards, LCFS

And so can production



Nationwide Summary

645 OPERATIONAL Projects (2,066 MW and 298 mmscfd)

~440 CANDIDATE Landfills (855 MW or 475 mmscfd, 42 MMTCO2e/yr Potential)

OPERATIONAL PROJECTS

CANDIDATE LANDFILLS*

*Landfill is accepting waste or has been closed 5 years or less, has at least 1 mm tons of waste, and does not have an operational, under-construction, or planned project; can also be designated based on actual interest by the site.

These data are from LMOP's database as of March 4, 2015.

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

Source:: USEPA, Landfill Methane Outreach Program (http://www.epa.gov/lmop/).

Plentiful resources:

- Waste-in-place: 440 candidate landfills could produce another 475 mmscfd (>500 million gge/yr) plus many of 645 landfills with existing WTE projects could increase production.
- "New" waste: Americans dump nearly 450 million lbs of municipal solid waste in landfills every year.
- 160 billion lbs (~50% US food production) is uneaten each year.
- RNG can be produced from food waste alone or co-digested in WWTPs or stand-alone anaerobic digesters.

Thank You

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