DECARBONIZING MINNESOTA’S NATURAL GAS END USES

Meeting 4

March 13th, 2020

Via Zoom
Ground Rules for Virtual Meeting

• Respect the commitment that you and others have made to this group by eliminating distractions.

• If you have something to say, please speak up!

• DO link your audio to your visual when prompted so that we can better manage participation.

• Use the “raise hand” feature if you’d like to say something, but aren’t sure when to jump in, so that facilitators can plan to call on you.
1. Click “Participants” at bottom of screen

2. Non-verbal feedback buttons
Meeting Goals

1. Build a shared understanding of the how the natural gas system works.

2. Better understand utility perspectives regarding changes to the natural gas system in response to pressures to decarbonize.

3. Discuss the certainties and uncertainties around natural gas end use decarbonization that were drafted at the previous meeting (if time allows).
Overview of Natural Gas System

John Heer, CenterPoint Energy
NATURAL GAS SYSTEMS, AN INTRODUCTION

13 MARCH 2020

John Heer, P.E.
Director of System Operations
NATURAL GAS SYSTEMS

- Delivery of Gas - (Our Business)
- Sources of Supply -
- Transportation to our service areas
- Distribution of Gas
- Measurement, Odorization, Regulation, etc.
- System Control
- Customers
- Local Storage
- Alternative Resources
<table>
<thead>
<tr>
<th>Electric Property</th>
<th>Gas Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (Volt)</td>
<td>Pressure (PSI, Bar)</td>
</tr>
<tr>
<td>Current (Amps)</td>
<td>Flow Rate (FT³/HR)</td>
</tr>
<tr>
<td>Power (KW)</td>
<td>BTU/HR, DT/HR</td>
</tr>
<tr>
<td>Energy (KWH)</td>
<td>BTU, Dktherm</td>
</tr>
<tr>
<td>Reactive Power (Vars)</td>
<td>No Equivalent¹</td>
</tr>
</tbody>
</table>

¹/ the gas business hasn’t figured out how to charge for imaginary power yet
GAS & ELECTRIC SYSTEM - DIFFERENCES

Energy Supply

Electricity Generation
9 KW

Gas Supply
30 DT

Energy Transmission

Electric Grid

Generation and use must match exactly at all times

Energy Use

Customer Use
9 KW

Customer Use
30 DT

Supply and use must eventually match but can vary significantly hour by hour due to transmission systems inherent storage ("line pack")
NATURAL GAS SYSTEMS

Interstate Pipelines

Production Areas

CNP
GAS SUPPLIES

Schematic geology of natural gas resources

- Conventional non-associated gas
- Coalbed methane
- Conventional associated gas
- Seal
- Sandstone
- Gas-rich shale
- Tight sand gas
- Oil
GAS SUPPLIES - SHALE GAS WELL

Uinta Basin

Colorado Utah

~12,000 Feet
GAS SUPPLY SOURCES

Source: EIA
How does natural gas get to Minnesota?
Figure 1. Interstate Natural Gas System Mainline Compressor Stations, 2006

Legend
- Interstate Pipeline
- Compressor Station

Note: EIA has determined that publication of this figure does not raise security concerns, based on the application of Federal Geographic Data Committee’s Guidelines for Providing Appropriate Access to Geospatial Data in Response to Security Concerns.

Source: Energy Information Administration, Natural Gas Division, Natural Gas Transportation Information System, Compressor Station Database.

1,200+ Compressor Stations, 17 million HP

Source: EIA
COMPRESSOR STATION
GAS TRANSMISSION LINES - MINNESOTA

Source: EIA
How does natural gas get to your home?
Distribution System

- TBS
- Odorizer
- HP Gas Mains
- Regulator
- Interstate Pipeline
- Service Lines and Meters
- Gas Main
- Meters
Town Boarder Stations
Odorizers
GAS MAINS
GAS MAINS
PRESSURE REGULATION
PRESSURE REGULATION
GAS METERS
# CUSTOMERS

|                    | 2019 US Consumption | 31 Trillion CF<sup>1</sup> | 2018 Minnesota | 490 BCF<sup>1</sup> |  |
|--------------------|----------------------|-----------------------------|----------------|----------------------| |
| Power Generation   | 36 %                 |                             | 13%            |                      | |
| Industrial         | 27 %                 |                             | 33%            |                      | |
| Residential        | 16 %                 |                             | 29%            |                      | |
| Commercial         | 11 %                 |                             | 23%            |                      | |
| Lease & Plant Fuel | 6 %                  |                             |                |                      | |
| Pipeline Fuel      | 3 %                  |                             | 2.5%           |                      | |
| Vehicle Fuel       | 0.16 %               |                             | 0.01%          |                      | |

<sup>1</sup> EIA Natural Gas Consumption by End Use
• Interstate Pipelines have demand based rates.
• Many Utilities, such as CNP have decoupled delivery rates.
• This is important!
• Gas throughput is not as significant to the transportation and delivery businesses.
CUSTOMERS - EXAMPLE RESIDENTIAL HOME

Gas Usage vs Temperature

BTU's Gas Used for Heating

Base Usage
What happens at -25F?
LOCAL STORAGE & PRODUCTION

- ~1,450,000 DT needed to meet CNP Minnesota design day requirements (-25F avg).
- Peak power needs of 70,000 DT/hr (20,000 MW)
- Approximately 80% is brought in through interstate pipelines under firm contracts.

- 20% of CNP Minnesota design day requirements can be produced and delivered from local storage facilities in Minnesota
  - Liquefied Natural Gas 72,000 DT/Day (20,000 MWH)
  - Underground Storage 50,000 DT/Day (15,000 MWH)
  - Propane Air MN 180,000 DT/Day (50,000 MWH)
GAS STORAGE

PROPANE-AIR PEAK SHAVING STATIONS

425 MW

85 MW
WHAT IS RNG?

- Renewable Natural Gas (RNG)
- Created from a renewable source
- Most commonly from a organic material such as ag waste, manure, landfill
- Digested by an anaerobic bacteria to produce a gas comprising methane and carbon dioxide (Biogas)
- The biogas will also contain other trace constituents that may be of concern.
BIOGAS

Raw Biogas
60% CH₄, 40% CO₂, H₂S, etc.

Pipeline Gas
88% CH₄, 9% C₂H₆, 1% C₃H₈, 1% CO₂, 1% N₂
UPGRADING BIOGAS TO RNG

• Biogas can be processed to remove almost all of the carbon dioxide (CO2)

• Many trace constituents must also be removed or significantly reduced

• Upgraded and cleaned biogas is **RNG** (also called biomethane)
TYPICAL BIOGAS UPGRADING EQUIPMENT
FOCUS ON LDC RENEWABLE NATURAL GAS

What are pipeline concerns with RNG?

- Will it burn properly in customer’s appliances?
- Is it Safe for customers and employees?
- Can it be integrated reliably into LDC system?
- Is it a reliable supply?
CAN IT BE INTEGRATED INTO THE PIPELINE SYSTEM?

- Where can the gas be used year round?
- Typical rural towns have big summer to winter swings.
- Metro areas have higher loads but limited biomass
Typical RNG Interconnection Schematic

- Biogas Supply
- Gas Control
- Control
- Shut Off Valve
- Recycle Out of Spec Gas Back to Supplier
- Distribution Main
- Meter
- Sample Port
- Odorizer
- GC
- T
- P
- CO2
- H2O
RNG INTERCONNECTION
SAFETY AND RELIABILITY

- Engineering and Design
- Pipeline Safety Management Programs
- Leak Detection
- Line Location
- Inspections
- Training and Qualification
- 24 x 7 Monitoring and Control
SAFETY

• Picarro is an innovative technology used for leak detection
• Full deployment of Picarro technology
• Picarro / Cavity Ring-Down Spectroscopy (CRDS) Vehicle
• Anemometer (top) measures wind speed and weather data
• Gas analyzer and computer processor highlight leak indication areas
Pipeline Internal Inspections

- Smart Pig
- Dumb Pig
- Pig Launcher
METHANE LEAKAGE REDUCTIONS

Alternatives to Venting
What is CenterPoint doing and planning around decarbonization strategies?

Erica Larson, CenterPoint Energy
• Green tariff, interconnection, renewable hydrogen pilot

• Carbon capture, offsets
Gas Utility Services

Regulated gas distribution jurisdictions in eight states with
~ 4.5 million customers, second largest in the U.S.
~ 119,000 miles of pipe, largest in the U.S.

Electric Utility Services

Electric transmission and distribution operations with ~2.4 million metered customers across ~5,000 sq. miles in and around Houston, Texas

Electric generation, transmission, and distribution to ~145,000 metered customers in southwestern Indiana

(1) Operational data based on information as of December 31, 2017
(2) Does not include approximately 72,000 natural gas customers as of December 31, 2017 that are under residential and small commercial choice programs invoiced by their host utility
Largest natural gas distribution business in Minnesota:

**Serving**
- 860,000 customers
- 260 communities

**Employing**
- 1,200 employees
CONSERVATION IMPROVEMENT PROGRAM

2013-2017 Average Energy Efficiency Performance of Natural Gas Utilities, Average Annual Dth Savings (bubble size)


MORE COST EFFECTIVE
• Wanted more detail on tracking and verification systems
• Wanted local supply
• Wanted a demonstration of scalability
• Encouraged the Company to resubmit a revised program proposal
Proposes a process for producers seeking interconnection
Proposes quality standards for injection

CenterPoint Energy will not (necessarily) buy the RNG – will transport to interstate system for producer
Will charge similar to existing transport tariff – a monthly basic charge, a volumetric “receipt” charge
CenterPoint Energy will seek a return on investments to serve RNG developers similar to return for transport customers
  • Reduces the need for upfront payment by developer
Changing Our Fuel Mix: Hydrogen Demonstration

- Generates renewable electricity
- Powers electrolysis
- Creates renewable hydrogen gas
- Added to pipeline system for natural gas customer use
Reducing Methane Leakage

Methane Emissions from CenterPoint Energy Operations

Other Strategies: Carbon Capture

- A portion of the flue gas is drawn from the common exhaust.
- C02 clean exhaust is returned to the chimney.
- Commercial grade pearl ash production.
- Heat recovered from chemical reaction and exhaust gases.
- Municipal water supply.
- Diverting valve.
- Mixing valve.
• Definitions

• Clarifies legislative intent that natural gas utilities can assist the state in meeting existing renewable energy and greenhouse gas reduction goals

• Alternative resource plans

• Renewable natural gas inventory
How is CenterPoint Energy Inc. Thinking about Decarbonization?: Corporate Carbon Policy

**NEW GOALS TO REDUCE CARBON EMISSIONS from 2005 levels**

- **70% reduction from our operations by 2035**
- **20-30% reduction from customer usage by 2040**

1. Partnering with customers to offer affordable conservation and energy-efficiency programs
2. Continuing to develop alternative fuels programs
3. Partnering with suppliers to lower their methane emissions
4. Piloting and supporting research and development
How Is CenterPoint Energy Inc. Thinking about Decarbonization?:

Imagining An Energy Future

Hypothetical Future Utilizing New Strategies and Technologies?

- Traditional Gas
- Low-Carbon Gas
- Community Thermal Loops
- Gas Heat Pumps
- Electric/Gas Hybrid Systems
- New Energy Efficiency
- Carbon Capture
- Carbon Offsets
What is Xcel doing and planning around decarbonization strategies?

Lauren Wilson, Xcel Energy
Xcel Energy

Serving eight states
- 3.6 million electricity customers
- 2 million natural gas customers

Nationally recognized leader:
- Wind energy
- Energy efficiency
- Carbon emission reductions and reporting
- Innovative technology
Leading the Clean Energy Transition
A bold vision for a carbon-free future

2019 Results
44% Lower Carbon Emissions

2030 Goal
80% Lower Carbon Emissions

2050 Vision
100% Carbon-Free Electricity

Company-wide emissions reductions from the electricity serving our customers, compared to 2005
Reducing Emissions from the Natural Gas System

Producers and Suppliers

- Partnering to encourage transparency and disclosure
- Exploring opportunities to drive best practices among our suppliers

Xcel Energy System

- Replacing pipelines
- Participating in EPA Natural Gas STAR, Methane Challenge
- Participating in ONE Future
- Connecting RNG, hydrogen and power to gas

Customer

- Increasing conservation
- Developing voluntary electrification programs
- Offering customers low-carbon supply options

Collaborative Natural Gas Sustainability Initiatives
The natural gas system is an energy workhorse

Customers depend on natural gas on cold winter days

Polar Vortex Peak Day Gas Volume

Equivalent to:

- 57,000 turbines
- 21 million gallons of heating oil
- 32 million gallons of propane
- 45 million rooftop solar installations
Challenges to Replacing Natural Gas

Technology

Impacts to Low-income Customers

Unintended Environmental Impacts

Customer Choice

Electricity Dependence

Safety and Comfort
Our System: Environmental Leadership

- EPA Natural Gas Star and Methane Challenge
- 50+ customer conservation programs
Our System: ONE Future Commitment

- Industry partnership started in 2014
- 20 members across the supply chain
- Goal is to limit emissions rate of entire supply chain below 1%
- Distribution must limit emissions rate below 0.2% (emissions divided throughputs, normalized)
Our Customers: Voluntary Offerings

We are pursuing a portfolio of programs to address customer emissions with the technology available today.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing Load</td>
<td>Expand gas energy efficiency</td>
</tr>
<tr>
<td>Beneficial Electrification</td>
<td>Gas to electric water heater programs</td>
</tr>
<tr>
<td></td>
<td>All electric community offering</td>
</tr>
<tr>
<td>Lower Carbon Supply</td>
<td>Renewable Natural Gas customer product</td>
</tr>
<tr>
<td></td>
<td>Hydrogen demonstration</td>
</tr>
</tbody>
</table>
Our Suppliers: Upstream Strategy

- **Disclosure**
  - Participating in initiatives that encourage increased disclosure and emissions reporting among suppliers
    - MJ Bradley Natural Gas Supply Collaborative
    - EEI’s Natural Gas Sustainability Initiative

- **Best Practices**

- **Performance**
  - Evaluating ways to further exert our buying power as an individual company
Reduce and repurpose: future innovation

- Renewable natural gas
- Hydrogen and power to gas
- Long-duration storage
- Hybrid appliances
Reducing Emissions from the Natural Gas System

Producers and Suppliers

- Collaborative Natural Gas Sustainability Initiatives
  - Partnering to encourage transparency and disclosure
  - Exploring opportunities to drive best practices among our suppliers

Xcel Energy System

- Participating in EPA Natural Gas STAR, Methane Challenge
- Participating in ONE Future
- Connecting RNG, hydrogen and power to gas
- Replacing pipelines

Customer

- Increasing conservation
- Developing voluntary electrification programs
- Offering customers low-carbon supply options
- Partnering to encourage transparency and disclosure
Discussion:

- Challenges and opportunities with regard to utility perspectives on decarbonizing natural gas.
- Certainties and uncertainties (revisit from last meeting if time allows)
DECARBONIZING MINNESOTA’S NATURAL GAS END USES

Meeting 4

March 13th, 2020

Via Zoom