Renewable Natural Gas Study Workgroup

Meeting #2

Stakeholder Presentations

April 20, 2022 2:00 - 5:00 PM (EDT)

MPSC
Michigan Public Service Commission

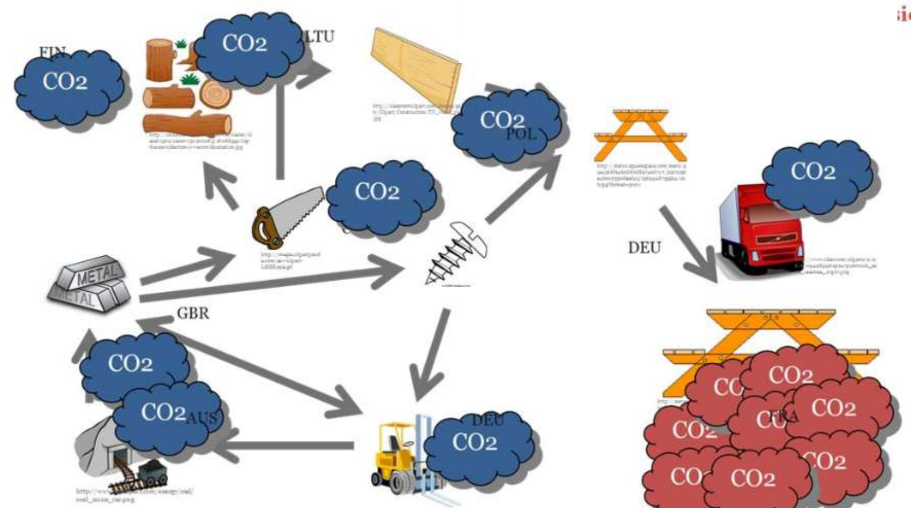
Presentation to the MPSC
RNG Study Stakeholder Meeting
April 20, 2022
Case No. U-21170

Life Cycle GHG Assessment of Manure Biogas

Louise Gorenflo
Michigan Food for All and the Earth Project

- For biogas to be considered as a resource that mitigates climate change, its embodied GHG emissions must be significantly less than the fossil fuel GHG emissions it displaces.

- Embodied GHG emissions means the sum total of all the CO2 equivalents emitted throughout the biogas' lifecycle, from production to generation to end use.



OECD CO2 emissions embodied in consumption http://oe.cd/io-co2

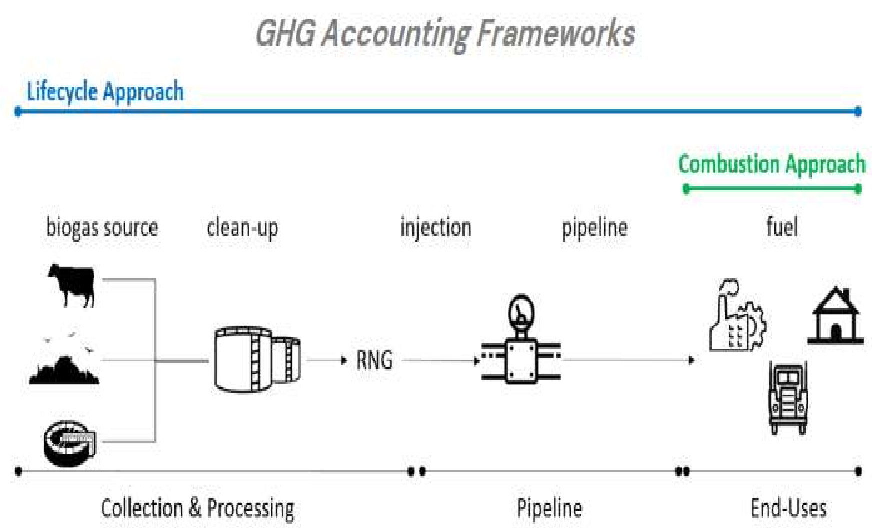
Key Points for a GHG Life Cycle Bioenergy Assessment

- A Life Cycle GHG Assessment (LCA) quantifies the global warming impact of energy systems.
- The GHG impacts of the bioenergy system being analyzed should be compared with a reference energy system, e.g. a fossil energy system, that is realistically likely to be displaced by the bioenergy system.
- The scope of the analysis (system boundary) should include all processes along the value chain with significant GHG emissions, including, where relevant, upstream processes of extraction or biomass production, and end-of-life processes.
- Changes in carbon stocks in biomass (land use) and soil cause GHG emissions. These can be very important and should be included in the analysis.

https://www.ieabioenergy.com/wp-content/uploads/2013/10/Using-a-LCA-approach-to-estimate-the-net-GHG-emissions-of-bioenergy.pdf

Combustion Approach for GHG Assessment – Creative Bookkeeping

- ICF states that "RNG in a combustion accounting approach is zero-rated and carbon neutral."
- ICF's choice of the combustion accounting framework rather than the GHG life cycle approach means that it will ignore all the GHG emissions up to the point of the biogas' combustion.
- The combustion approach, called "creative bookkeeping" by the London Financial Times, is commonly used by the bioenergy industry to justify bioenergy projects.



The Combustion Approach has been Discredited

European Burning of US Forests

England and EU nations meet up to 30% of their renewable energy policy by burning woodchips for electricity sourced from clearcutting forests in southeastern U.S. The wood that goes into the burner Is deemed carbon neutral. The scientific community has pushed back on that assumption.

The European Commission has drafted a policy that states that biomass-fueled installations will count as renewable if they produce 70% fewer emissions than fossil fuels based on an LCA approach.

U.S. Corn ethanol accounting

Within the Renewable Fuel Standard, corn ethanol is deemed carbon neutral.

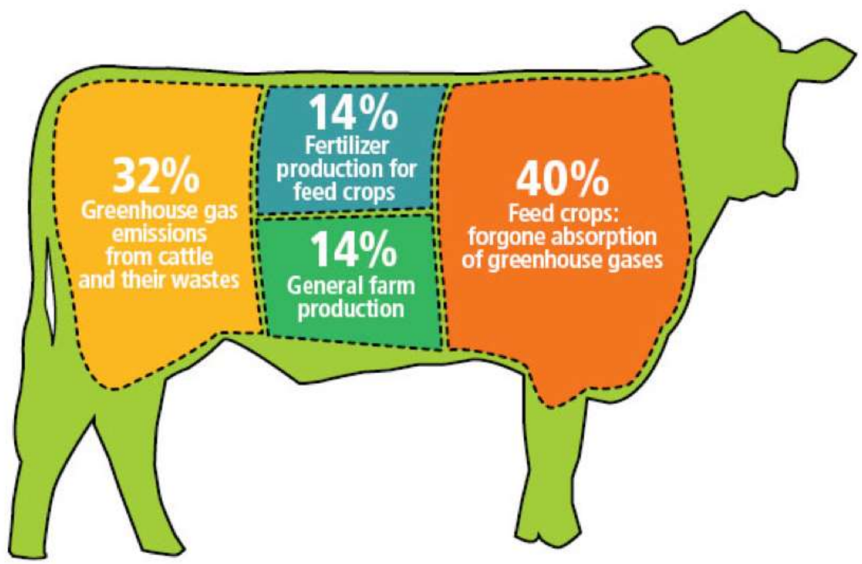
Recent research finds U.S. corn ethanol production does not mitigate climate change largely due to the pressure to convert land to grow more corn and intensive fertilizer use.

The carbon intensity of corn ethanol produced under the Renewable Fuel Standard is no less than gasoline and likely at least 24% higher.

Due to recent Life Cycle Accounting research, the carbon neutrality of corn ethanol is being reviewed by the USDA.

https://www.pnas.org/doi/10.1073/pnas.2101084119

Life Cycle GHG Assessment for Biogas Derived from Livestock Manure



LCA: Feedstock Production GHG Factors

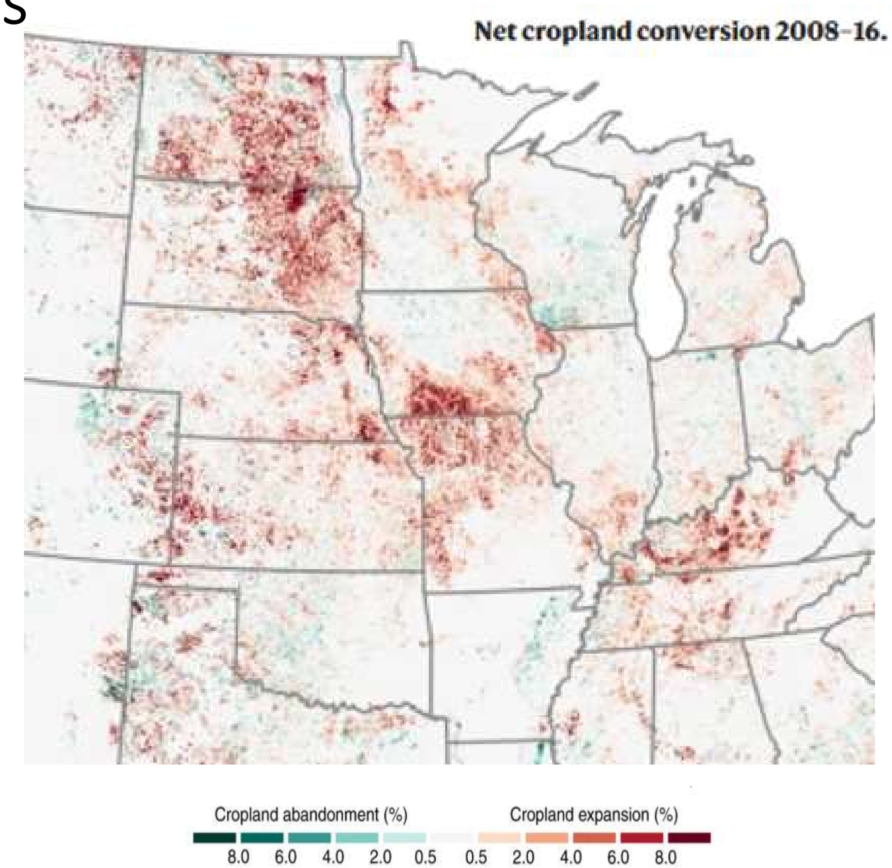
Use of Fertilizer in Corn Production

- 8.3% of US emissions of nitrous oxide.
- Production of fertilizer is a major source of methane emissions.

Land use conversion – loss of land as a carbon sink.

There has been an 8.7% increase of cropland – conversion of natural or conserved areas to grow more corn

Research available on embodied GHG emissions of dairy livestock feed:
https://www.researchgate.net/profile/Felix-Adom/publication/257680036_Regional_carbon_footprint_analysis_of_dairy_feeds_for_milk_production_in_the_USA/links/55d3391c08ae7fb244f58315/Regional-carbon-footprint-analysis-of-dairy-feeds-for-milk-production-in-the-USA.pdf?origin=publication_detail

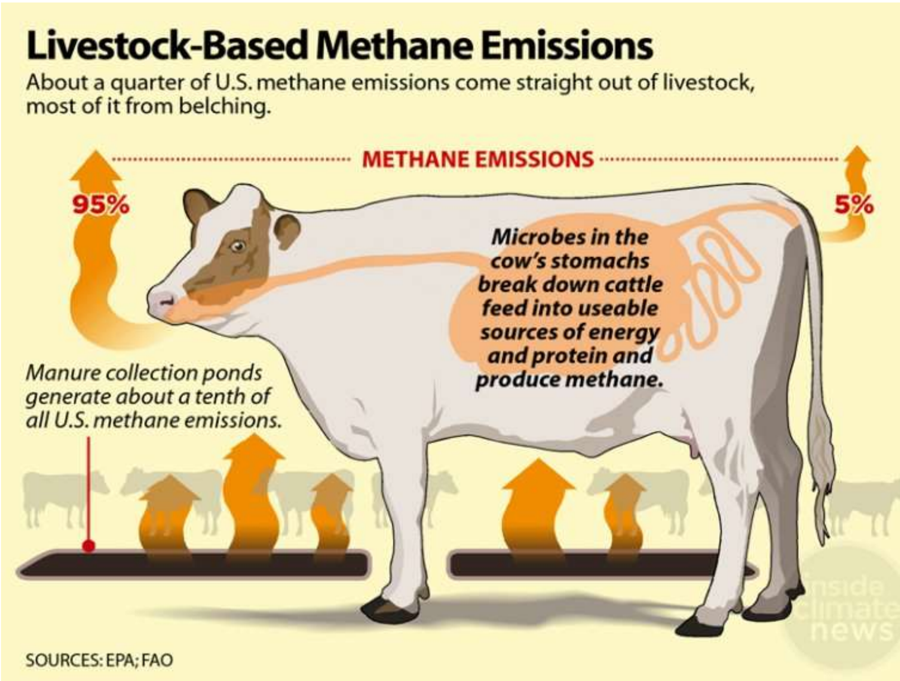


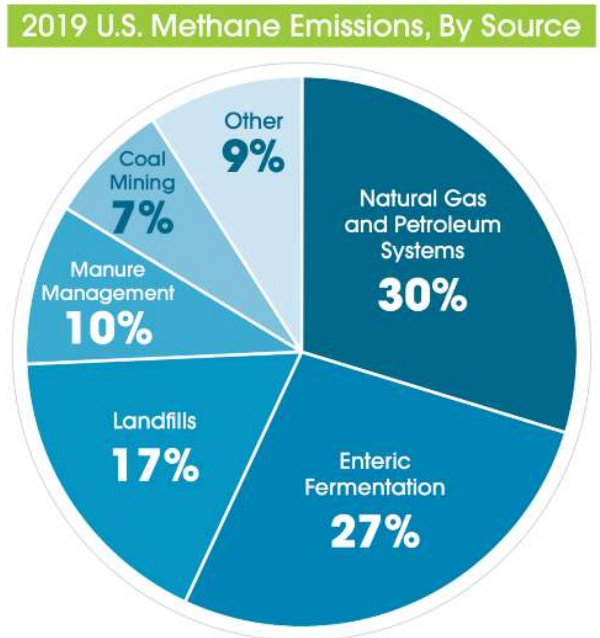
Rates of net conversion calculated as gross cropland expansion minus gross cropland abandonment and displayed as a percentage of total land area within non-overlapping 3 km × 3 km blocks. Net conversion was most concentrated in the eastern halves of North and South Dakota, southern Iowa, and western portions of Kansas, Kentucky, and North Carolina.

https://www.pnas.org/doi/10.1073/pnas.2101084119

LCA: GHG Emission Factors of the Primary Digester – the Dairy Cow

Enteric emissions (cow burps) are a large methane source.





U.S. Environmental Protection Agency (2021). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019

Need to add enteric emissions within LCA.

LCA: GHG Emission Factor – Storage of Liquefied manure

- Cow manure become liquefied when it is hosed off the concrete flooring of the CAFO shed.
- Reminder – liquefying the manure is an industry practice selected to minimize its costs. No methane would be released from the manure if the cows were pastured.
- The manure is collected and stored in a lagoon, where anaerobic activity releases methane into the air.

LCA: Embodied GHG emissions in construction of a biodigester and equipment

According to IEA Bioenergy, the GHG emissions from construction and dismantling of all facilities must be included.

https://www.ieabioenergy.com/wp-content/uploads/2013/10/Using-a-LCA-approach-to-estimate-the-net-GHG-emissions-of-bioenergy.pdf

LCA – GHG emissions of biodigester operation

- Above the 40th parallel north, the biodigester must be heated. Michigan lies between 42 and 45 longitude. During the winter months, the heating requirements of the biodigester are large.
- The GHG emissions from heating, pumping, stirring and other biodigester and gas cleaning processes must be accounted for.
- If onsite Combined Heat and Power uses some of the methane as an energy source, the methane used in that process must be deducted from the total captured by the process.

Temperature Ranges of Biogas Production

Biogas is generated in three temperature ranges:

- Psychrophilic (less than 68 °F)
- Mesophilic (86 °F to 104 °F)
- Thermophilic (122 °F to 140 °F)

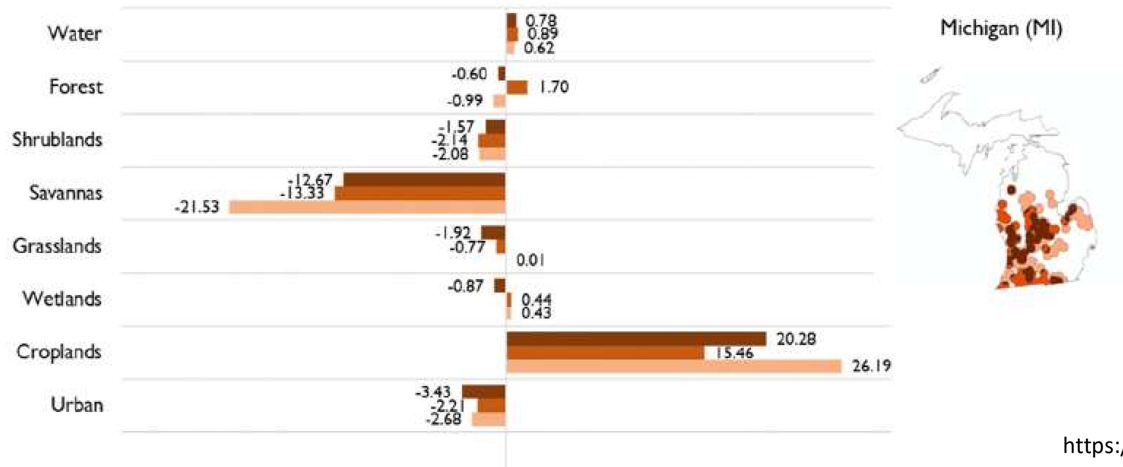
Conventional AD/biogas systems are commonly designed to operate in either the mesophilic or thermophilic temperature range.

https://www.epa.gov/sites/default/files/2020-11/documents/agstar-operator-guidebook.pdf

Biodigester waste product – liquefied manure

- Missing completely from ICF's study is the waste from the biodigester process – the digestate.
- The digestate is liquefied manure, the same that went into the biodigester with some methane captured.
- Current practice is to spread liquefied manure digestate onto fields.
- The digestate includes all the phosphorus and nitrogen that was in the liquefied manure that was loaded into the biodigester.

LCA - Land use changes from land application of CAFO manure in Michigan



https://pubmed.ncbi.nlm.nih.gov/34392208/

Percentage of total losses surrounding swine CAFOs and dairy CAFOs in both Michigan (MI) and North Carolina (NC). Areas impacted by both dairy and swine CAFOs (i.e., overlap) are shown in dark brown, using 2001 and 2017 MODIS data.

The research found land use changes from natural areas to fields to dump manure.

- Natural areas losses occurred within 15 km radius of CAFOs, but not in control areas, which represents the loss of a significant carbon sink.
- Natural lands near CAFOs changed to cropland, likely to meet the need to dump the manure.

https://pubmed.ncbi.nlm.nih.gov/34392208/

LCA – GHG emissions from land application of manure digestate

- Must account for nitrous oxide emissions from manure, a gas 300 times more powerful than CO_2. 7% of US emissions of nitrous oxide comes from livestock manure management.

- Must account for phosphorus entering waterways and causing eutrophication. Lake Erie algal blooms, driven in part by livestock manure, emits large quantities of methane.

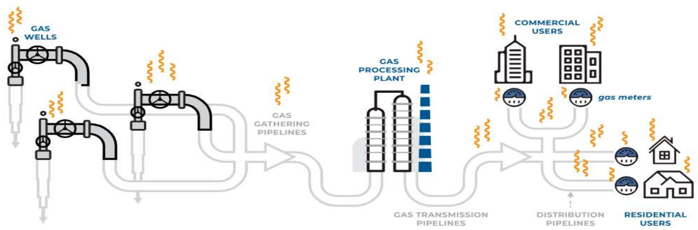
LCA - GHG emissions from pipeline construction and operation.

- The Federal Energy Regulatory Commission has issued new policy statements saying it will consider a natural gas pipeline project's GHG impacts along with its other environmental impacts as part of the "hard look" at environmental impacts required under the National Environmental Policy Act (NEPA).

(https://www.ferc.gov/news-events/news/ferc-updates-policies-guide-natural-gas-project-certifications)

- The LCA must account for the GHG emissions of pipeline construction to the utility line, including any land use conversion.

LCA – GHG emissions from methane leaks from biodigester to end user



- At scale, researchers report (1) that RNG biodigester systems could be climate intensive due to the influence of methane feedstock and leakage rates.
- Cities are leaking methane at twice the rate previously believed, according to recent research (2).
- EPA assumes a 2.3% leakage rate from the U.S. natural gas supply (2% from well to city gate and 0.3% in the local distribution system) (3).
- Methane and nitrous oxide emissions from natural gas stoves emit 0.8–1.3% of the gas they use as unburned methane, according to recent research (4).

1 https://iopscience.iop.org/article/10.1088/1748-9326/ab9335

2 https://www.science.org/content/article/major-us-cities-are-leaking-methane-twice-rate-previously-believed

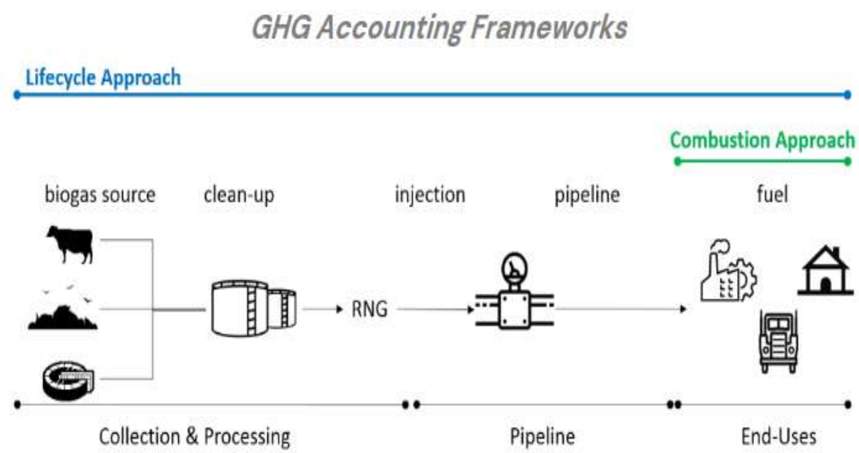
3 https://www.edf.org/sites/default/files/US-Natural-Gas-Leakage-Model-User-Guide.pdf

4 https://www.scientificamerican.com/article/gas-stoves-leak-more-methane-than-previously-thought/

Conclusions

Manure Biogas is not carbon neutral

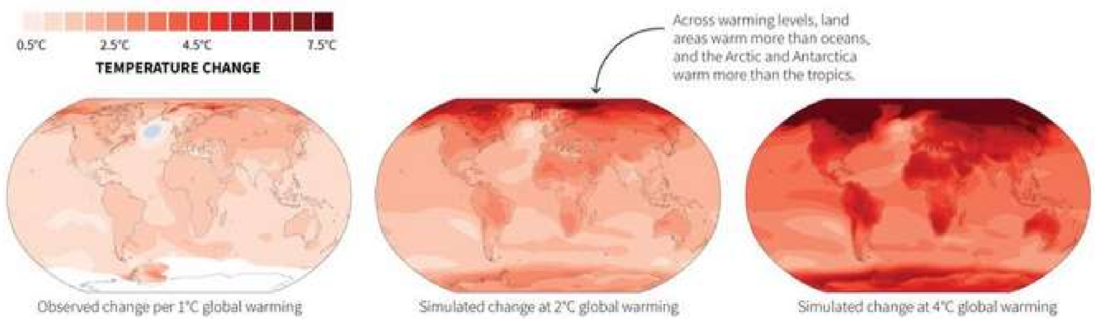
Lifecycle Approach



- Governments are becoming increasingly aware that the combustion approach assumption of carbon neutrality of feedstock does not demonstrate that bioenergy actually mitigates climate change.

- ICF's decision to opt for the combustion approach does the MPSC a disservice in not analyzing whether biogas actually mitigates climate change.

The Climate Imperative

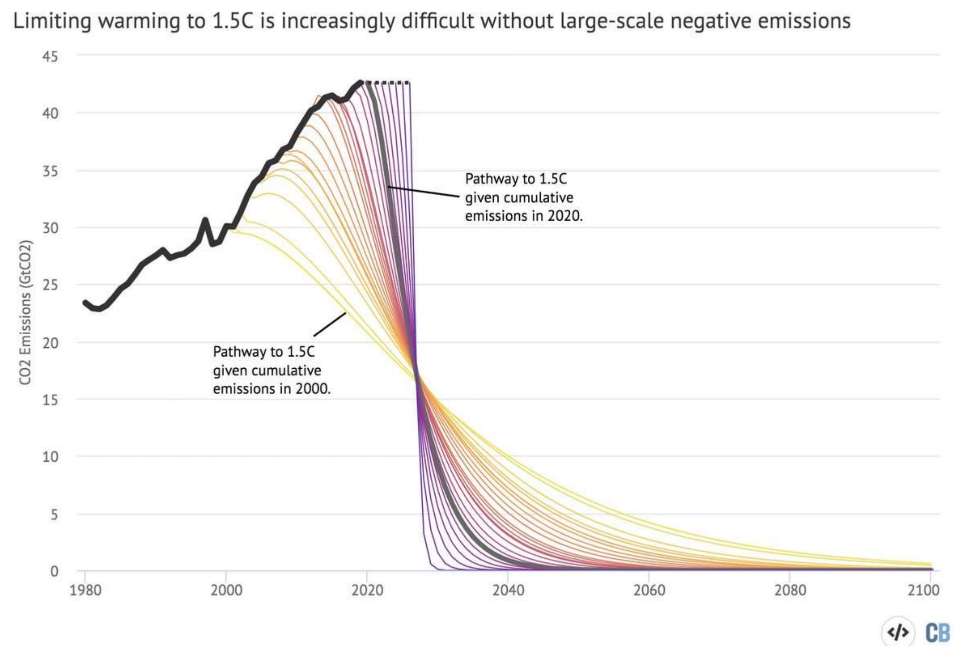


- The IPCC 6th Assessment Report requires a 43% decrease in GHG emissions by 2030 to achieve the 1.5C climate goal. If we persistently choose to greenlight carbon intensive energy projects, we'll seal our fate.

- We already live in a climate changed world. We now get to decide how horrific that world will become.

Time for the MPSC's actions to reflect the climate imperative

- The MPSC needs data-driven analysis that fully accounts for lifecycle GHG emissions, especially those that claim climate mitigation benefits.
- For Michigan to reduce its fossil fuel consumption and achieve the climate imperative, it must reject projects that would further entrench the fossil fuel industry.
- MPSC needs to avoid the buildout of climate intensive infrastructure that will become stranded assets when we do reduce our fossil fuel emissions by 2030 by 43%.



Trust

- We trust that the MPSC, when it has adequate and impartial information, will clearly discern what is self-serving from what benefits the public welfare.
- You have been given the responsibility to consider the climate implications of the cases that come before you.
- We ask that the MPSC obtain an impartial and complete GHG lifecycle accounting of livestock manure biogas that will determine whether manure biogas actually mitigates climate change.

Thank you

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Gas Strategy Update

Craig C. Degenfelder
Executive Director – Gas Strategy

April 2022

CMS ENERGY

Consumers Energy
Count on Us®

Consumers Energy Gas System

1.8 Million Customers

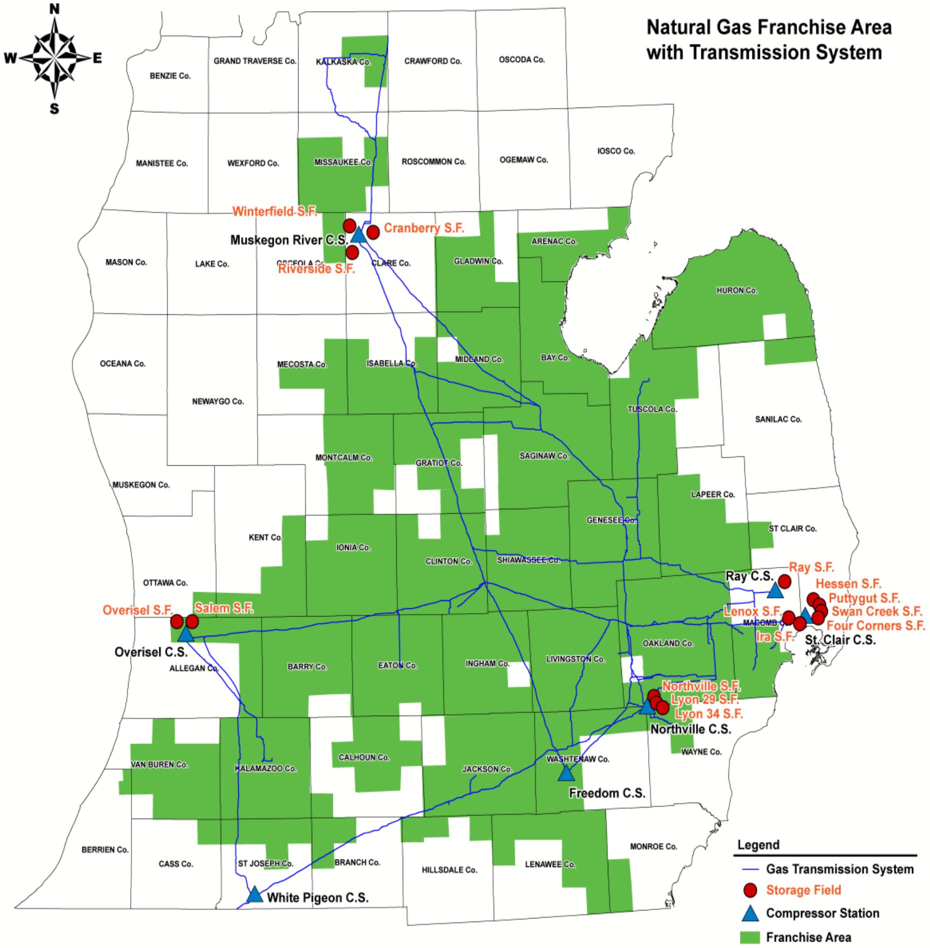
28,065 Miles of Distribution Main

2,392 Miles of Transmission Pipeline

9 Interstate Interconnections

8 Compressor Stations

15 Storage Fields



Interconnected, diverse and resilient system serving our customers.

Gas Business Strategy

External Drivers

- Safety and cyber security events
- Governmental regulations (MPSC, PHMSA, EPA, TSA, SEC)
- Abundant and lowest cost fuel
- Michigan's focus on environmental sustainability

Objectives	Goals
Safe	Accelerate remediation of vintage materials
Reliable	Ensure resilient network and optimized system
Affordable	Minimize bill growth by investing now while gas prices remain low, and offer energy waste reduction and low-income support programs
Clean	Reduce methane emissions & add new carbon offset customer programs and new clean fuel technology investments (RNG, H2)

External and internal factors drive gas business objectives and goals.

Decarbonization Pathways

CMS ENERGY

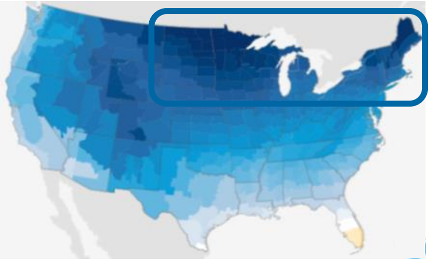
Consumers Energy

Count on Us®

U.S. Regions with relevant conditions similar to Michigan

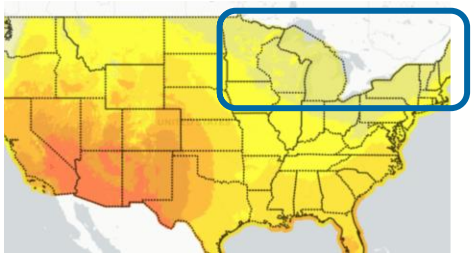
Cold winter climate

Avg. min. January temperature

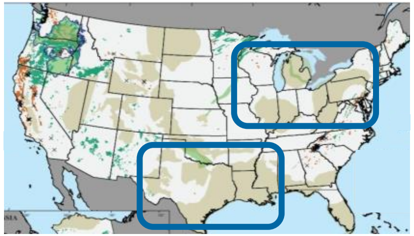


Limited available renewables

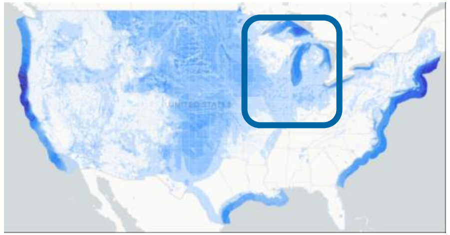
Solar



High carbon sequestration potential[1]



Wind[2]



As states across the US move towards full decarbonization, almost all levers will need to be pulled in every state:

- **Electrification, powered by renewables**
- **Fossil natural gas with CCUS**
- **Zero-carbon gas (e.g., hydrogen, biogas)**

States with **warmer climates and better renewables potential** will likely have more building electrification powered by solar and wind compared to Michigan

States with cold climates and limited renewables that lack Michigan's sequestration resources, may build higher cost renewables, rely more heavily on imports (e.g., hydro imports from Canada to New England), or build nuclear

Customer mix and building stock will also influence the cost and viability of electrification across regions

States like Ohio, Pennsylvania, Indiana, etc. may end up relying more heavily on natural gas with sequestration, similar to Michigan

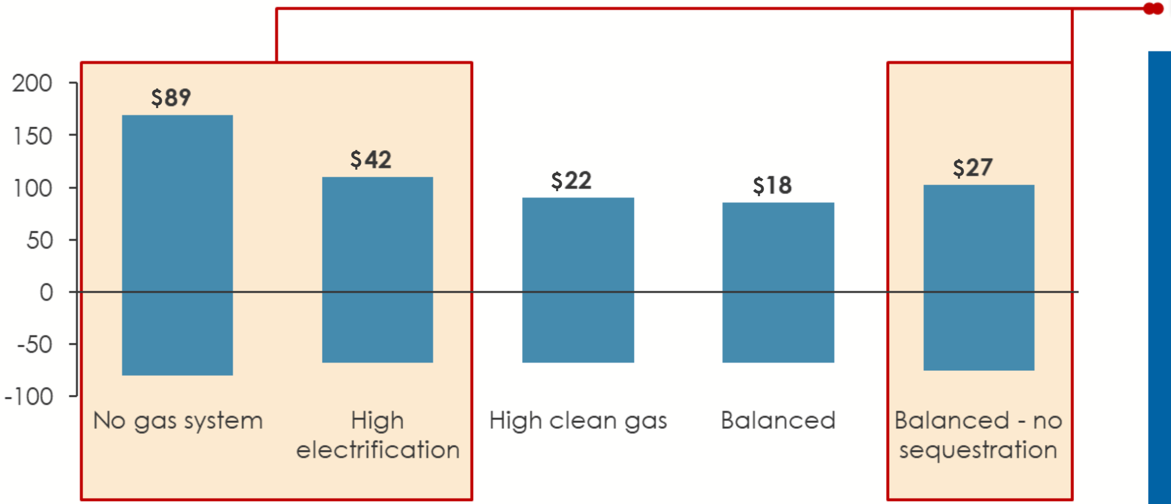
1. Image provided for illustrative purposes. Does not represent carbon sequestration assumptions used in decarbonization scenario modeling
2. Despite relatively high potential for offshore wind, siting challenges constrain development

Source: National Oceanic and Atmospheric Administration, climate.gov; US Dept. of Energy, National Renewable Energy Lab, RE Atlas; US Geologic Survey, "Geologic Carbon Storage Potential in the United States;"

Michigan Societal Cost Impact by Scenario

NPV of total system costs relative to reference case[1]

$B, 2020 – 2050, all of Michigan



Disallowing either the natural gas system or sequestration from the system results in **prohibitively expensive pathways**

1. **Gas distribution** enables cost effective heating
2. **Gas transmission is needed to supply gas to power plants that firm renewable power**
3. **Carbon sequestration** is needed to cost effectively negate emissions
4. Gas provides **system resiliency, diversification**, and energy for **hard-to-electrify end-uses**

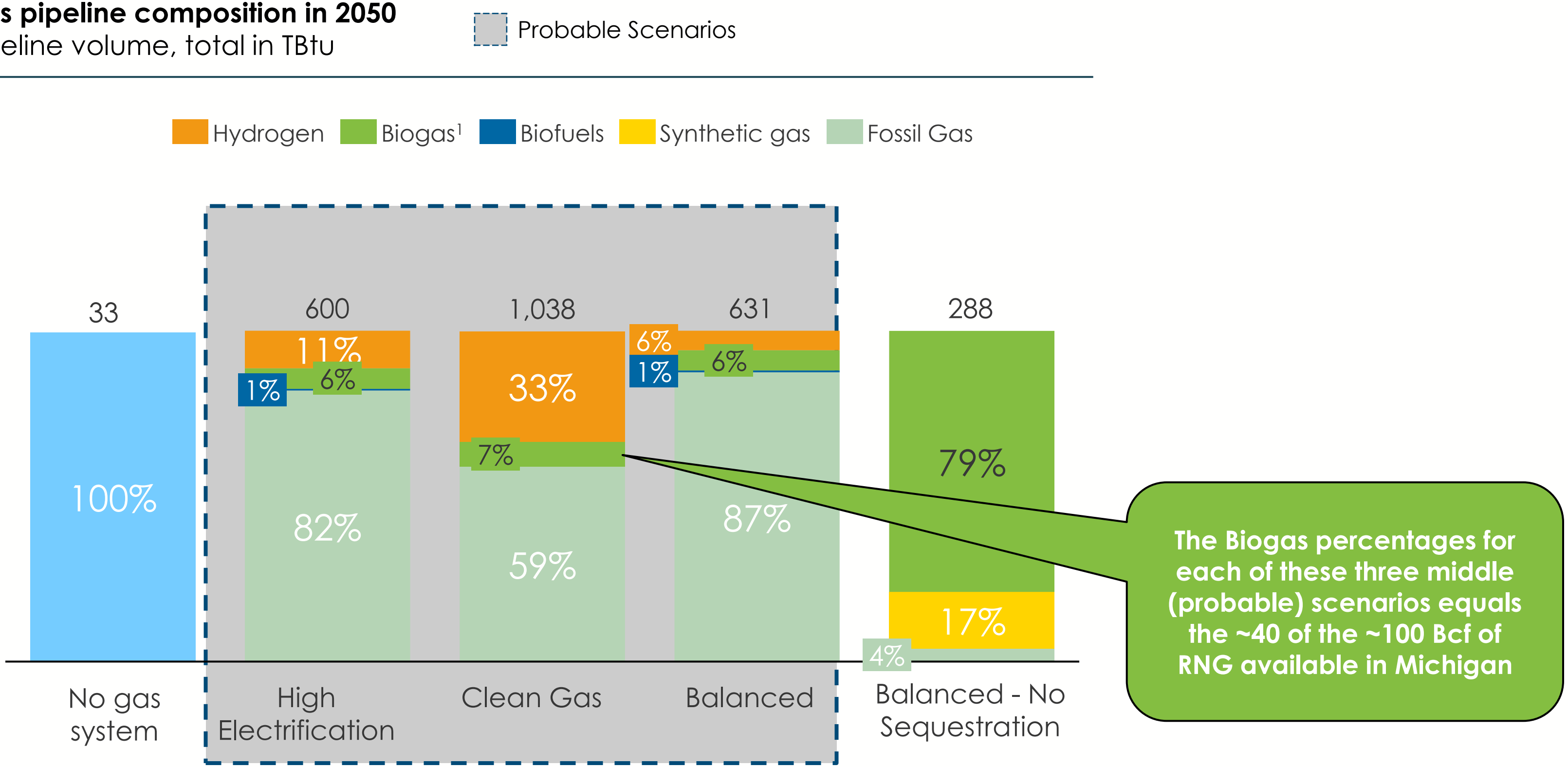
1. Gas infrastructure costs based on high-level initial assessment. Granular data on Michigan-system pipeline inventory can be used to develop more detailed analyses

Consumers Energy Count on Us

A future with no gas system is exceedingly expensive.

Michigan Energy Composition by Scenario

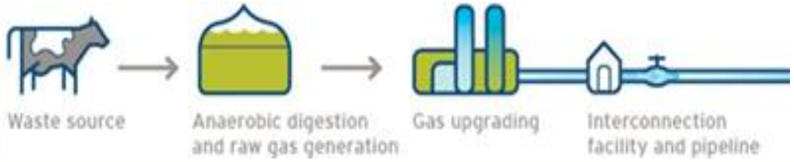
Michigan Gas pipeline composition in 2050
% of total pipeline volume, total in TBtu



Consumers Energy Count on Us

The gas system enables cost-effective decarbonization and RNG plays a key role.

RNG Process, Assets and Facility



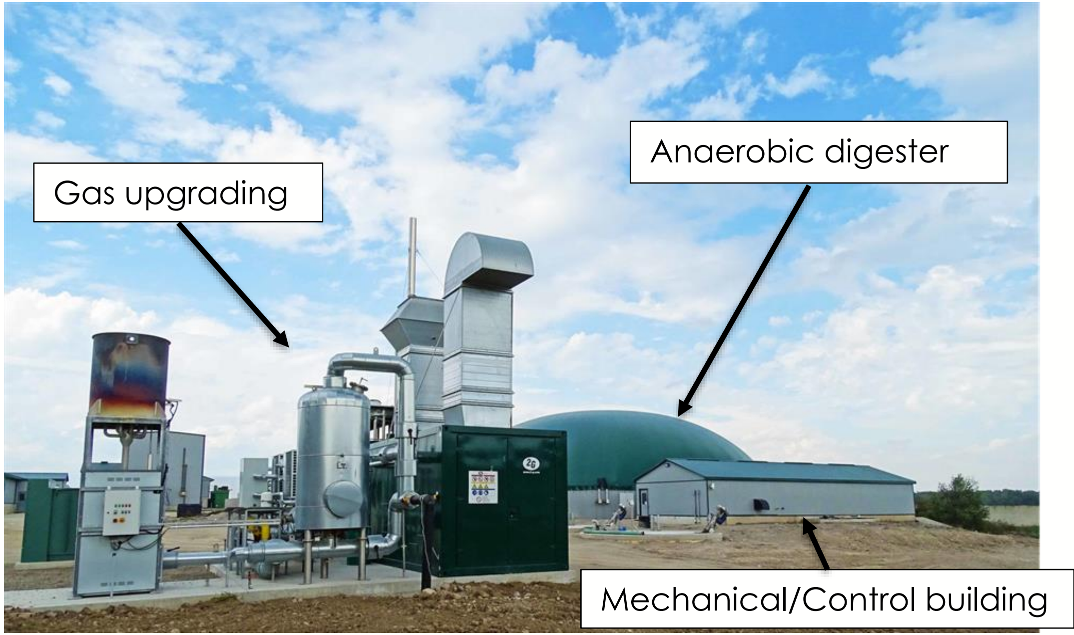
Local benefits:

1) Revenue stream to Farm owners
2) Reduced manure management operational expenses
3) Eliminated odors
4) Tax base for townships

Carbon benefits:

MMBTU Output x Emissions Abatement Factor = Carbon Abatement Potential

e.g., 50k mmbtu x -0.31 = -16k tons (~3,500 gasoline cars)



Propane to Natural Gas Economics

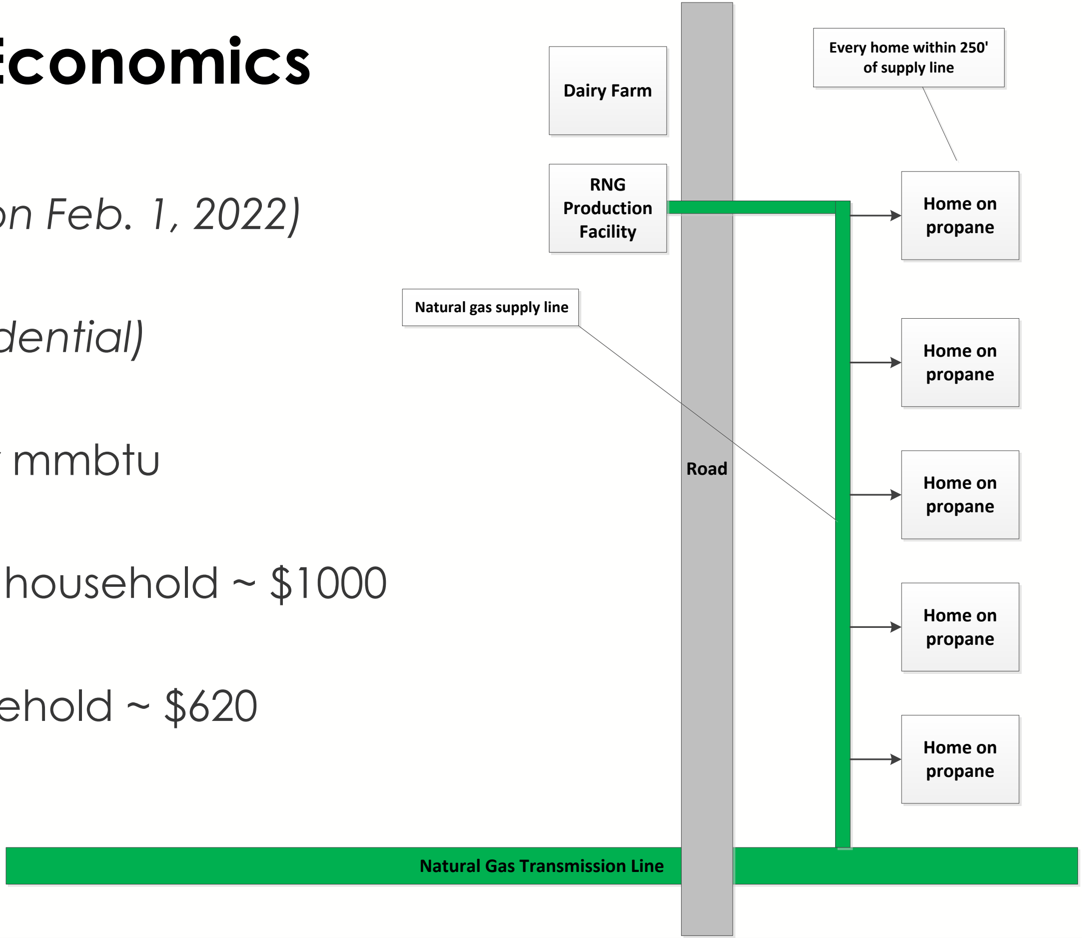
Propane ~ $14.20 per mmbtu
(Based on propane average $/gallon Feb. 1, 2022)

Natural gas ~ $8.84 per mmbtu *(residential)*

Savings per home ~ 38% savings per mmbtu

Estimated annual propane cost per household ~ $1000

Estimated natural gas cost per household ~ $620



Natural gas hookups from propane saves homeowners ~ $380/yr.

Residential Space Heating & Cooling Comparison

Cost of Energy per mmbtu

	Natural Gas	Propane	Electricity
$/mmbtu	$8.52	$27.76	$51.36

Technology Efficiency

	Efficiency
Gas furnaces - Energy Star	95%
Propane furnace - Energy Star	95%
Natural gas absorption heat pump	123%
Air source heat pump	249%
Geothermal heat pump - closed loop water to air	360%

Technology Cost

	Air Source Heat Pump	GeoThermal Heat Pump	Natural Gas Heat Pump	Propane + AC	Natural Gas + AC	Natural Gas + AC (w/ offsets)
Estimated capital	$5,631	$21,695	$13,801	$13,967	$5,951	$5,951
Estimated annual energy cost	$1,419	$2,165	$1,559	$2,315	$890	$928

Consumers Energy Count on Us

Natural Gas furnace + electric AC unit is most economic.

Many positive & direct benefits for Michigan!

Diverting Organics From Landfill and Converting Into Carbon Negative RNG

Margaret Laub

Project Development Manager, Anaergia

Margaret.Laub@anaergia.com

Anaergia

Fueling A Sustainable World

Recommendations to Support RNG Feasibility & Carbon-Neutral Goals

1. Landfill-diverted organic waste is a major feedstock for carbon-negative RNG from AD
2. Well-established AD pathway – but requires RNG pricing reflecting the value of carbon-negative RNG
   a) Lifecycle accounting methodology
   b) Align value ($/MMBTU) with 2021 Federal Interagency Working Group report social cost of methane
   c) Update landfill capture assumption to reflect latest science on fugitive emissions from landfill

Anaergia

Enabling a Zero Waste Future

Wastewater Biosolids

Source Separated Organics

Municipal Solid Waste

Food Processing Waste

Agricultural Waste

Integrated Solutions

Renewable Power

Renewable Gas

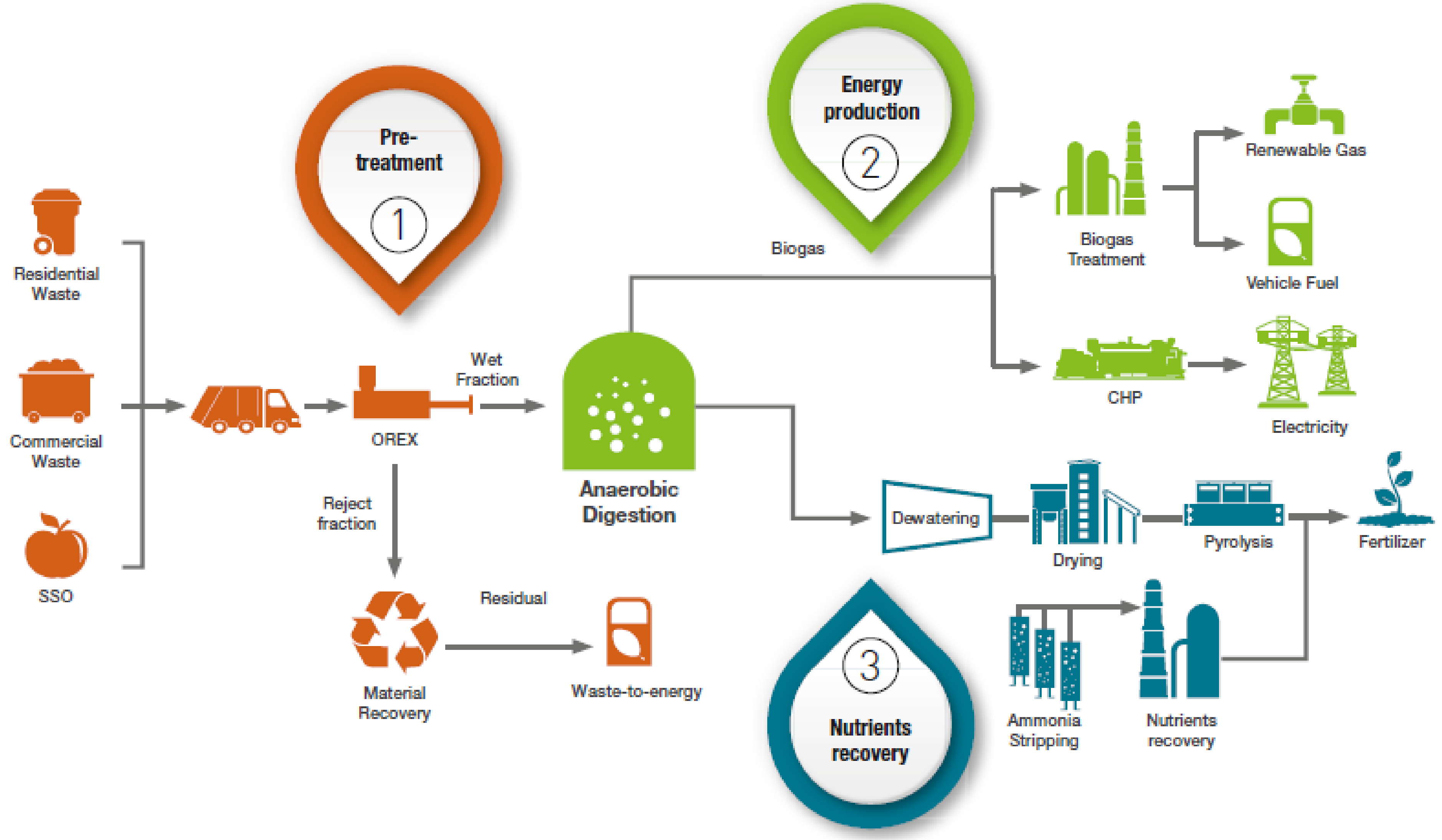
Recyclables

Fertilizer

Clean Water

Our mission is to convert waste into useful resources, protect the environment, and sustain life for generations to come.

Anaergia's Capability Across Solid Waste and Wastewater



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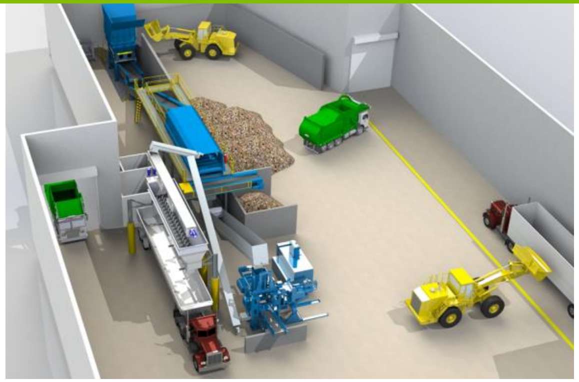
Select North American Facilities
Flexible delivery combinations of Design Build Own Operate Finance (DBOOF)

Solid Waste

SOUTH BAYSIDE WASTE MANAGEMENT AUTHORITY
SAN CARLOS, CA
DB + SERVICE

WASTE MANAGEMENT
SUN VALLEY, CA
DB + SERVICE

CITY OF TORONTO
TORONTO, CANADA
PROCESS + SUPPLY + O&M



UNIVERSAL WASTE SYSTEMS
LOS ANGELES, CA
DB + SERVICE

Wastewater

ANAERGIA
RIALTO, CA
DBOOF

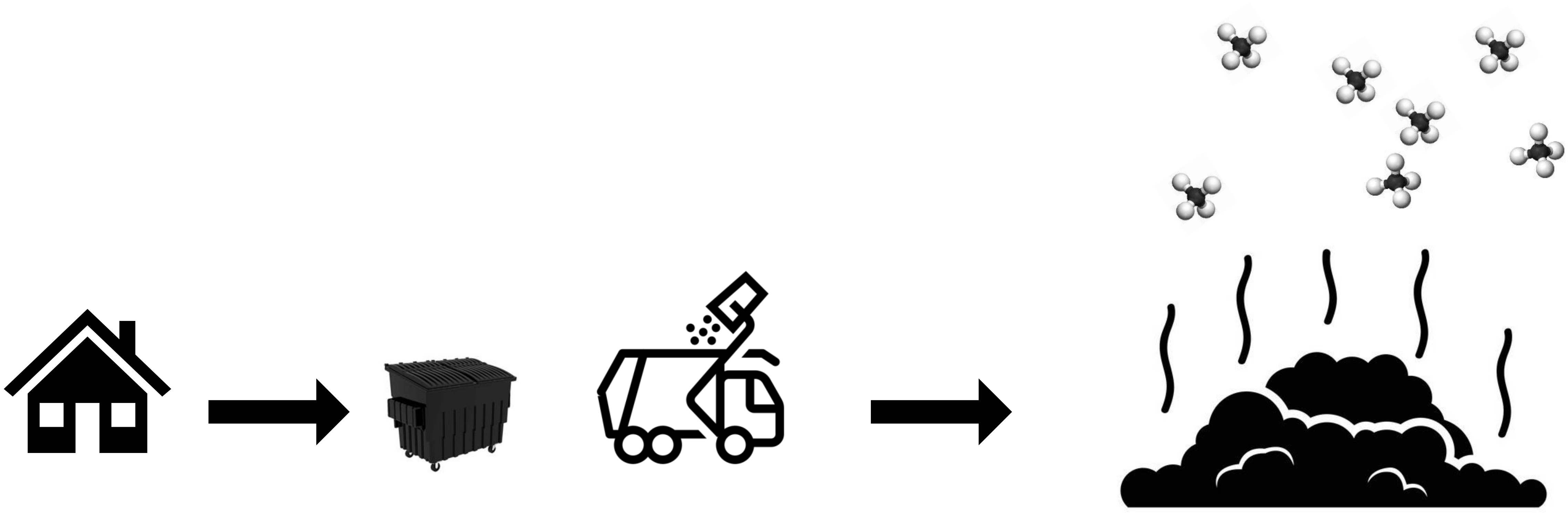
EAST VALLEY WATER DISTRICT
HIGHLAND, CA
SUPPLY

VICTOR VALLEY WATER RECLAMATION AUTHORITY
VICTORVILLE, CA
DBOOF

CAMDEN COUNTY MUNICIPAL UTILITIES AUTHORITY
CAMDEN, NJ
SUPPLY + O&M

HALE AVENUE RESOURCE RECOVERY FACILITY
ESCONDIDO, CA
DBOOF

Degradation of organics at landfill creates fugitive methane emissions



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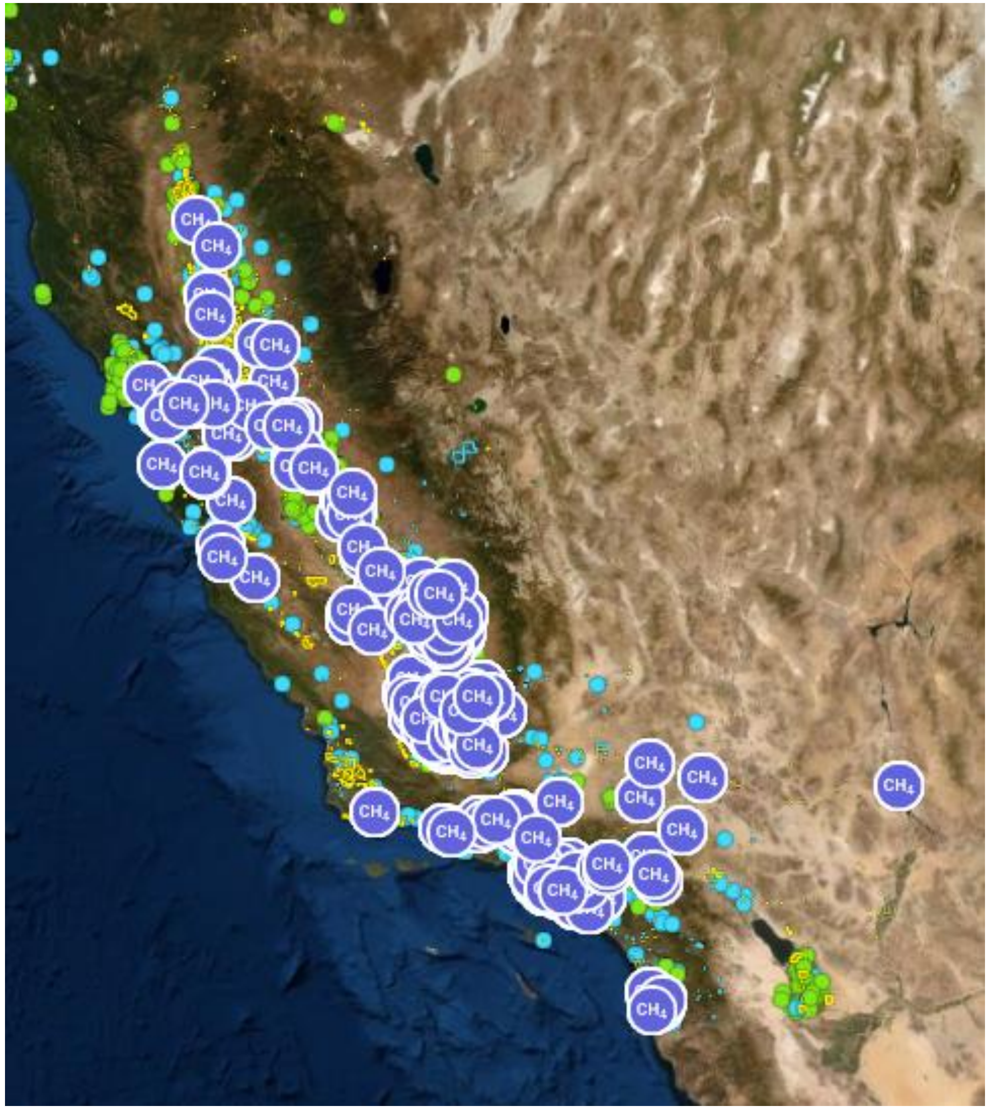
NASA JPL: Landfills are the largest source methane emissions in CA (41%)



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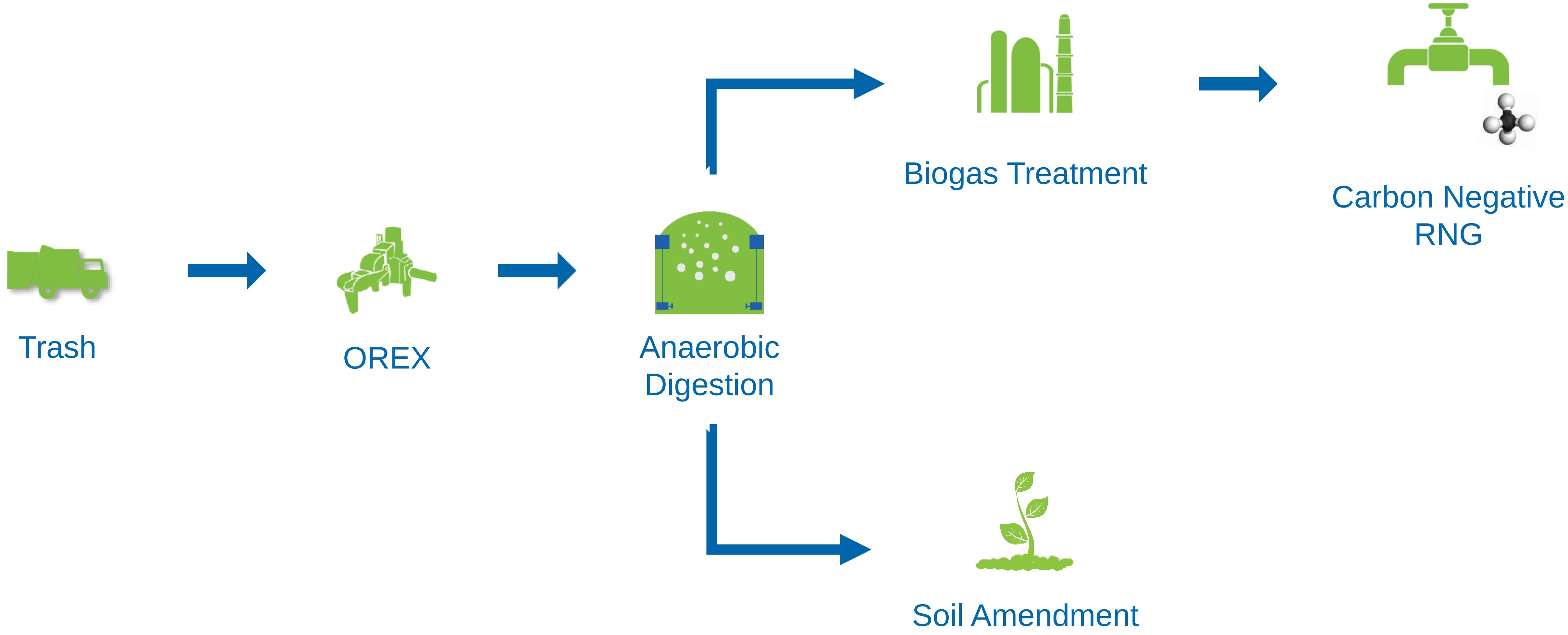
Organic Waste is Largest Fraction of Landfilled Municipal Solid Waste (MSW)

Anaergia

Anaergia's solutions divert organics from landfill, prevent fugitive methane emissions, and produce carbon negative RNG



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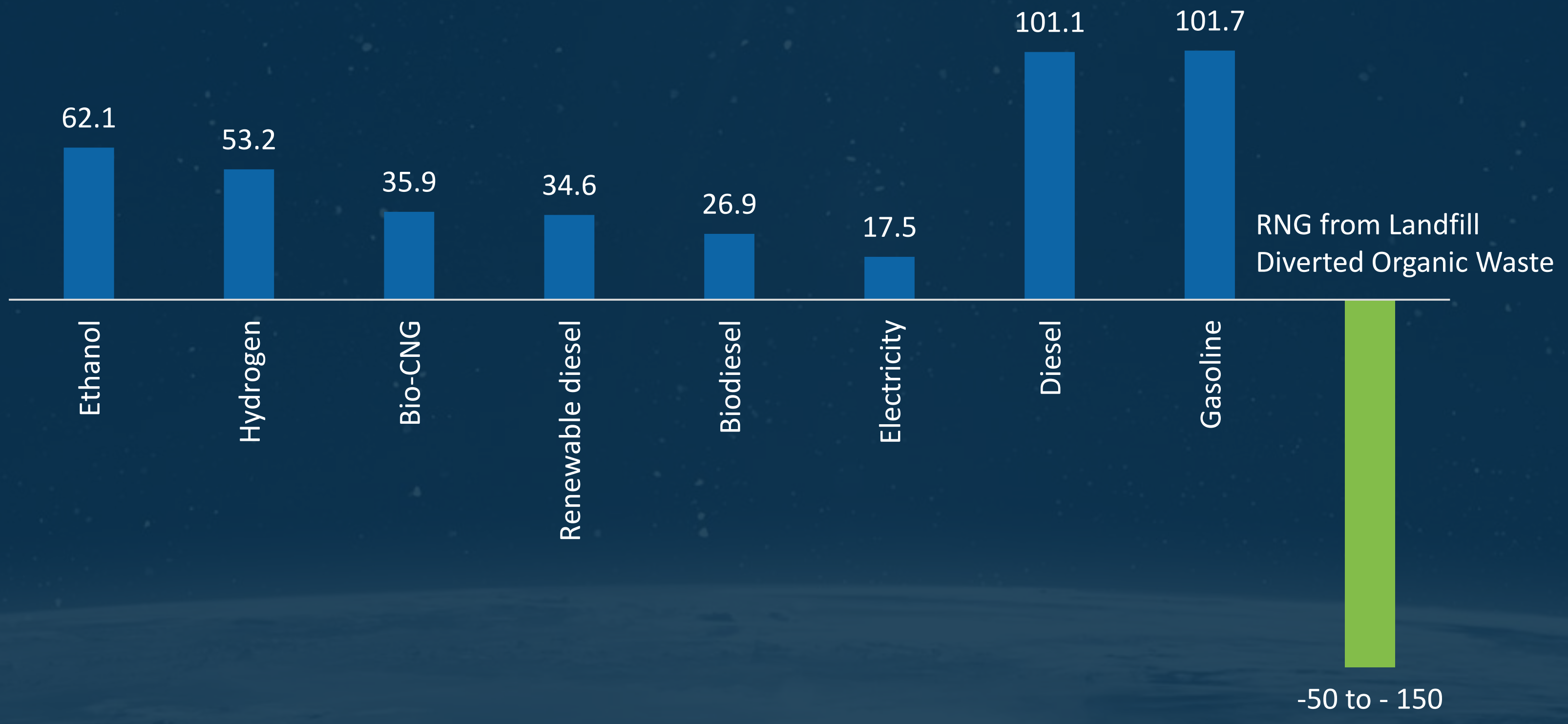
Renewable Natural Gas –

The Only Carbon Negative Fuel & Key Tool in Achieving Carbon Neutrality

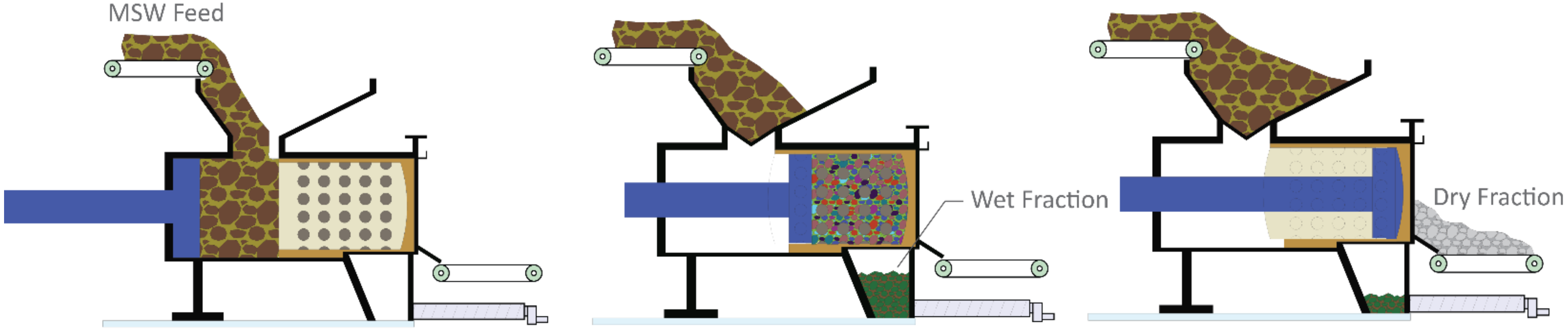
Weighted Average Carbon Intensity of Competing Transportation Fuels in 2019 (gCO_2e/MJ)[1]



Converting methane-emitting waste into renewable natural gas produces a carbon negative fuel to achieve emissions goals

1) California Air Resources Board

Organics Extrusion Press (OREX) Separates Organics from Municipal Solid Waste (MSW) to Produce Renewable Energy and Fertilizer with AD



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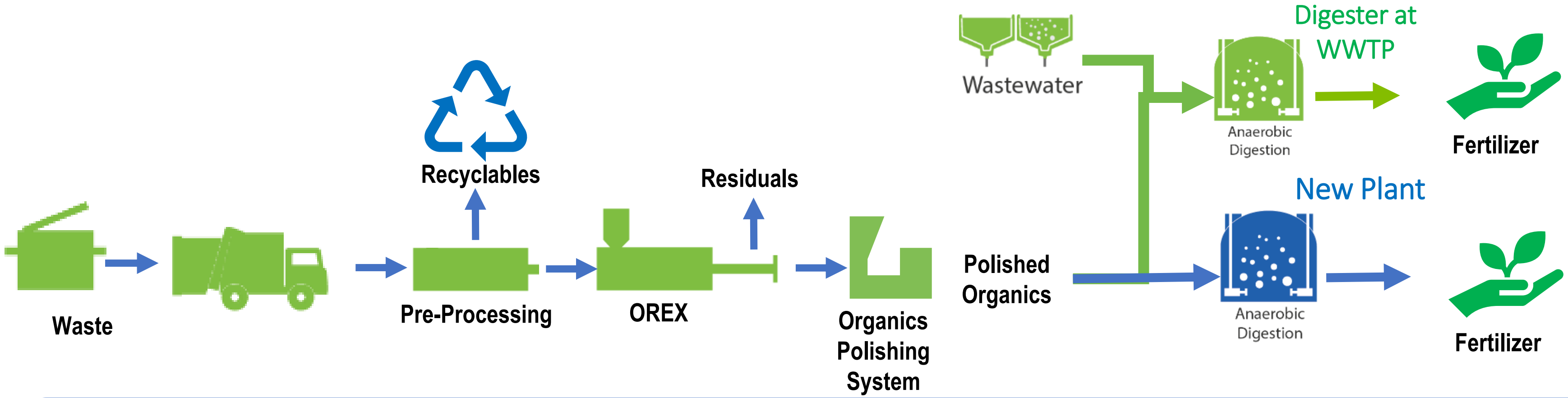
OREX + Organics Polishing System (OPS) Generates Digestible Slurry

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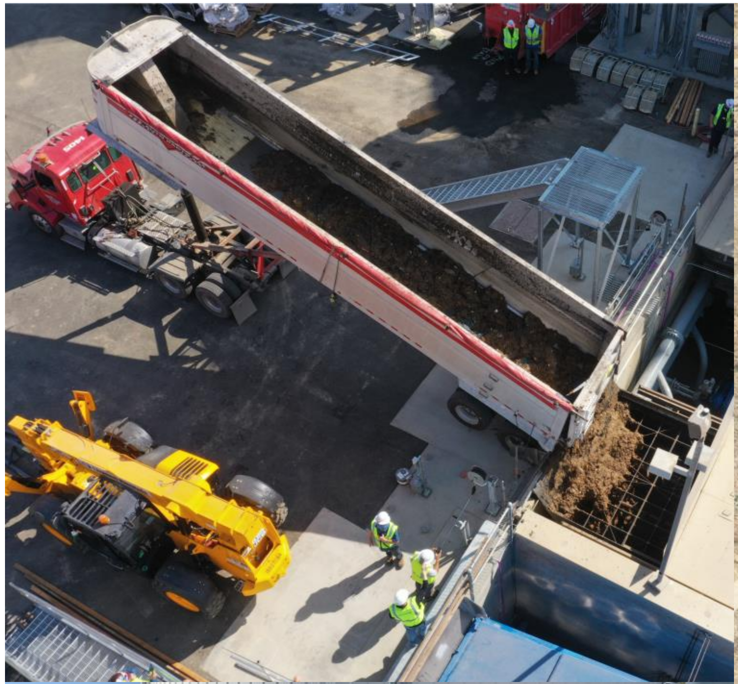
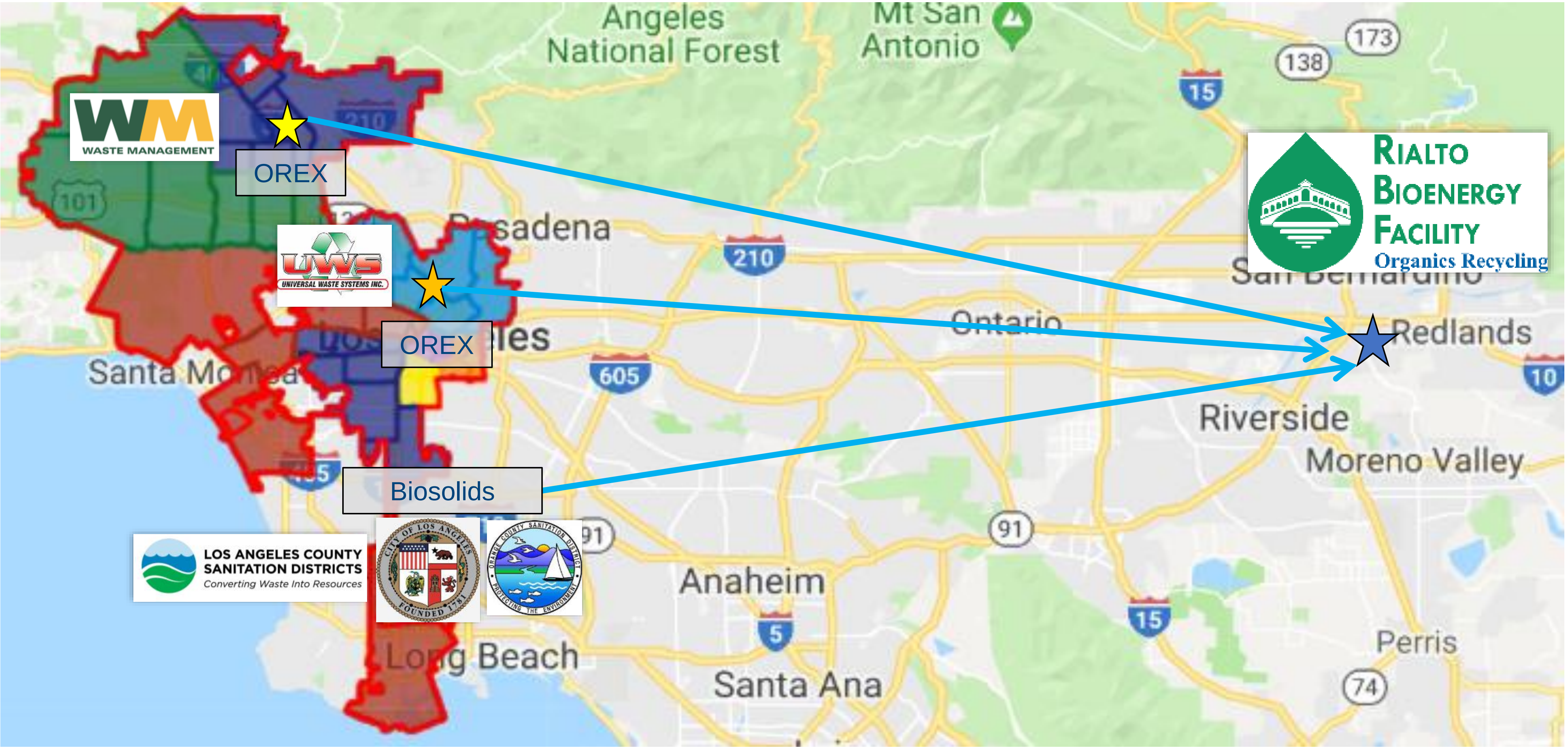
Rialto Bioenergy Facility:
Largest Organic Waste to RNG Digester Facility in North America



Anaergia

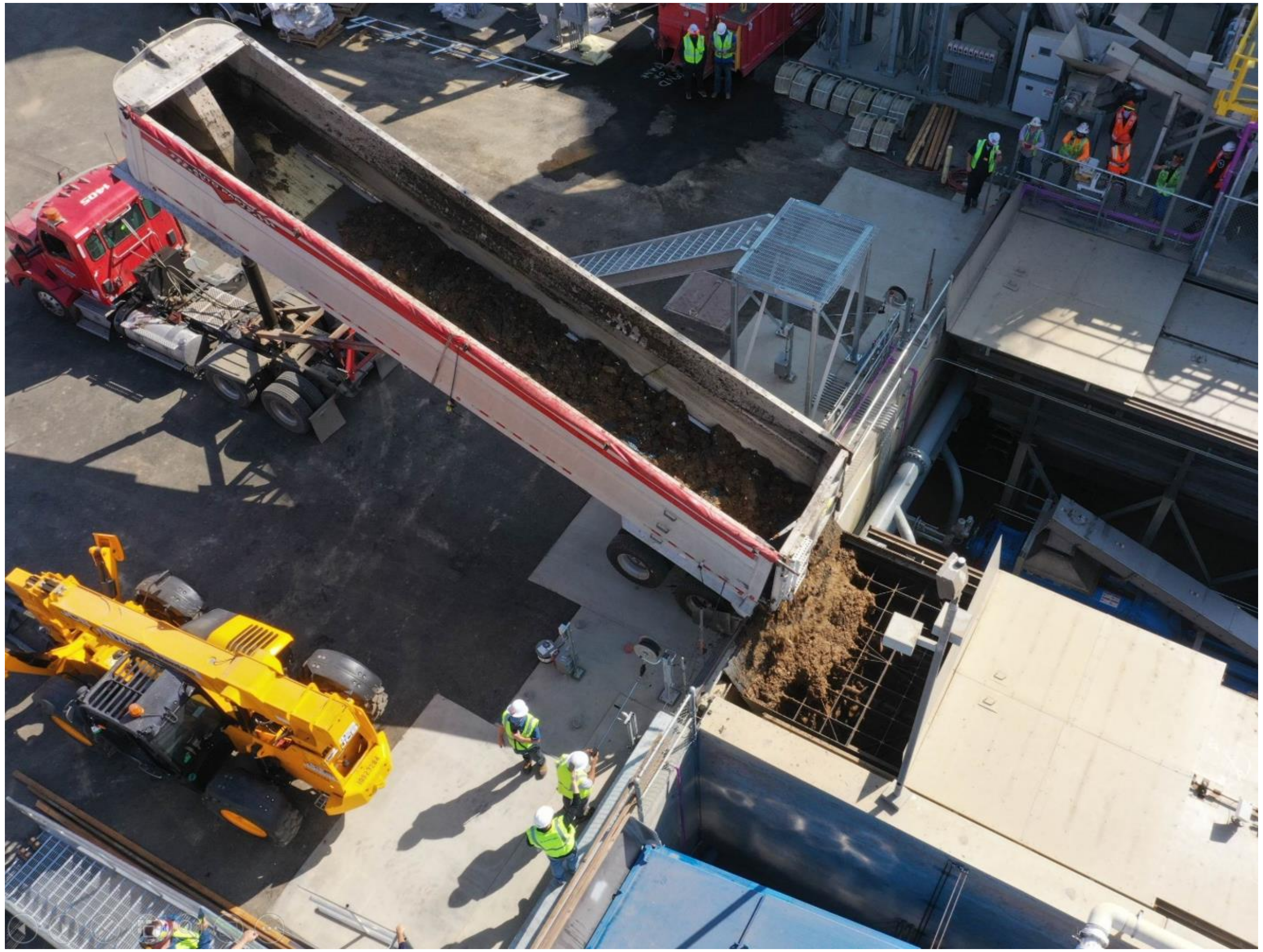
- Design capacity of 1,000 TPD
- Reducing GHG emissions by >50,000 MTCO2e annually

Anaergia Rialto Bioenergy Facility AD Processes Landfill Diverted Organics



Anaergia OREX Line at WM Sun Valley MRF (Sun Valley, CA)

OREX Recovers Organics from MSW for AD at Dedicated Facilities & WRRF



Organic fraction being delivered to Rialto Bioenergy Facility

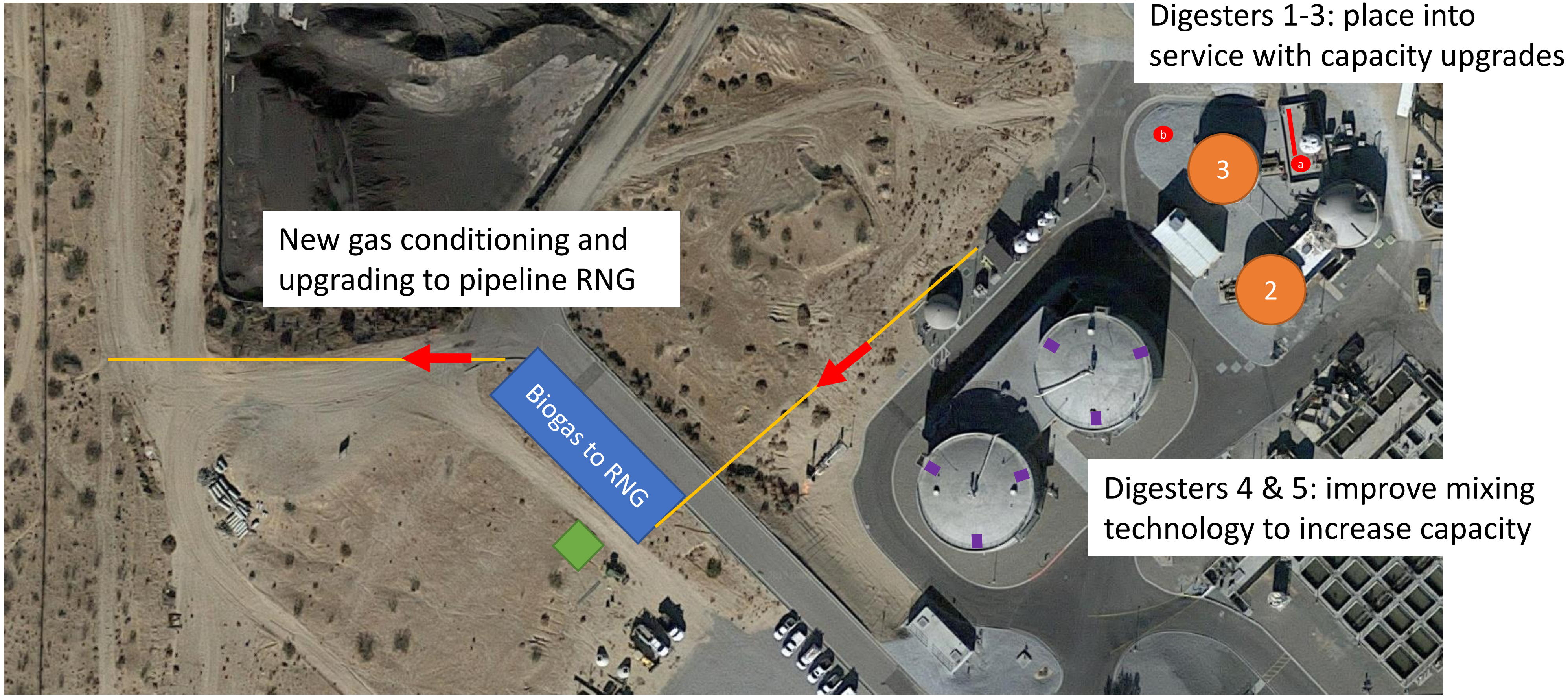
Anaergia

Victor Valley Wastewater Reclamation Authority: Enhancing WRRF RNG with Landfill-Diverted Organics

- Founded in 1978
- Serves 279 square mile area
- Treats 12 MGD

Anaergia

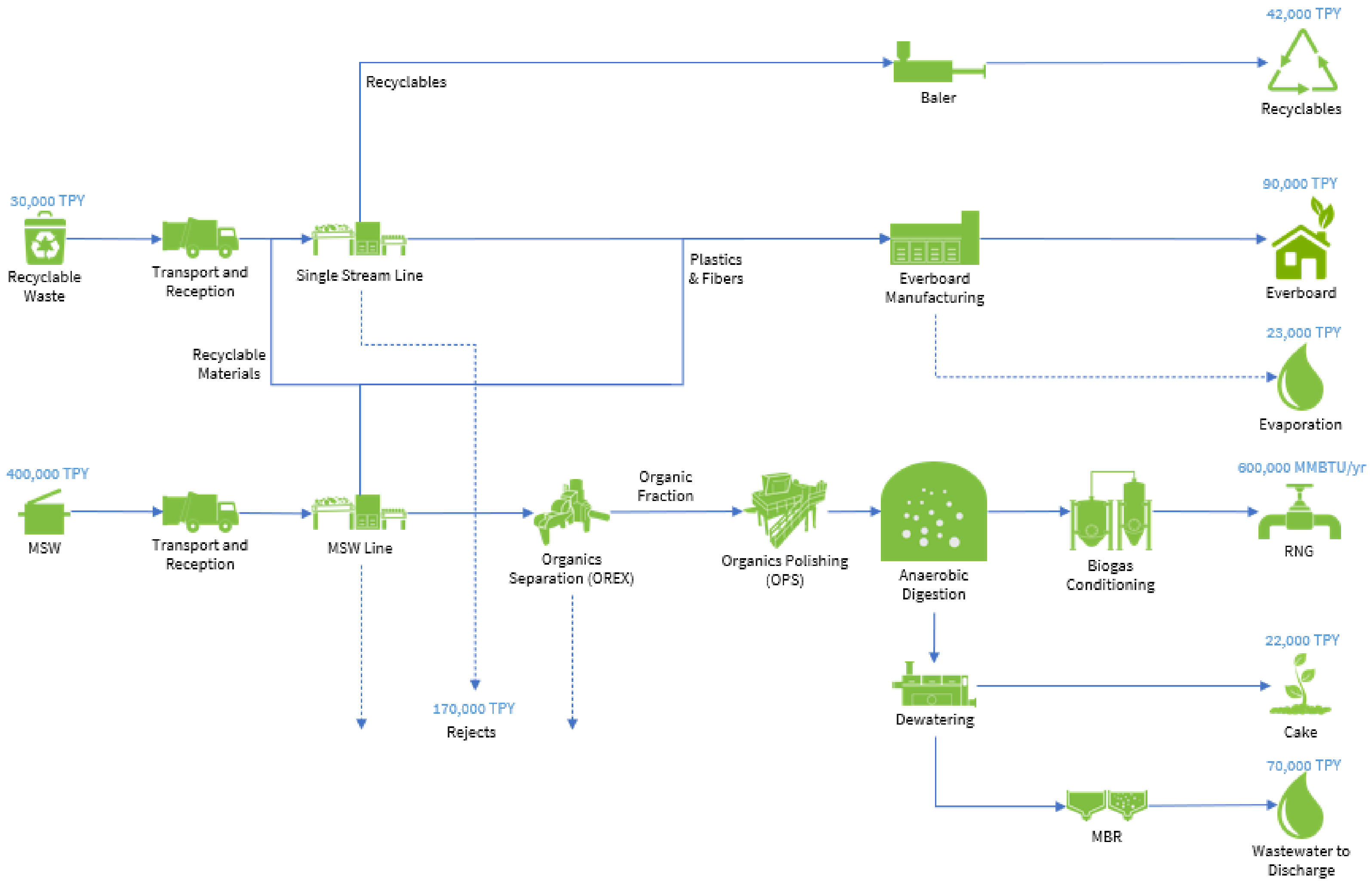
P3 to Co-Digest Landfill Diverted Organics at WRRF



P3 infrastructure increases digester capacity and generates revenue to fund future CIP needs

Anaergia

Kent County, MI Sustainable Business Park



Anaergia

Lifecycle Accounting Methodology: Carbon Intensity of biomethane facilities should be considered, and evaluated using CA-GREET 3.0 as basis

CALIFORNIA AIR RESOURCES BOARD

Summary of the Tier 1 Simplified CI Calculator for Biomethane from Anaerobic Digestion of Organic Waste
Release date: August 13, 2018 (corrected)

Applicant:		Digester Location:	
Application Number			

Digester Gas Production Electricity Mix	3-CAMX Mix
Digester Gas Production	
Biogas Production	
Raw Inlet Gas as Feedstock, SCF at 60°F	0
Average Methane Content, % CH_4	0
Biogas Processing	
Natural Gas, HHV in MMBtu	0
Electricity, kWh	0
Biomethane Production	
Biomethane, HHV MMBtu	0
Natural Gas Transport	
NG Transport Electricity Mix	1-U.S. Ave Mix
Pipeline Distance to Centroid of CNG stations, miles	0
Pipeline Distance to LNG facility, miles	0

Fuel Production Electricity Mix	See below for each fuel
Fuel Production	
Compressed Natural Gas (CNG) Production	
CNG Production Electricity Mix	3-CAMX Mix
Liquefied Natural Gas (LNG) Production	
Liquefaction Facility Location	0
LNG Production Electricity Mix	3-CAMX Mix
Total LNG production, gallons	0
Total Natural Gas Purchase, HHV in MMBtu	0
Electricity, kWh	0
LNG Transport	
Truck, miles	0

Pathway Descriptions and Results

Finished Fuels	Carbon Intensity from Inputs (gCO_2e/MJ)	Optional Headroom Carbon Intensity (gCO2e/MJ)	Total Carbon Intensity (gCO2e/MJ)
Compressed Natural Gas (CNG)	0.00	0.00	0.00
Pathway Description: RNG produced from anaerobic digestion of organic waste, processed in , pipelined to California for Compressed Natural Gas (CNG) dispensing.			
Liquefied Natural Gas (LNG)	0.00	0.00	0.00
Pathway Description: RNG produced from anaerobic digestion of organic waste, processed in , pipelined to California for liquefaction, then transported and distributed by truck to California LNG stations.			
Liquefied CNG (or L-CNG)	0.00	0.00	0.00
Pathway Description: RNG produced from anaerobic digestion of organic waste, processed in , pipelined to California for liquefaction, then transported by truck to California LNG stations, re-gasified and compresses to Liquefied CNG.			

CARB Tier 1 Simplified CI Calculator for Biomethane from Anaerobic Digestion of Organic Waste could serve as model for CI determination

Anaergia

Lifecycle accounting method should incorporate latest data on methane emissions at landfills to update the landfill capture rate

Article

California's methane super-emitters

https://doi.org/10.1038/s41586-019-1720-3

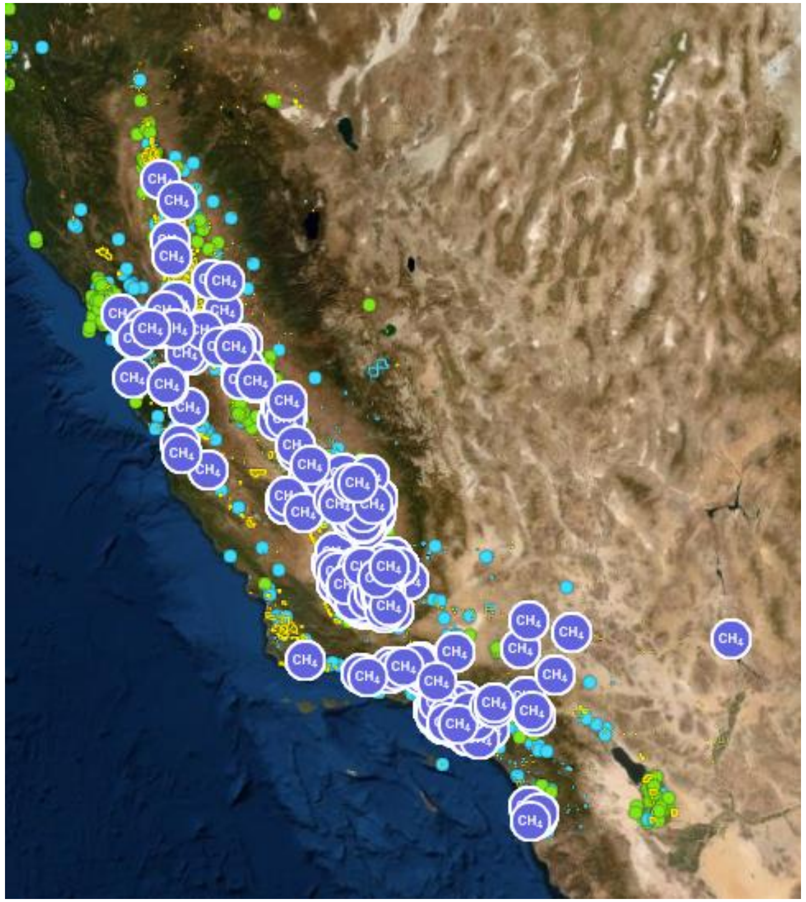
Received: 5 December 2018

Accepted: 20 August 2019

Published online: 6 November 2019

Riley M. Duren[1,2*], Andrew K. Thorpe[1], Kelsey T. Foster[1], Talha Rafiq[3], Francesca M. Hopkins[3], Vineet Yadav[1], Brian D. Bue[1], David R. Thompson[1], Stephen Conley[4], Nadia K. Colombi[5], Christian Frankenberg[1,6], Ian B. McCubbin[1], Michael L. Eastwood[1], Matthias Falk[7], Jorn D. Herner[7], Bart E. Croes[7], Robert O. Green[1] & Charles E. Miller[1]

Methane is a powerful greenhouse gas and is targeted for emissions mitigation by the US state of California and other jurisdictions worldwide[1,2]. Unique opportunities for mitigation are presented by point-source emitters—surface features or infrastructure components that are typically less than 10 metres in diameter and emit plumes of highly concentrated methane[3]. However, data on point-source emissions are sparse and typically lack sufficient spatial and temporal resolution to guide their mitigation and to accurately assess their magnitude[4]. Here we survey more than 272,000 infrastructure elements in California using an airborne imaging spectrometer that can rapidly map methane plumes[5–7]. We conduct five campaigns over several months from 2016 to 2018, spanning the oil and gas, manure-management and waste-management sectors, resulting in the detection, geolocation and quantification of emissions from 564 strong methane point sources. Our remote sensing approach enables the rapid and repeated assessment of large areas at high spatial resolution for a poorly characterized population of methane emitters that often appear intermittently and stochastically. We estimate net methane point-source emissions in California to be 0.618 teragrams per year (95 per cent confidence interval 0.523–0.725), equivalent to 34–46 per cent of the state's methane inventory[8] for 2016. Methane 'super-emitter' activity occurs in every sector surveyed, with 10 per cent of point sources contributing roughly 60 per cent of point-source emissions—consistent with a study of the US Four Corners region that had a different sectoral mix[9]. The largest methane emitters in California are a subset of landfills, which exhibit persistent anomalous activity. Methane point-source emissions in California are dominated by landfills (41 per cent), followed by dairies (26 per cent) and the oil and gas sector (26 per cent). Our data have enabled the identification of the 0.2 per cent of California's infrastructure that is responsible for these emissions. Sharing these data with collaborating infrastructure operators has led to the mitigation of anomalous methane-emission activity[10].



Recommend updating landfill capture rate from 75% to **34%** to reflect latest direct measurement studies

Anaergia

Price of biomethane ($/MMBTU) from landfill diverted organics should be aligned with social cost of methane

- Strongly support use of 2021 Federal Interagency Working Group (IWG) estimate of the social cost of methane
- Encourage updating the social cost of methane to match 2021 IWG report
- Urge consideration of carbon negative biomethane projects when evaluating social cost and pricing

Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide
Interim Estimates under Executive Order 13990

Interagency Working Group on Social Cost of Greenhouse Gases, United States Government

Table ES-2: Social Cost of CH_4, 2020 – 2050 (in 2020 dollars per metric ton of CH_4)

	Discount Rate and Statistic			
Emissions Year	5% Average	3% Average	2.5% Average	3% 95th Percentile
2020	670	1500	2000	3900
2025	800	1700	2200	4500
2030	940	2000	2500	5200
2035	1100	2200	2800	6000
2040	1300	2500	3100	6700
2045	1500	2800	3500	7500
2050	1700	3100	3800	8200

Anaergia

Thank You

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Anaergia

Fueling A Sustainable World

The Case Against Using CAFO Manure as RNG Feedstock

Public Health & Environmental Risks

Socioeconomic & Environmental Justice Impacts

Subsidies & Environmental Commodities: The Black Gold Rush

MPSC presentation (April 20, 2022)

Cheryl A. Ruble, MD

CAFO: Concentrated Animal Feeding Operation
RNG: Renewable Natural Gas

CAFO-ASSOCIATED PUBLIC HEALTH & ENVIRONMENTAL RISKS: MORE THAN METHANE

Anaerobic digestion effects (assuming no CAFO expansions/new constructions)

GREEN: MITIGATE BUT NOT ELIMINATE

RED: COULD WORSEN

1. **INFECTIOUS DISEASES**
   a) Pathogens
      - **Recreational water illnesses**
      - **Foodborne illnesses ("food poisoning")**
      - Zoonoses (direct contact, workers)
      - Pandemic potential: Influenza A and coronaviruses

   b) Antibiotic resistance: Emergence and spread
2. **CONTAMINATION OF DRINKING WATER SOURCES (private drinking water wells not protected by the SDWA*)**
   a) **Nitrate-nitrogen: Methemoglobinemia ("blue baby syndrome"), pregnancy complications, cancer (colorectal and others)**

   b) **Pathogens**
3. **NUTRIENT WATER POLLUTION (nitrogen and phosphorus)**
   a) **Harmful algal blooms (HAB) – cyanotoxins**
      - Microcystin: Hepatoxic (humans & animals)
      - BMAA: Linked to human neurodegenerative diseases

   b) **Eutrophication: Aquatic plant and animal life (dead zones, fish kills)**
4. **HARMFUL AIR EMISSIONS**
   a) Directly harmful to humans
      - Workers: (OSHA exempt ≤ 10 employees)
        - **Toxic emissions: Ammonia (NH4)**, hydrogen sulfide (H2S), others
      - Neighbors/local communities
        - **Odor:** H2S, NH4, volatile organic compounds (VOCs)
        - Respiratory tract irritants: H2S, NH4, others
        - Particulate matter (PM) pollution, incl. PM2.5 & bioaerosols (adsorbed pathogens & endotoxin)

   b) Harmful to **planet** earth
      - Climate change/GHG: **Methane (CH4)**, **nitrous oxide (N2O)**, carbon dioxide (CO2)
      - Ozone-depletion: N2O
      - Water pollution: Nitrogen deposition

*Safe Drinking Water Act

Anaerobic digestion is **not** a means of CAFO waste disposal

- Digestate nutrient (nitrogen & phosphorus) concentrations remain about the same.
- Most digestate will be land-applied locally as fertilizer.
- Digestate nutrients are more water-soluble and therefore more likely to move with water, increasing the risk of leaching into groundwater and runoff to surface waters.

"Land application of digester effluent, compared with fresh manure, may have a higher risk for both ground and surface water quality problems. Compounds such as nitrogen, phosphorus and other elements become more soluble due to anaerobic digestion and therefore have higher potential to move with water."

US EPA NRCS Code 366: Anaerobic Digester

Misinformation: A Concerning Example

Astonishingly, Michigan's Adaptive Management Plan for Lake Erie to combat harmful algal blooms includes on-farm anaerobic digesters, promoting the misconception that anaerobic digestion will reduce nutrient runoff, when in fact, the opposite is more likely true.

Anaerobic digesters provide a source of renewable energy while reducing nutrient run-off from current land application of manure.

Michigan DAP Adaptive Management Plan Draft, v.6.3, 25 Feb 2020

CAFO-ASSOCIATED PUBLIC HEALTH & ENVIRONMENTAL RISKS: MORE THAN METHANE

RNG-INCENTIVIZED CAFO EXPANSIONS/NEW CONSTRUCTIONS → RISK AMPLIFICATION

Generally, there are no CAFO size or density restrictions—even in impaired watersheds

1. **INFECTIOUS DISEASES**
   a) Pathogens
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      - Climate change/GHG: Methane (CH4), nitrous oxide (N2O), carbon dioxide (CO2)
      - Ozone-depletion: N2O
      - Water pollution: Nitrogen deposition

*Safe Drinking Water Act

The push for manure biogas could **increase** GHG emissions

- **ENTERIC FERMENTATION**
  - Ruminants – mostly dairy & beef cattle (cow burps)
  - **MORE COWS = MORE METHANE:** For every 1 part CH4 captured from cow CAFO waste storage structures, another 3 parts are released into the air from EF
- **LAND USE CHANGES (LUC) & INCREASED FERTILIZER USE**
  - LUC: Conversion, sequential cropping, less cropland abandonment. LUC GHG not outweighed by gains in feed crop production efficiency.
  - **MORE LIVESTOCK = MORE FEED CROPS = MORE CO2 (LUC) & N02 (FERTILIZER)**
- **DIGESTATE STORAGE & LAND-APPLICATION**
  - **DIGESTATE NITROUS OXIDE (NO2) & TOXIC AMMONIA EMISSIONS MIGHT INCREASE**, depending on how it is managed[1]

*NO2 is a much more potent GHG than methane and depletes the ozone

[1] Holly, M. A., et al. (2017) *Agriculture, Ecosystems and Environment*, 239

Financial incentives for CAFOs & CAFO anaerobic digester projects

TAXPAYER-FUNDED

Environmental commodities (lucrative market value) generated by RNG production

- **Federal**
  - **Transportation sector: Renewable Fuel Standard (RFS) → Renewable Identification Numbers (RINs)** → helps gasoline and diesel refiners/importers meet **Renewable Volume Obligations (RVOs)**
- **State**
  - **Electricity sector: Renewable Energy Certificates (RECs)** → helps utilities meet **Renewable Portfolio Standards (RPS)**
  - **Transportation sector: California's Low Carbon Fuel Standard (LCFS)**, effective 2011, → **LCFS Credits**. Oregon (2016) and Washington (May 2016) have adopted and many other states, including Michigan are considering adopting similar programs.

Other resources

- Tax credits/abatements
- Grants (state & federal)
- Guaranteed loans
- Ratepayer hikes to support CAFO manure-based RNG production
- Programs promoting CAFO manure-derived biomethane production (financial and logistical/technical support):
  - USDA/NRCS Environmental Quality Incentives Program (EQIP)
  - USDA Rural Energy for America Program (REAP)
  - Build Back Better Act
  - U.S. Methane Emissions Reduction Action Plan
  - EPA AgSTAR program
  - USDA Partnerships for Climate-Smart Commodities

PRIVATE EQUITY INVESTMENT

Investors capitalize on and ultimately reap the benefits of taxpayer-funded sources.

Just how lucrative is California's LCFS?

Professor Smith's California math:

One dairy cow generates ~22.5 MMBTU gas/year worth $68

It costs $294 to get $68 worth of gas from a dairy cow's manure.

Factor in LCFS subsidy: $12 per diesel-gallon equivalent = $86/MMBTU

One dairy cow generates a total LCFS subsidy of $1,935/year

5000 dairy cows = ~$10,000,000/year

This fact should make us pause. The large subsidy is designed to prevent methane emissions that would have happened otherwise. ***But, what if the farmer adds cows because of the subsidy? Then we are no longer paying to reduce emissions.***

"I had heard people saying this was kind of a big deal, and I sort of put off looking into it for a while, because I was thinking, 'How big of a deal could it really be?'" he says.

When he calculated the potential revenue from emissions credits, "I was stunned," he says.

Aaron Smith, PhD
Professor of Agricultural Economics at UC Davis
NPR interview (Feb 10,2022)

The combination of policy (Senate Bill 1383, requiring reductions in short-lived climate pollutants) and regulatory incentives (both federal and state) have driving the recent inflection in RNG growth. ***In our view, RNG producers are not in the business of producing RNG; they are in the business of monetizing RNG's environmental benefits through various federal and state programs.***

Energy & Power – Biofuels: Renewable Natural Gas
A game-changer in the race for net-zero
Stifel Equity Research (March 8, 2021)
(RNG industry report geared toward investors)

Some headlines to further prove my point

- *California's Green-Energy Subsidies Spur a Gold Rush in Cow Manure* (Wall Street Journal, Feb 19, 2022)
- *U.S. Gain* Brings More Dairy-Based RNG to California* (U.S. Gain website, May 5, 2020)
- *California clean fuel standard sparks Midwest RNG boom* (Energy News Network, May 13, 2021)
- Energy revenue could be a game-changer for dairy farms (Hoard's Dairyman, Sept 23, 2021)

*Businesses like U.S. Gain contract with energy companies to "offtake" (transport and distribute) RNG produced outside of California for a slice of the environmental commodity pie, further testament to the value of LCFS Credits.

Mounting evidence:
Environmental commodities (ECs) are incentivizing CAFOs

- Dairy biogas: Lowest carbon intensity scores → Highest CARB (California Air Resources Board) LSCF subsidies. Swine biogas CI scores also favorable.
- Economy of scale:
  - The more manure the better
  - *Prioritize larger facilities to the extent feasible* (ICF PowerPoint Presentation, Stakeholder Meeting #1, Jan 10, 2022)
- Specific examples of dairy CAFO expansions
  - Wisconsin: 15 dairy CAFOs with ADs have expanded 52,131 animals since registering for California LCFS Credits.
  - Iowa: *Nine Iowa dairies get digester permits since new law, seven plan expansion* (The Gazette, Dec 3, 2021)
  - Michigan: Brightmark Energy (Castor Project): One of three involved dairy CAFOs expanded (nearly doubled the number of cows) soon after AD construction).

Commercial manure biogas P & D: Poised for takeoff in Michigan

Michigan manure CAFO AD projects partnerships with energy companies:

- Public utilities:*
  - Consumers Energy: Dairy CAFO (Kent County)
- Private energy companies:
  - Brightmark Energy (Castor Project): 3 dairy CAFOs (Muskegon & Ottawa Counties). One of the CAFOs expanded (nearly doubled the number of cows) soon after AD construction).
  - SJI and REV LNG: 4 Thumb Area dairy CAFOs

Michigan is attractive to the CAFO industry: Strong RTF Act, abundant water resources, new pork & diary processing plants, Clean Fuels Standard program under consideration

*DTE Energy has not yet partnered with any Michigan CAFOs but has invested in 10 out-of-state dairy CAFOs (WI x8, NY x1, SD x1). The company is benefitting from California's LCFS (offtake agreements).

Adverse Socioeconomic Impacts & Environmental Injustice

- Decline in residential property values.
- Non-market value: Negative impact on local economies related to tourism, fishing, and water recreation.
- Cost externalization. Corporations and integrators reap the lion's share of the profits. CAFO contract farmers own the debt and the waste. Neighbors/local communities suffer the pollution and economic losses.
- Right to Farm laws: Preempt local zoning ordinances. Consequently, communities have little to no say. Generally, there are no CAFO size or density restrictions, let along moratoriums, even in impaired watersheds.
- **Environmental injustice: CAFOs are disproportionately clustered in disadvantaged rural communities**

Other CAFO manure biogas concerns

- **Gas infrastructure investments:** Transport of biogas to upgrading facilities & biomethane to the natural gas grid.
- **Methane leakage:** Anywhere along the path from pit to pump. "*Anticipated leakage is climatically significant: literature estimates for methane leakage from biogas production and upgrading facilities suggest that leakage is in the 2%–4% range (mass basis), up to as much as 15%.*"[1]
- **Safety concerns:**[2]
  - *A very high level of management is required. A methane digester can be extremely sensitive to environmental changes, and a biological upset may take months to correct.*
  - *Methane is difficult to store, since at normal temperatures the gas can be compressed but not liquefied without special, very expensive equipment.*
  - *Methane can form an explosive mixture if exposed to air.*

[1] Grubert, E., et al. (Aug 11, 2020): Environmental Research Letters, 15 (8)
[2] Purdue University Cooperative Extension Service (AE-105)

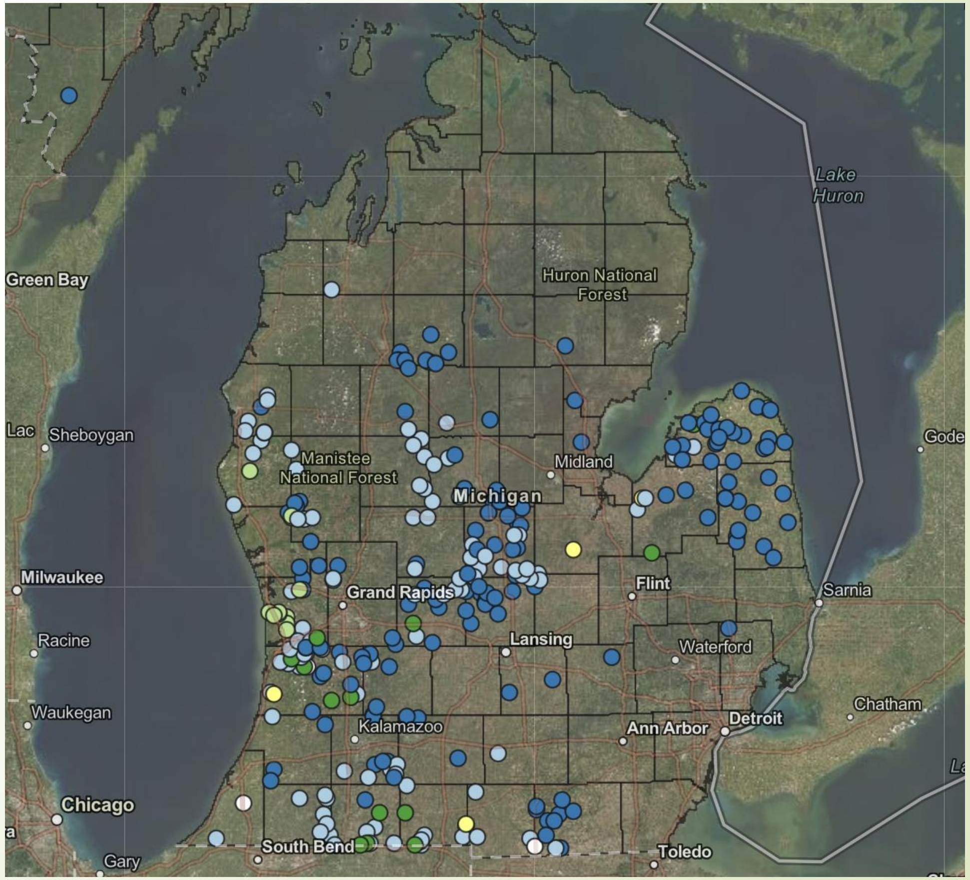
"The Gas isn't Always Greener"

Prioritize public health, clean air and water, and environmental justice

Conclusions:

- **Call for independent formal Health & Environmental Impact Statements**
- The ICF RNG study does not address the **other harms** associated with CAFOs besides CH4 emissions from stored manure.
- GHG emissions LCA methodology for manure biogas does not account for **increased GHG emissions from inevitable CAFO expansions & new constructions spurred by lucrative ECs.**
- **Do not sanction CAFO manure as RNG feedstock or approve ratepayer support.**
- **Explore alternative RNG feedstocks & alternatives to RNG.**

Current MI CAFO map: 300 +



RNG Inventory Workshop Stakeholder Comments

Presented by Strategen Consulting and Energy Futures Group on behalf of NRDC

April 20, 2022

Discussion Agenda

1. Analysis of Electrification and Alternatives
2. Inputs, Assumptions, and Methodology
3. Cost and Benefit Analysis
4. The GREET Model
5. Competing Uses and Attribute Double-Counting

No Assumptions for Analysis of Alternatives to RNG

- Is ICF just planning to reference other studies – nothing MI-specific?
- If so, that is hugely problematic
  - Economics of electrification, in particular, vary widely
    - Avoided electric/gas costs
    - Grid emissions rates
    - Climate
- Better to not address alternatives than to do so this way
  - Unapplicable results otherwise
  - Potentially highly misleading

We previously provided input on suggested alternatives to analyze, as well as how to analyze electrification alternatives, but have no sense of whether our suggestions have been adopted or accepted.

Relatively Simple Calculations Possible – Heat Pump Example

EQUIPMENT COSTS

High Effic ASHP	$7,193
Displaced furnace	($3,255)
Displaced central A/C	($4,304)
Net Cost	($366)

Navigant 2018 Appliance Efficiencies forecast for U.S. EIA Reference Case (https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf)

UTILITY SYSTEM COSTS

MPSC Efficiency Potential Study avoided costs

- adjusted to reflect recent market changes, or
- Caveated to acknowledge much higher gas and, to lesser extent, electric prices today

HEATING & COOLING ENERGY USE

MPSC Efficiency Potential Study or U.S. EIA 2015 RECS

- 66.2 MMBtu gas heating (MW-ENC region)
- Converts to 6765 kWh for 92% furnace to HSPF 9.0 HP
- ~6000 kWh when furnace fan and cooling savings added

EMISSIONS

Gas reductions are easy; electric increases are hard

- Installation year
- Pace of grid decarbonization
- Estimating long-run marginal impact

Solution: present as range depending on marginal grid emission impact

- If grid doesn't get cleaner
- If grid is 90% decarbonized
- Points in between

Result: ~$22/ton at forecast avg MI grid emissions in 2030; ~$8/ton at forecast avg CA grid emissions in 2030 (NREL Cambium emissions forecast, using unadjusted MPSC Potential Study avoided costs)

STRATEGEN

A lifecycle GHG emissions assessment must be included in order to fully account for the emissions of RNG and alternatives

- During 1st stakeholder (January 10, 2022) workshop ICF said that it would assess emissions using both the lifecycle approach and the combustion approach.
- The inputs and assumptions document indicates that only the combustion approach will be used.
  - "A combustion GHG accounting framework is the standard approach for most volumetric GHG targets, inventories and mitigation measures (e.g., carbon taxes, cap-and trade programs and RPS programs."

- A lifecycle approach accounts for all emissions associated with a measure and should be used when comparing RNG to alternatives.
  - Actual GHG impacts of using RNG to displace fossil gas vary significantly depending on the source of RNG.
  - It is important to recognize that multiple relevant programs focus on the lifecycle approach, not the combustion approach which illustrates the value of the lifecycle approach to fully value emissions of RNG.
  - California LCFS, EPA RFS, OR Clean Fuel Program, WA Clean Fuel Standard

- We are requesting additional clarity on the specific bounds that will encompass the combustion analysis and are emphasizing the importance of fully accounting for emissions at all stages of the RNG lifecycle.

There is a general lack of support for assumptions and significant gaps in the information provided

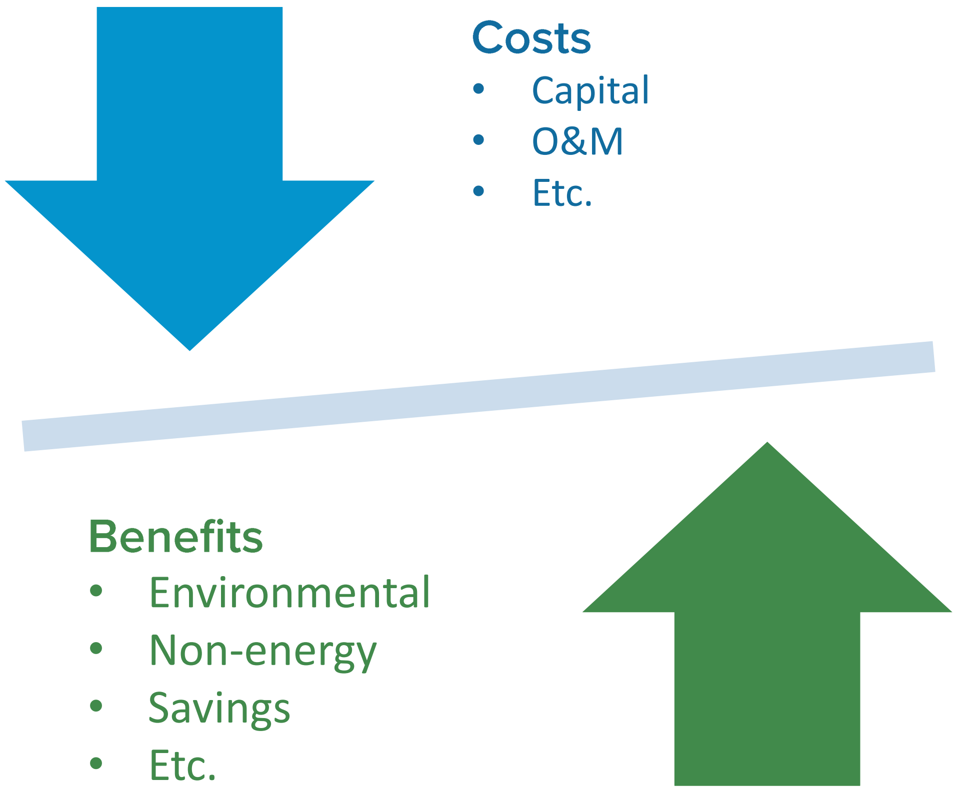
- We appreciate the inclusion of additional detail, but it is crucial for stakeholders to be able to review source material.
    - Several tables of information are unsourced (e.g., Tables 14, 15, 16, 17, 19, 20, 21, 22)
    - We have identified multiple examples of assumptions that are not consistent with sources that we have found (e.g., construction/engineering costs and the 95% capacity factor for animal manure) but without access to the sources that ICF used there is no way to fully analyze or validate these assumptions.

- There are gaps in the information provided regarding the cost analysis of RNG.
    - ICF states that its cost model “presumes changes in the underlying structure of project financing” but then doesn’t detail what changes.

- The study does not detail how ICF will define market considerations which are key inputs explicitly identified in other inventory studies.
    - For example, Washington and Oregon RNG inventory studies consider capital expenditures and the economics of RNG which informs their determination of the RNG potential in the state.

STRATEGEN

There is a lack of consideration of the full suite of costs and benefits associated with RNG



- The model's marginal abatement cost approach should be based on net costs.
- The analysis should include all quantifiable costs and benefits. Benefits include:
    - Environmental benefits (such as the reduction of criteria pollutants)
    - Non-energy benefits (economic development, energy security, public health, etc.)
    - Savings

STRATEGEN

The GREET Model has limitations which must be recognized upfront if it is to be used to analyze the lifecycle or combustion emissions of RNG

- GREET is a useful tool to calculate GHG emissions intensity of molecular fuels so long as the limitations are well established and socialized.

Key limitations:

- The GREET model was designed for transportation end uses, and the consumption component of the lifecycle assessment is associated with different driving modes, and it is not equipped to analyze the variety of end uses for RNG.
- The GREET model does not account for GHG emissions at the end use/consumption level such as combustion occurring for household gas heating and cooking end uses. Specifically, there is a clear and concerning lack of consideration of the end-use emission of criteria pollutants.
    - The study should add the emissions from end use criteria pollutants and methane emissions from customer gas appliances using best estimates. ICF should work with the utilities to identify these emissions and rely on best research.
- GREET does not account for methane leakage from customer gas appliances (e.g., stoves, water heaters), which recent research from Stanford has shown may be significant.
- GREET uses a highly conservative estimate of methane leakage from natural gas infrastructure systems. GREET allows for an optional/opt-in setting for a relatively more rigorous assessment of leakage using assumptions from Alvarez et al., however, these estimates are still conservative and are now outdated.

STRATEGEN

Consideration of alternative uses for process inputs will impact the expected supply curve for RNG

- RNG facilities will have different production costs based on the type of resource, its feedstock type and supply, and its ability to access the market.
- Regardless of the production costs of a single source of RNG, the price at which consumers will pay for RNG will be the cost of the marginal RNG unit.
- A supply curve of RNG resources – in increasing prices per increment of biogas supply – should be included so that the Commission can see the market clearing price at different levels of demand.
- Additionally, this analysis should take into account double counting issues so as to not overestimate the supply availability of RNG.

Presentation to Working Group on Fossil Gas Alternatives

Jackson Koeppel
April 20th, 2022

Presentation Outline

1. There are two important methodological limitations on this study
    a. Lack of full cost accounting of RNG development
    b. Lack of analysis of RNG as a driver on infrastructure investment
2. Without acknowledgement, those limitations could lead to imprudent and costly policy and regulatory decisions
3. The final study must acknowledge its limitations for use in policy and regulatory decision-making

Methodology Limitations

Full-Cost Accounting

The MPSC and ICF have taken a narrow interpretation of the word “cost” in the legislature’s directive, as is commonly done. This interpretation excludes public health costs associated with the continued use of gas for anything other than on-site energy generation the serious health costs associated with various feedstocks analyzed in the study.

There is no methodology to compare the different life-cycle health impacts of the different feedstocks, or to compare that to other energy resources.

This methodological limit also fails to consider the implication of considering feedstocks like trash and cow manure as “renewable” and the policy implications of doing so. This definitional problem creates drivers that reinforce unsustainable agriculture and waste management practices that directly harm communities impacted by the associated health risks.

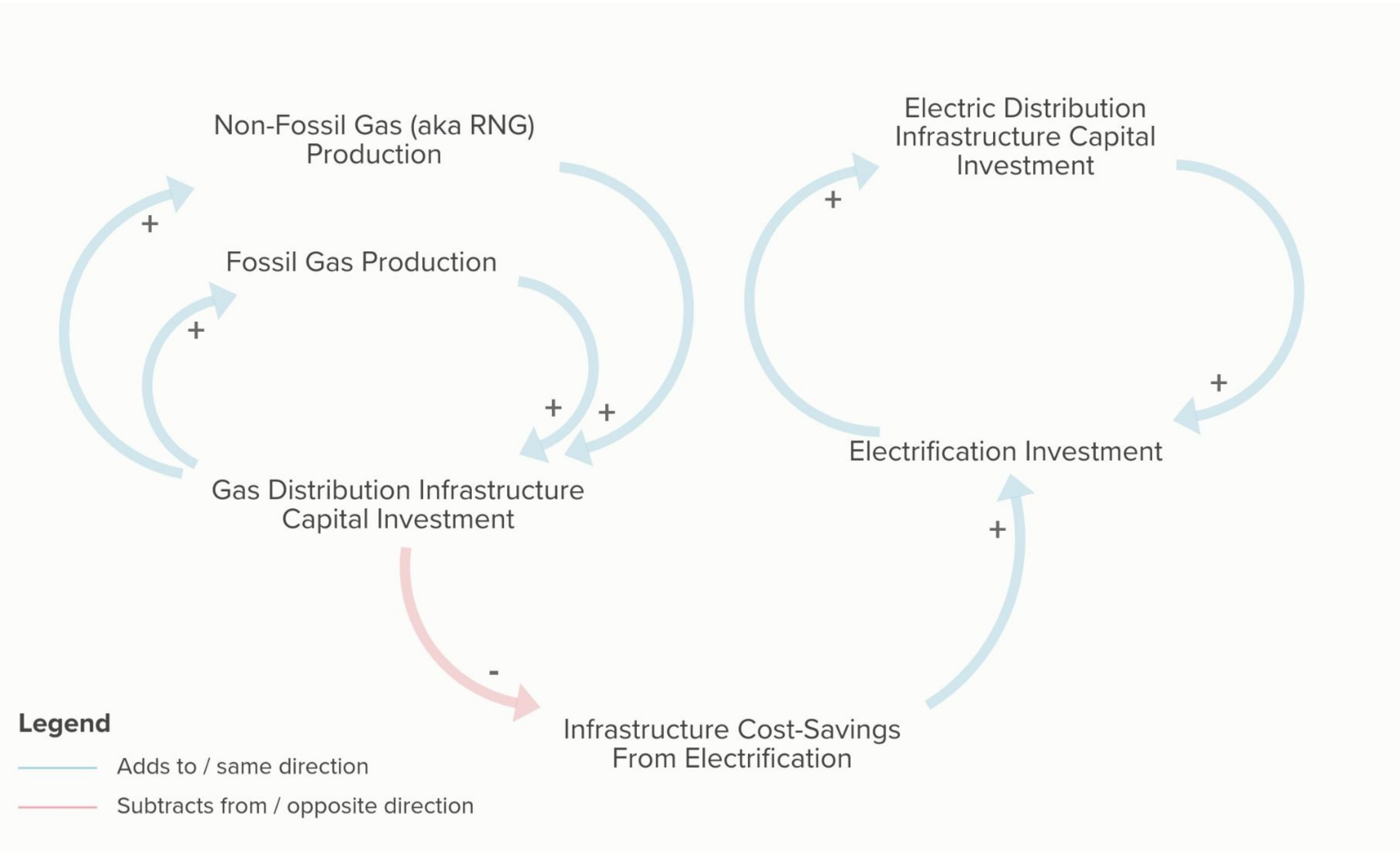
Infrastructure Investment Drivers

Methodology for comparing gas from feedstacks to other GHG reduction strategies - like electrification - fails to account for the positive feedback loop effects that could be created.

Further RNG investment and deployment incentivizes investment into the gas distribution system. Investment into that system erodes the cost savings of electrification, which become most fully realized in a scenario where the gas distribution is fully phased out.

Further RNG investment and deployment also incentivizes continued investment in the infrastructure for generating its feedstocks, which in this study include trash and manure, whereas prioritizing electrification inventivices investment into the aging electric grid, sorely in need of improvement.

Impact on Policy & Regulatory Decisions


Non-Fossil Gas (aka RNG) Production
Fossil Gas Production
Gas Distribution Infrastructure Capital Investment
Electric Distribution Infrastructure Capital Investment
Electrification Investment
Infrastructure Cost-Savings From Electrification
+
+
+
+
+
+
+
-
Legend
Adds to / same direction
Subtracts from / opposite direction

Conceptual Model Insights

- Non-Fossil Gas Production incentivizes continued Fossil Gas Production
- Both forms of gas production require and incentivize investment in gas distribution
- Investment in gas distribution infrastructure can directly drive down the infrastructure cost benefits of electrification
- Driving that value down works against electrification investments, and decrease investment in electric distribution system

There is a dynamic relationship between developing RNG and the viability of other models that is not captured in the static cost comparison methodology.

Possible Areas Of Impact

- Michigan Legislature
  - Budgets
  - Climate policy
  - Technologic development
- MI Public Service Commission
  - Integrated Resource Plans
  - Rate Cases

Recommendations for mitigation of harm

Proposed language for inclusion in study

1. This study is not alone an adequate assessment of the “potential for renewable gas development in this state” without further analysis of the systemic impacts of doing so
2. The study results should not be misconstrued as being usable by policymakers or regulators as justification for RNG development without addressing its methodological limits
3. Further policy-making regarding RNG must be preceded by a life cycle analysis of the impacts RNG development would have on energy infrastructure investment and human health compared with high-electrification and gas elimination scenarios to avoid short-sighted decisions
4. The wide definition of feedstocks included in this study may or may not fit under the term “renewable”, but they all fit under the alternate term Fossil Gas Alternatives (FGA) which does not blanket them as such