PwrPt-C5b 10-3-19
Cammack-BiogasBlack Hills

Renewable Natural Gas:

Waste-to-Energy Opportunities

Black Hills Energy
Improving life with energy

Agenda

Biogas & landfill gas

Renewable Natural Gas (RNG)

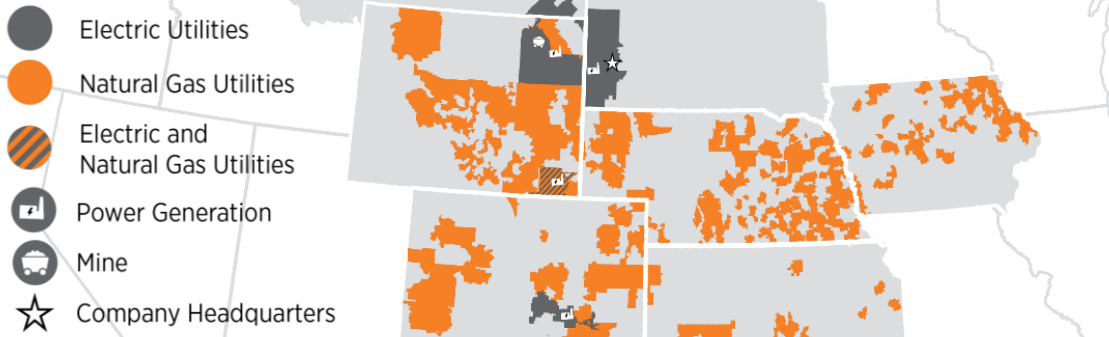
Current Black Hills Energy projects

Opportunities & challenges

Black Hills Corporation

Based in Rapid City, SD, we serve more than 1.2 million electric and natural gas utility customers in Arkansas, Colorado, Iowa, Kansas, Montana, Nebraska, South Dakota and Wyoming.

Black Hills Corporation is a customer-focused, growth-oriented energy company with a tradition of exemplary service and a vision to be the "*energy partner of choice*".



Electric and Gas Utility Company

1.27 Million
Utility customers in 8 states

46,000 Miles
Natural gas lines

1.1 Gigawatts
Electric generation

9,000 Miles
Electric lines

2,900
Employees

What is Biogas/Landfill Gas?

Mixture of different gases produced by an **anaerobic process** (breakdown of organic matter in the absence of oxygen)

Organic materials are the “feedstock” and include animal manure, food scraps, agricultural residues, sewage, or solid (landfill) waste

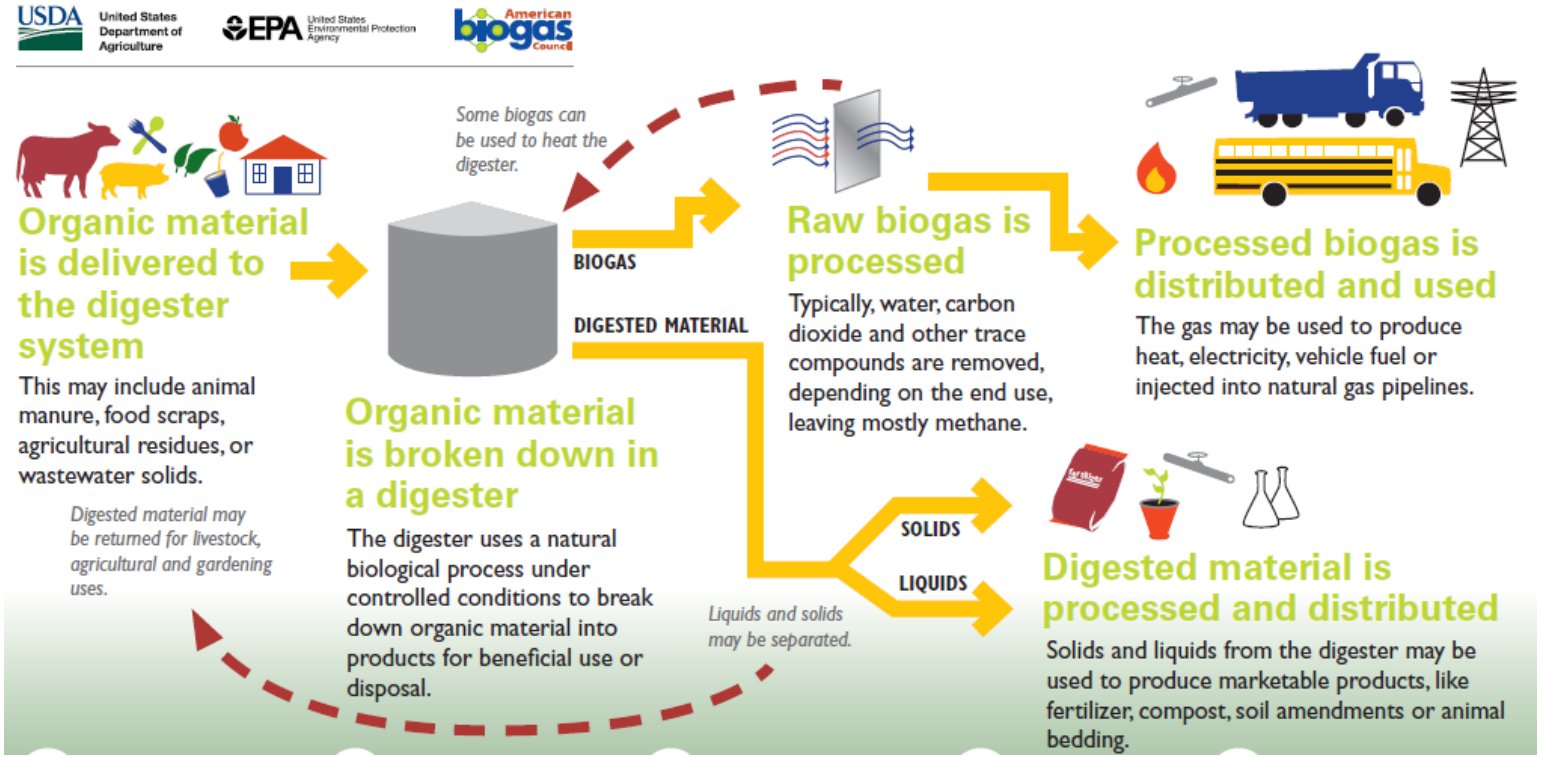
Produced by either:

1. Anaerobic **digestion** with anaerobic bacteria in a closed system, or
2. Breakdown of wet, biodegradable waste inside a **landfill** due to chemical reactions and/or microbes (cover mechanically compresses waste and prevents exposure to oxygen)

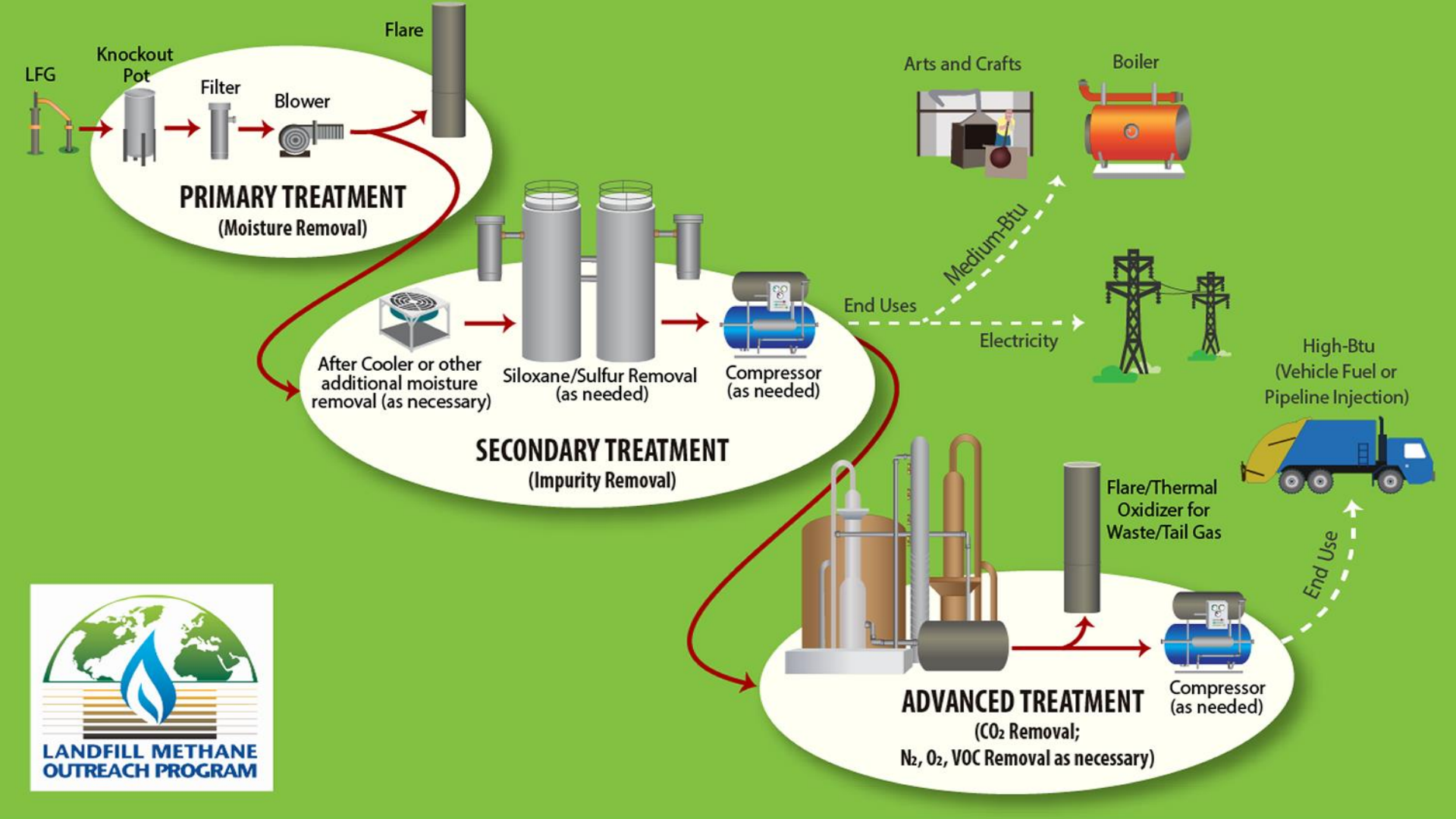
Primarily **methane** (40-60%) and **carbon dioxide** (40-50%), with small amounts of oxygen, nitrogen, hydrogen sulfide, and non-methane organic compounds

Renewable energy source for direct use, generating electricity, alternative vehicle fuel or injection into natural gas pipelines

Anaerobic Digester Biogas



Courtesy American Biogas Council


LFG
Knockout Pot
Filter
Blower
Flare
PRIMARY TREATMENT
(Moisture Removal)
After Cooler or other additional moisture removal (as necessary)
Siloxane/Sulfur Removal (as needed)
Compressor (as needed)
SECONDARY TREATMENT
(Impurity Removal)
End Uses
Arts and Crafts
Boiler
Medium-Btu
Electricity
High-Btu (Vehicle Fuel or Pipeline Injection)
End Use
Flare/Thermal Oxidizer for Waste/Tail Gas
Compressor (as needed)
ADVANCED TREATMENT
(CO_2 Removal;
N_2, O_2, VOC Removal as necessary)
LANDFILL METHANE OUTREACH PROGRAM

Renewable Natural Gas (RNG)

Raw biogas or landfill gas is processed or purified to **remove contaminants** (primarily carbon dioxide and hydrogen sulfide)

Following purification, RNG contains > **90% methane** and ~**950 Btu**

RNG is **comparable** to traditional natural gas

- Stringent specifications and testing insure **quality**

Why is RNG important?

- "**Greens**" the natural gas grid (decarbonization)
- Furthers environmental initiatives and mandates – methane is **21x** more powerful as **greenhouse gas** than carbon dioxide
- Increases petroleum displacement in **transportation** (natural gas vehicles)

Why is RNG valuable?

- **Renewable Fuel Standard (RFS)** requires blending of renewable fuels with nation's motor vehicle fuel supply
  - **Renewable Identification Numbers (RINs)** are "proof of compliance" for Obligated Parties
  - RINs are the **economic driver** of most biogas projects
  - RINs can be **much more valuable** than the gas commodity itself

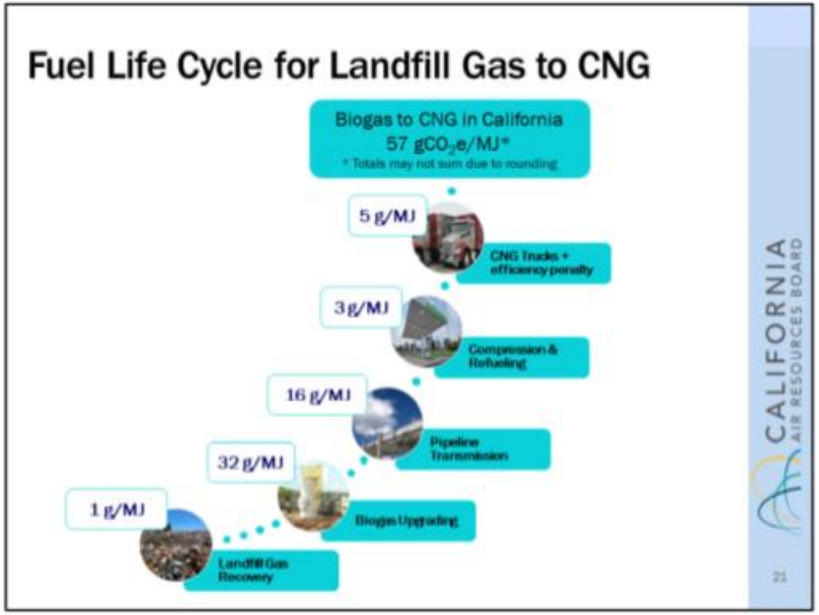
- EPA views all North American gas pipelines as **"one" big pipeline** (mass balance)

- California Low Carbon Fuel Standards (LCFS) have created an **additional market**

September 2019 prices

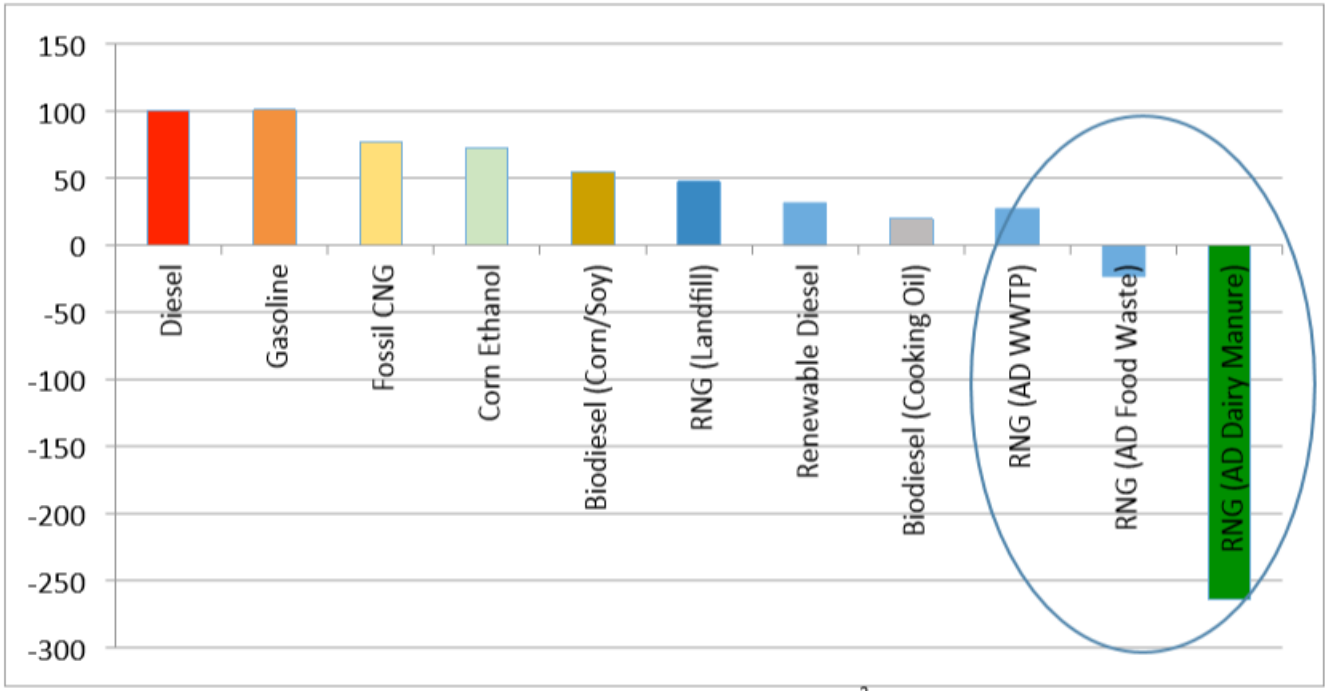
	One MMBtu of Pipeline Quality Biogas Produced in the Midwest and Used for Transportation in California		
	Value of Gas	$3.00	11%
Feedstock	Value of Federal Credits (D3 RINs)	$8.21	29%
Carbon Intensity	Value of California Credits (LCFS)	$17.17	61%
	Total	$28.38	100%

Lifecycle Carbon Intensity



Carbon Intensity: A rating for the carbon content of a fuel. It is the emission rate of a given pollutant (e.g. GHG) relative to the intensity of a specific activity (e.g. amount of fuel combusted, #animals in confinement, etc.). CI takes into account all steps of producing, transporting and consuming a fuel (i.e. complete life cycle).

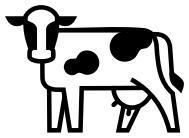
Lifecycle Carbon Intensity



(Source: CARB 2017, 2019[2])

Imagine….

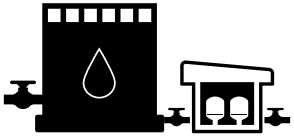
For the next 15 minutes you are all producers of biogas



Dairy owner/operator

Landfill diverted food/green waste project developer

Landfill owner/operator



Wastewater Treatment Plant owner/operator

These producers all have one thing in common: They want to produce RNG and inject it into a common carrier pipeline

Dubuque Iowa WRRC Project

City of Dubuque's Water Resource Recovery Center (WRRC)

Partnership between:

- **City of Dubuque**
  owns WRRC and is receiving revenue from sale of biogas
- **BioResources Development**
  is processing raw biogas and creating ~200 Mcf/day of pipeline quality RNG
- **Black Hills Energy**
  is quality testing, then injecting the RNG into our distribution system
- **N1 Energy**
  is marketing RINs

In-service as of February 28, 2018

Dubuque Iowa WRRC Project

Dubuque, IA WRRC Project

Sarpy County LFG Project

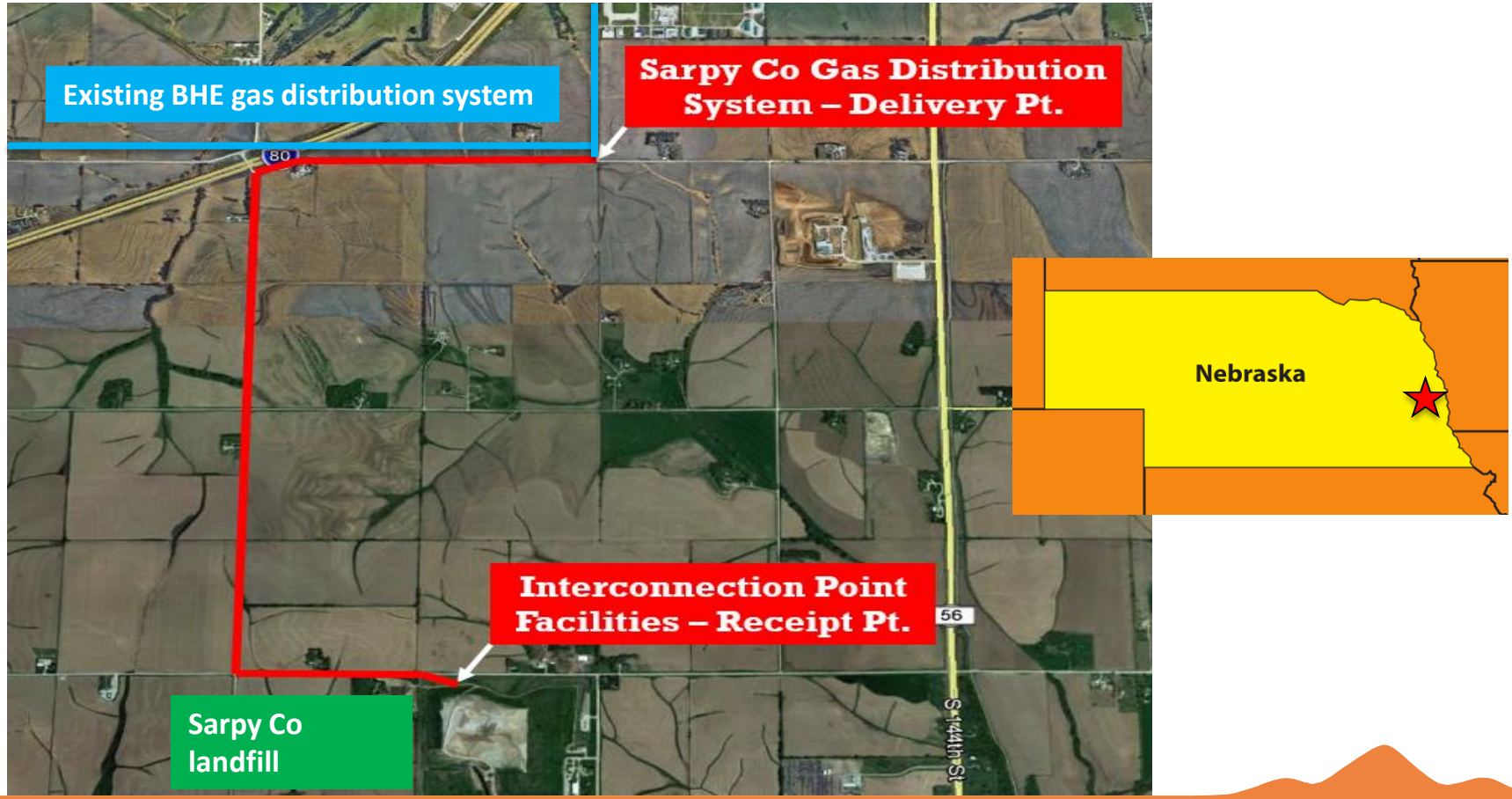
Municipal landfill southwest of Omaha with 1.3 million tons in place on 160 acres that was closed in 2018

Partnership between:

- **Sarpy County** – originally collected and flared the landfill gas
- **BioResources Development** – processing raw landfill gas and creating ~1,000 Mcf/day of pipeline quality RNG
- **Black Hills Energy** – quality tests, then injects the RNG into our distribution system
- **N1 Energy** – markets RINs

In-service as of July 12, 2018

Map of Sarpy Co. LFG Project



Sarpy County LFG Project

Butler County LFG Project

Large regional landfill near David City that was collecting and delivering raw landfill gas to Henningsen Foods

- Boiler issues led to contract cancelation

Aria Energy:

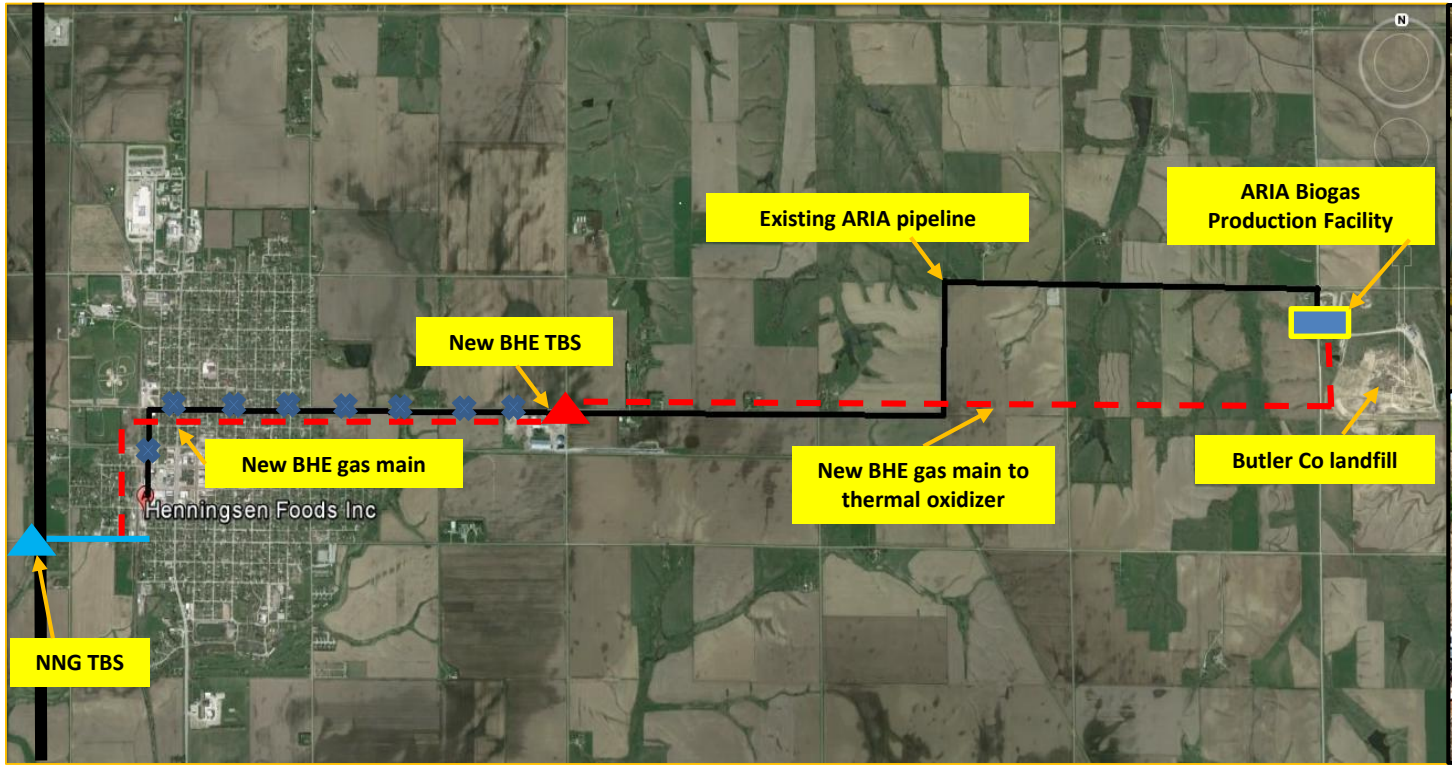
- Installed a landfill gas purification system to produce RNG meeting pipeline quality standards
- Is selling the “brown gas” to Henningsen Food’s supplier
- Is marketing the environmental attributes into the RIN market

Black Hills Energy:

- Built infrastructure to connect
- Is testing the quality of RNG
- Is injecting ~600 Mcf/day of RNG into our gas distribution system
- Is providing gas for thermal oxidizer

In-service as of December 18, 2018

Butler County LFG Project



Butler County LFG Project

Opportunities

There are 645 landfills nationally with operational waste to energy projects but < 70 currently produce RNG

Increasing amount of organic waste:

- Americans dump 450 million tons of municipal solid waste into landfills every year
- ~50% U.S. food production is uneaten each year

Potential state & local bans of organic waste from landfills

Potential state renewable gas standards

RINs & LCFS

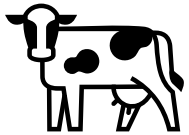
- Value to refiners and importers on secondary market

Environmental initiatives and mandates

Good community partner

- Utilizing a “waste” sourced energy

Sources of organics to produce RNG



Agricultural Waste

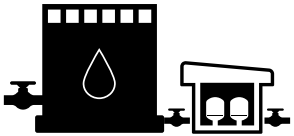
8,000
large farms and dairies

Food Waste

66.5 million
tons per year

Landfill Gas

1,750
landfills



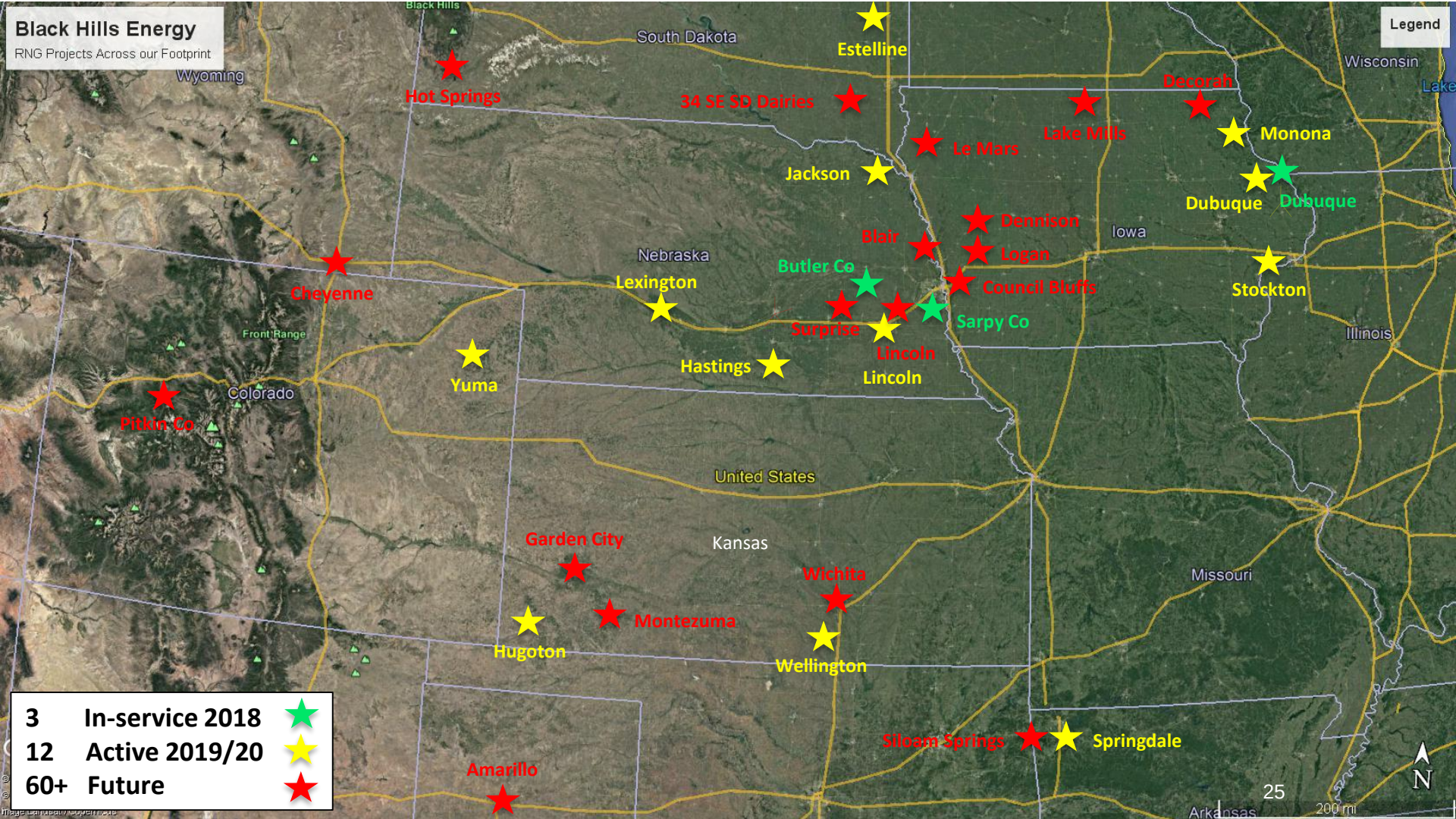
Waste Water

17,000
facilities

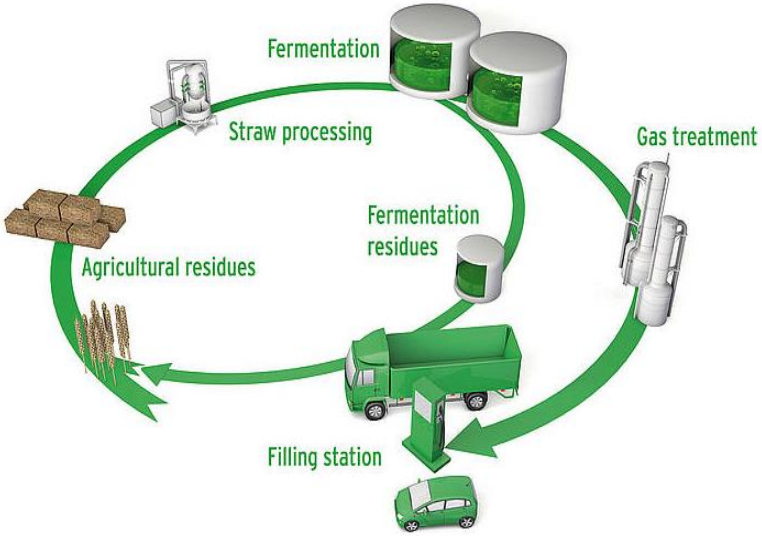
CAFO Opportunities for BHE

Table 30: CAFO Sites in Study Area

Concentrated Animal Feeding Operations (CAFO)				
CAFO STATE	CAFO #	Permitted Animal #	Estimated Annual Biogas Potential (Mcf)	Estimated Annual Manure (tons)
Arkansas	158	1,687,516	640,251	542,109.8
Colorado	206	8,804,766	19,573,870	23,728,414.3
Iowa	8,989	141,319,941	67,986,912	55,975,403.2
Kansas	3,635	9,732,919	58,116,631	80,391,123.1
Montana	873	1,227,976	6,277,945	8,920,028.5
Nebraska	671	32,412,968	33,263,532	42,445,650
South Dakota	388	8,770,752	23,204,854	29,573,667.8
Wyoming	49	194,120	986,827	1,374,778.5


Black Hills Energy
RNG Projects Across our Footprint
Legend
Black Hills
South Dakota
Wyoming
Estelline
Hot Springs
34 SE SD Dairies
Decorah
Wisconsin
Lake Mills
Monona
Le Mars
Jackson
Dubuque
Dubuque
Dennison
Blair
Iowa
Logan
Nebraska
Butler Co
Council Bluffs
Stockton
Lexington
Cheyenne
Sarpy Co
Surprise
Front Range
Lincoln
Illinois
Hastings
Yuma
Lincoln
Colorado
Pitkin Co
United States
Garden City
Kansas
Wichita
Missouri
Montezuma
Hugoton
Wellington
Siloam Springs
Springdale
Amarillo
Arkansas
3 In-service 2018
12 Active 2019/20
60+ Future
25
200 mi
N

Verbio


Fermentation
Straw processing
Gas treatment
Fermentation residues
Agricultural residues
Filling station


verbiogas
GAS GEBEN!
Verbiogas
VERBIO

Challenges / Lessons Learned

Displaces natural gas load

Connecting to existing gas distribution systems
- Costs
- LP or HP
- Line pack

Gas quality concerns & responsibilities – LDC and customers

Developer qualifications
- Experience
- Expertise
- Equipment

Credit security – RIN & LCFS markets dependent upon:
- Renewable Fuel Standards (RFS)
- CNG/LNG being dispensed into the transportation sector

Allowing for future growth

Will happen whether you're involved or not
- Utility often the "missing link"

Slow to develop

Public concern
- Odors

Key RNG questions for BHE

Location:

- Is the project within our service territory or a state where we operate a gas utility?
- How far from our gas distribution system?
- Any interstate pipelines in the area?
- Is there three phase power available at your site?

Production:

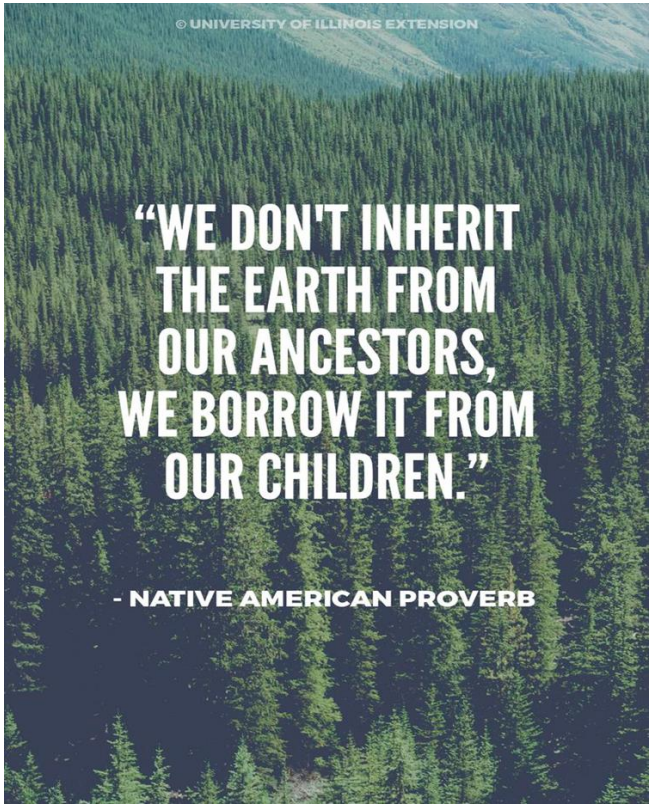
- What is your estimated volume of RNG today? In the future?
  - Does BHE have capacity to handle this volume?
- Do you want BHE to purchase the entire “green gas” package, just the “brown gas” molecules, or will it all be handled by your marketer/third party?

Timeframe:

- Where are you in your process?
- What is your in-service target date?

Financial:

- Who are your partners?
- Will you be able to provide credit security (i.e. Letter of Credit, etc.)?



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Thank you!

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