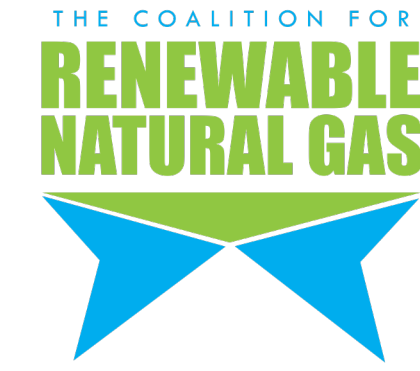


RNG WORKS



RENEWABLE NATURAL GAS

Overview & Trends:

A Utility Perspective

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Renewable Natural Gas Overview and Trends: a Utilities Perspective

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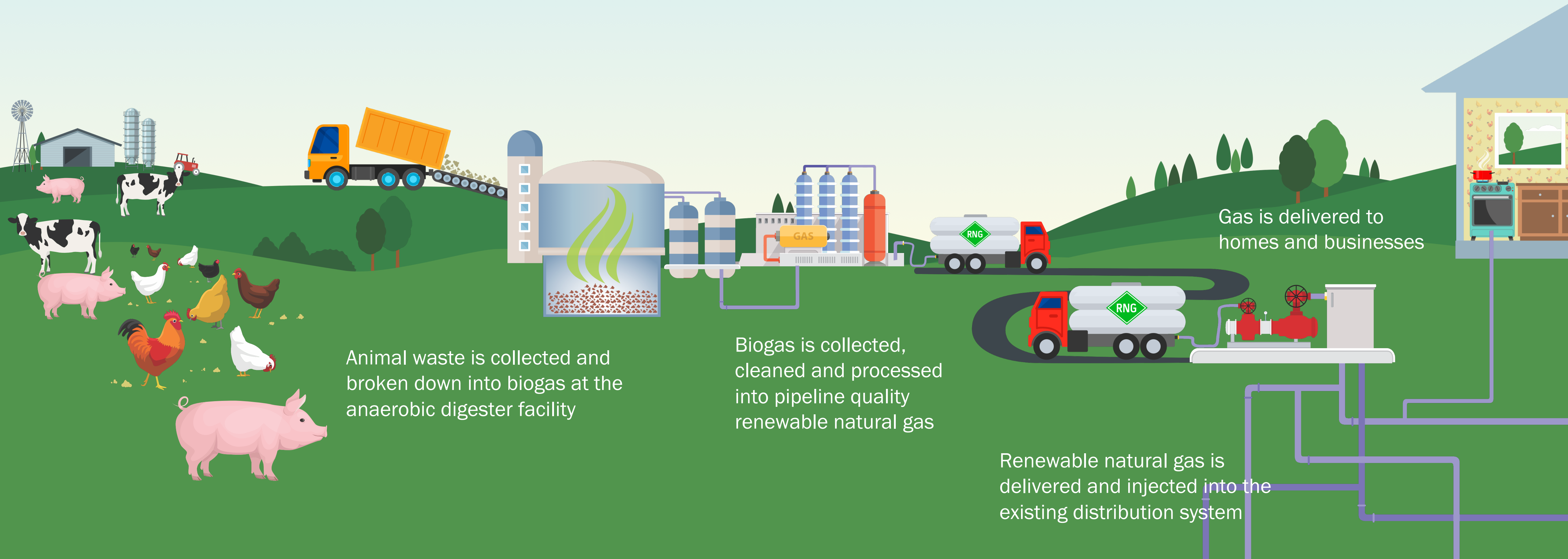


Contents

- What is RNG?
- Where does RNG come from and how is it used?
- What are the various development roles in the RNG industry?
- What is driving the RNG market to be so popular?
- How many RNG projects are there and what is the trend?



Renewable Natural Gas



Animal waste is collected and broken down into biogas at the anaerobic digester facility

Biogas is collected, cleaned and processed into pipeline quality renewable natural gas

Gas is delivered to homes and businesses

Renewable natural gas is delivered and injected into the existing distribution system

What is RNG?

RENEWABLE NATURAL GAS (RNG):

Any pipeline compatible gaseous fuel that is derived from organic matter, such as agricultural waste, landfills and wastewater treatment facilities

- As organic matter decomposes it creates biogas, a methane rich gas that can be cleaned and purified to create biomethane, known more commonly as RNG
- RNG is an ultra clean and ultra low carbon gas alternative
- Fully interchangeable with traditional natural gas

Where does RNG come from?

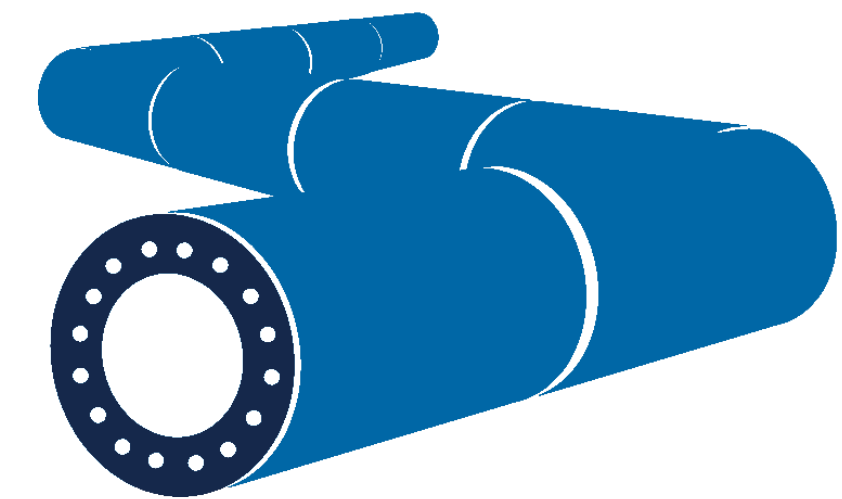


RNG is fossil-free natural gas that is produced by cleaning and processing biogas into pipeline-quality gas.



Anaerobic Digestion (AD) is the most often used technology to produce biogas from feedstock such as animal manure, agricultural byproducts and wastewater facilities.

Landfills capture biogas from on-site collection systems.



Biogas must be treated and cleaned, raising it to a standard where it can be injected into gas pipelines.

Sources & Production of RNG

13,000 BIOGAS FACILITIES Today the EPA estimates the United States alone as an opportunity to develop 13,000 biogas facilities to produce RNG.

This would be enough RNG produced to power **3 MILLION HOMES!**

POTENTIAL SOURCES OF ORGANICS USED TO PRODUCE RNG INCLUDE:



FOOD WASTE
66.5 MILLION
TONS / YEAR



WASTEWATER
17,000
FACILITIES



AGRICULTURE
WASTE
8,000
LARGE FARMS
AND DAIRIES



LANDFILL GAS
1,750
LANDFILLS

*Per RNG Coalition (2019)

How RNG is made

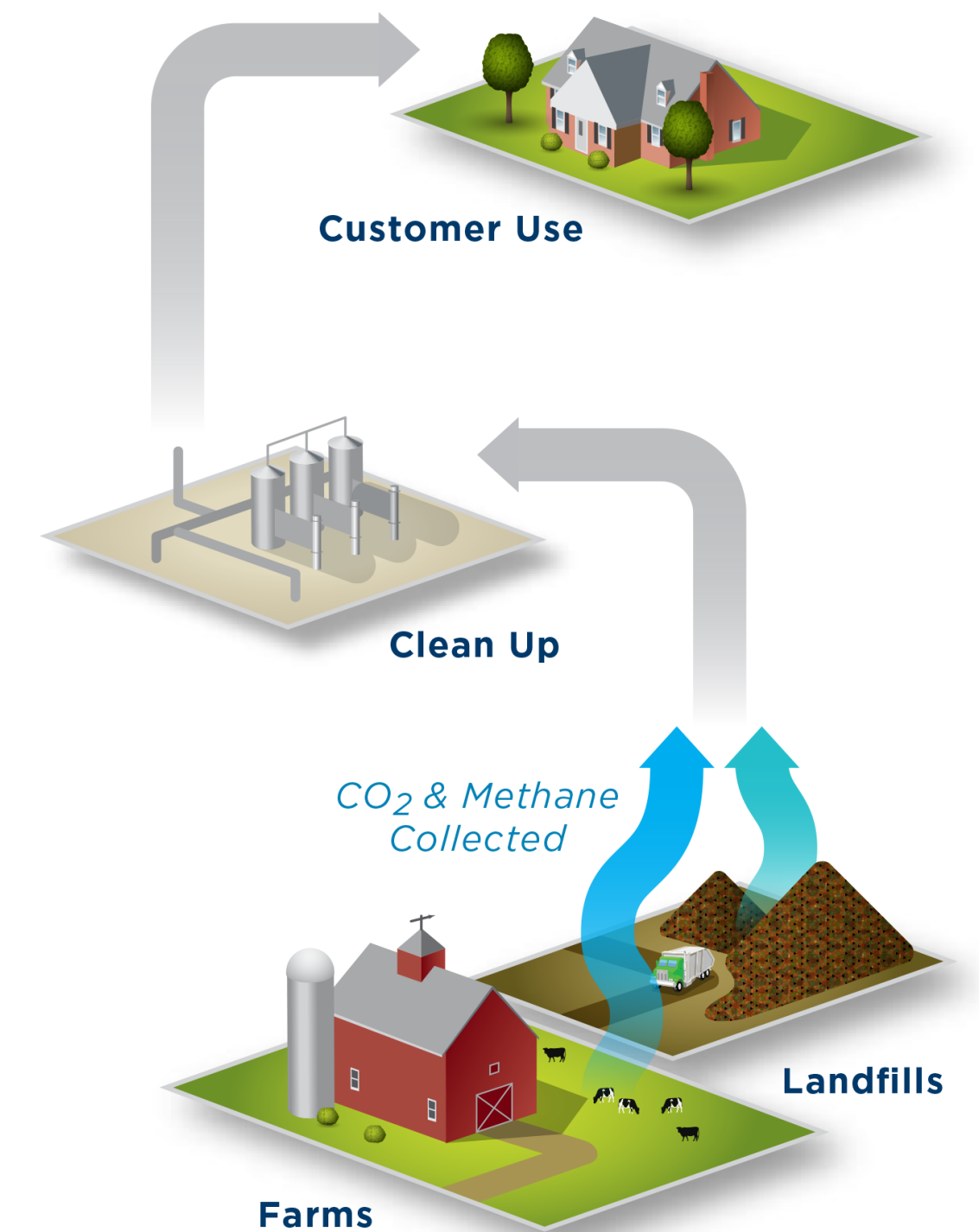
The anaerobic digestion process uses microorganisms to break down organic material in a zero-oxygen environment, producing methane and carbon dioxide

From the anaerobic digester (AD), biogas travels to biogas cleaning equipment where carbon dioxide and other contaminant gases are removed, leaving only methane and a small amount of nitrogen, making RNG impossible to distinguish from traditional natural gas

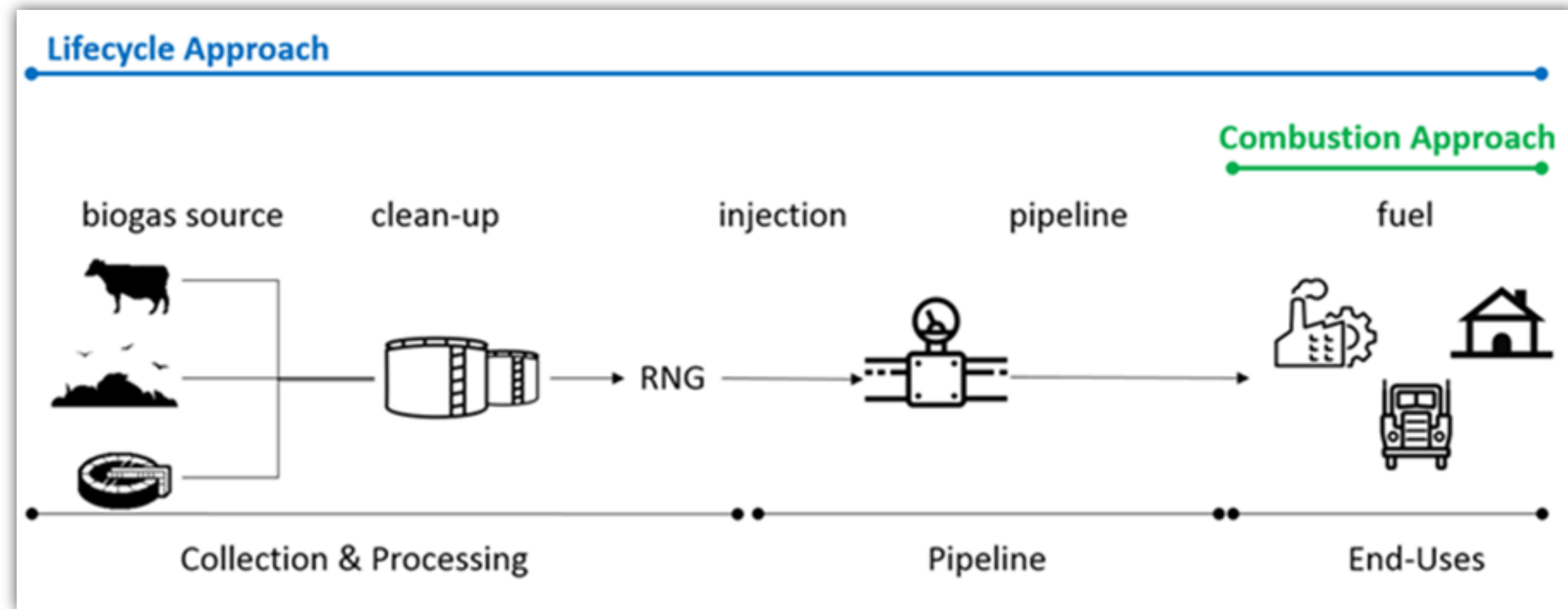
The material that is left after anaerobic digestion happens is called digestate

- Digestate is rich in nutrients and can be used as fertilizer for crops or further processed into products that are bagged and sold in stores, which provides additional RNG project revenue streams for developers

In addition to anaerobic digestion, biogas is produced naturally from decomposition of municipal solid waste at landfills



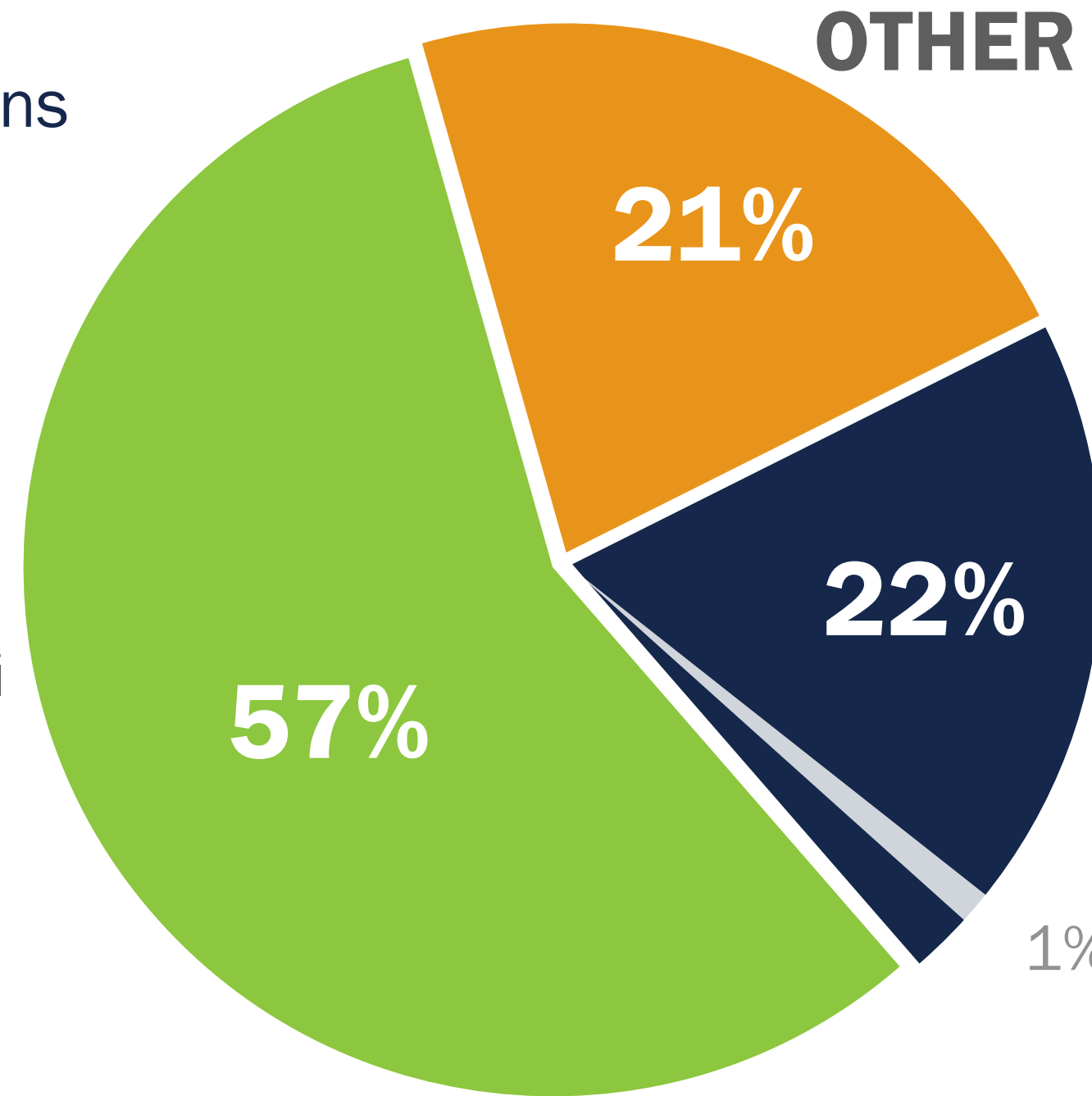
RNG Lifecycle



Reducing Methane Emissions

57 PERCENT of total U.S. methane emissions come from organic and agriculture sources such as manure, enteric fermentation, landfills and wastewater treatment.

ORGANIC & AG



Distribution systems owned and operated by local natural gas utilities emit **LESS THAN 1 PERCENT** of U.S. methane emissions

Natural Gas Systems

1% Local natural gas distribution systems

Source of U.S. Methane Emissions in 2019



Roles in RNG Development

RNG Developer

- Identify projects and secure investments to “sell” the design of the project or develop project from cradle to grave using own resources
- Equity share and Partnership opportunities

Technology Provider

- Proven technology of maximizing production of raw biogas for a specific feedstock that can be cleaned and converted to RNG
- “Secret Sauce” or “recipe”

Biogas Clean-up Equipment

- Purchase from a Manufacturer of Biogas Clean-up skid to produce RNG
- Owner and operate responsibilities

RNG Transport

- Move RNG from project site into market
- Pipelines or Virtual Pipelines

RNG Interconnection

- Inject RNG into existing pipelines
- Fee for Service
- Hubs based on strategy and capacity needs both now and in the future

RNG Offtake

- Purchase RNG (usually at premium if attributes are bundled), index price if attributes are separated
- Renewable Portfolios (ESG)

RNG Market Drivers

Primary existing drivers of RNG development are policies and incentives to decarbonize the transportation market

Federal and state programs, such as the Renewable Fuel Standard (RFS) and California's Low Carbon Fuel Standard (LCFS), provide a monetary credit to RNG that is used as a transportation fuel

Use in Local Distribution Companies (LDCs)

- Economic issues around premiums that can be paid
- Regulatory matters

Industrials and Companies with Renewable Portfolios



Since the climate impact of methane is greater than that of carbon dioxide, eliminating methane emissions from waste streams yields a net lifecycle GHG reduction when that methane is combusted in lieu of traditional gas, rather than being emitted to the atmosphere or flared.

RNG Economics



The cost of upgrading the methane content and cleaning raw biogas can vary based on the biogas makeup and volume, but is typically capital intensive.

	Feedstock	Cost Range (\$/MMBtu)
Anaerobic Digestion	Landfill Gas	\$7.10 – \$19.00
	Animal Manure	\$18.40 – \$32.60
	Water Resource Recovery Facilities	\$7.40 – \$26.10
	Food Waste	\$19.40 – \$28.30

Per ICF, development cost by feedstock type.



In addition to the capital costs for developing equipment, annual operating costs incurred to maintain treatment systems can be expensive depending on feedstock used.

Renewable Fuel Standard (RFS)

FEDERAL PROGRAM

- Federal Program that requires transportation fuel sold in the United States to contain a minimum volume of renewable fuels
- The U.S. Environmental Protection Agency (EPA) administers the RFS program and establishes the volume requirements for oil refiners, gasoline and diesel importers
- EPA tracks compliance through the Renewable Identification Number (RIN) system, which assigns a RIN to each gallon of renewable fuel
 - To generate RIN, EPA certifies that RNG was produced, injected in pipeline and was used solely for transportation fuel
 - Four different types of RINs based on feedstock; each with own market value (D3 RIN greatest value)
- The volumes required of each obligated party are based on a percentage of its petroleum product sales. Obligated parties can meet their renewable volume obligations (RVOs) by either selling required biofuels volumes or purchasing RINS from parties that exceed their requirements

California Low Carbon Fuel Standard (LCFS)

STATE PROGRAM

- As a State program, LCFS requires refineries and fuel suppliers in California to reduce the carbon intensity of its transportation fuels
- Transportation fuels must meet an annual carbon intensity (CI) target that decreases each year
- Refineries and fuel suppliers can meet these targets by mixing in fuels with lower CI into the overall supply or purchasing credits
- Fuels with CI below the target level (based on a lifecycle analysis) are able to generate credits
- Under the rule, RNG is considered a low carbon fuel and can generate credits
 - To generate LCFS credit, California Air Resource Board (CARB) certifies that RNG was produced, injected in pipeline and was used solely for transportation fuel in California
- Oregon and other States also implementing state run Credit Programs

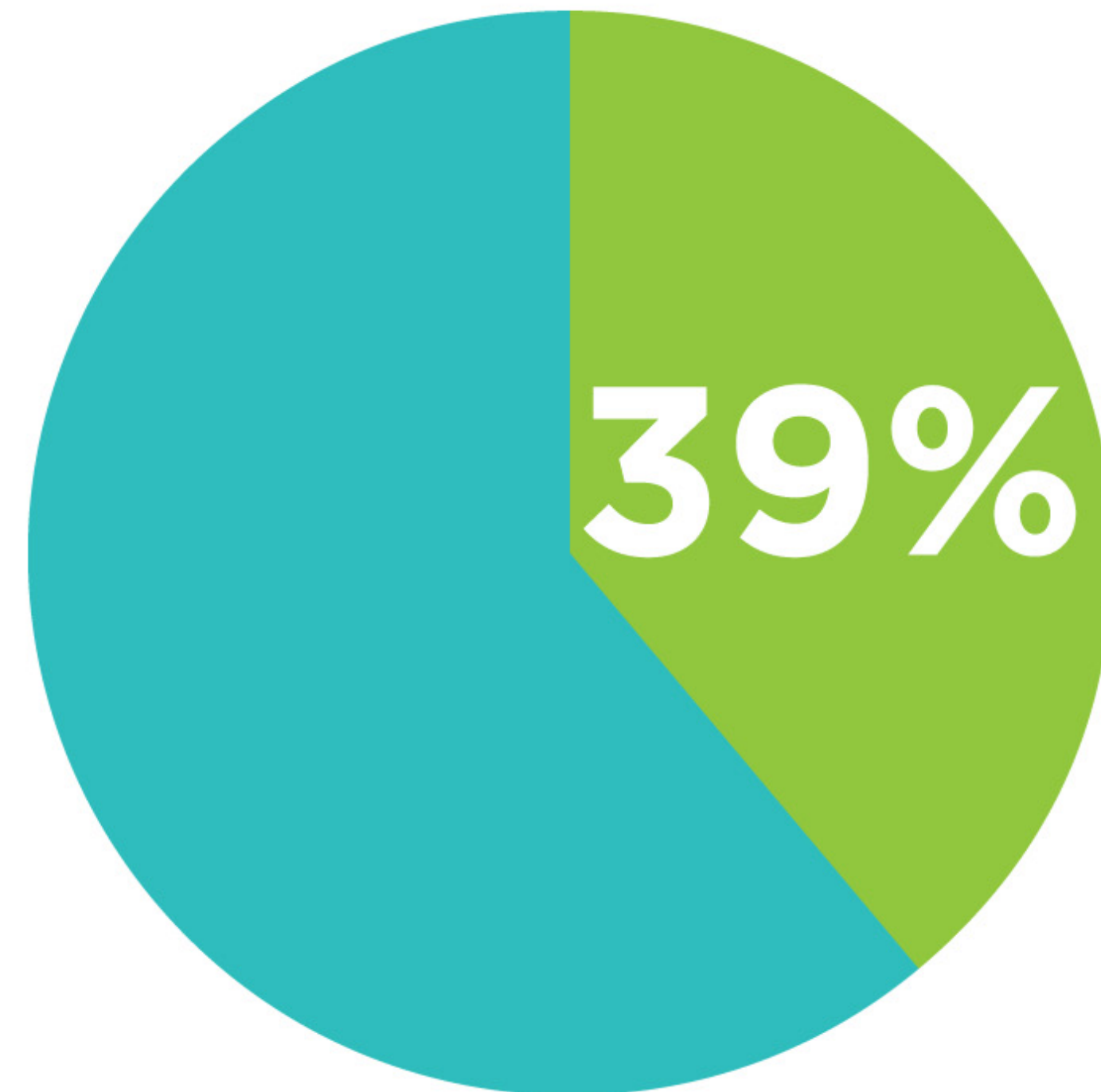
RNG Transportation Result

2019 NGV Fuel Use

717 Million GGE Total

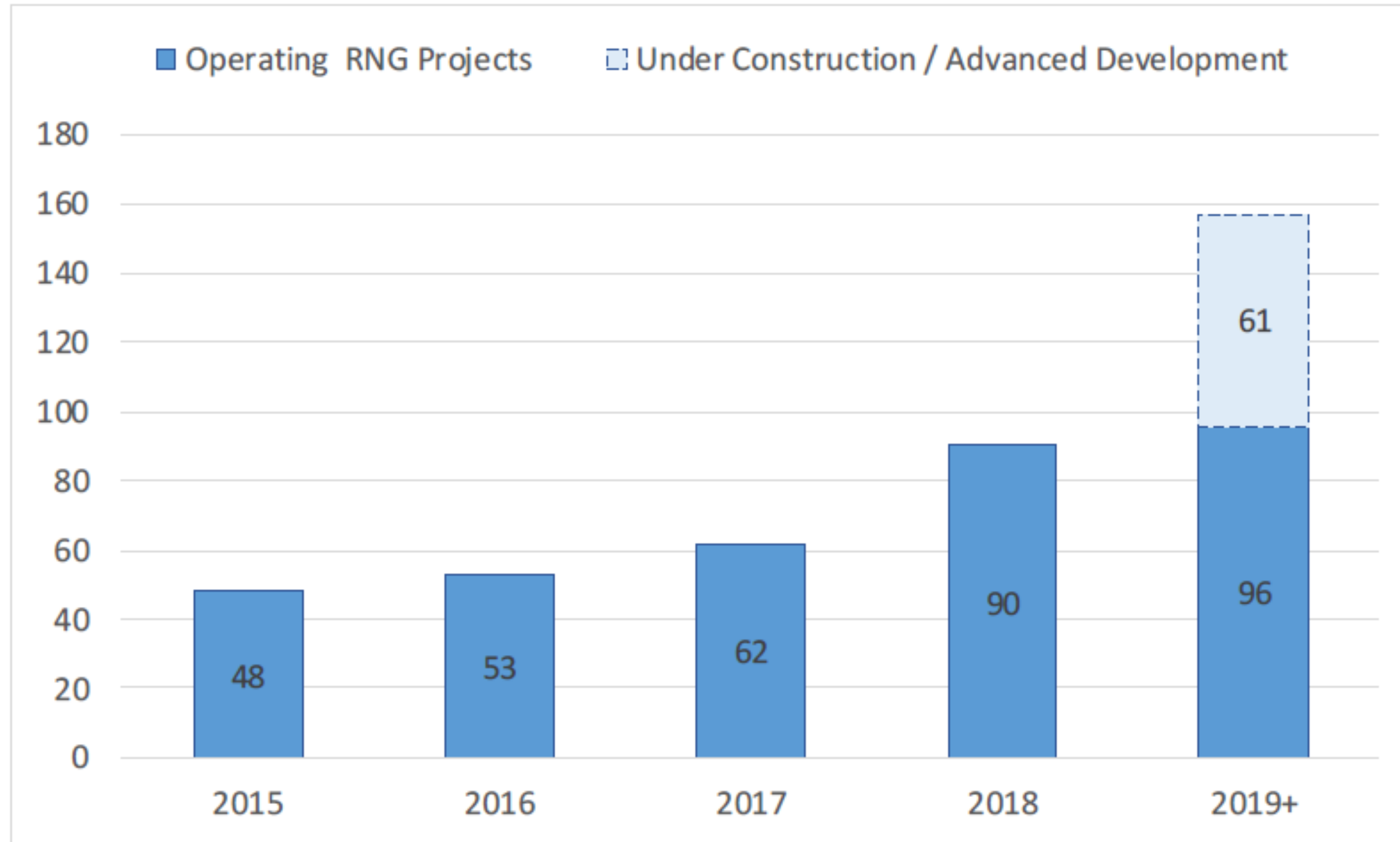
In 2019, **39%**, of all on-road fuel used in natural gas vehicles was RNG

- Conventional Natural Gas
440 Million GGE
- Renewable Natural Gas
277 Million GGE





Active RNG Projects



Source: RNG Coalition

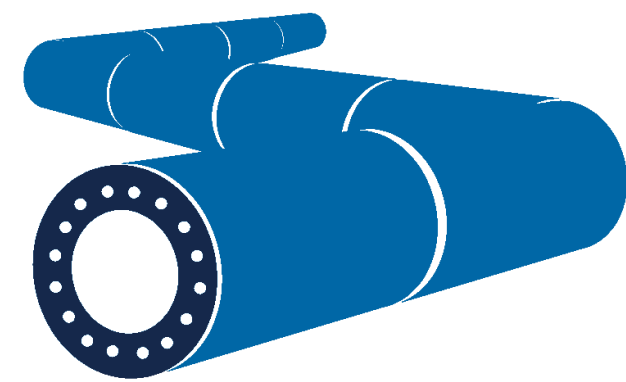


Success of RNG

Success in development of RNG projects, expansion of existing or creation of new RNG markets is dependent upon:



**ENVIRONMENTAL
POLICIES & MARKETS**



**ACCESS TO &
INTERCONNECTION
WITH NATURAL GAS
INFRASTRUCTURE**



**DEVELOPMENT OF
NATURAL GAS FUELING
STATIONS AND
DEPLOYMENT OF
NATURAL GAS VEHICLES**



**OVERCOMING BIAS
AGAINST NATURAL GAS
IN FAVOR OF OTHER
ALTERNATIVES**



**NEED TO BE PROACTIVE! EDUCATE AND ADVOCATE –
NEEDS TO BE AN INDUSTRY-WIDE EFFORT**

Thank You

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