Meeting Goals

1. Build a shared understanding of how natural gas consumption contributes to greenhouse gas emissions and other pollutants.

2. Build a shared understanding of the breakdown of natural gas end uses across Minnesota, including from the perspective of the state and different sized cities.

3. Review conversations and themes from the previous meeting to identify guiding principles that can provide boundaries to support a productive process (to continue being refined in subsequent meetings).
Emissions and Pollutants Associated with Natural Gas

Dr. Margaret Cherne-Hendrick, Fresh Energy
Emissions and pollutants associated with natural gas

Margaret Cherne-Hendrick, PhD
Director, Beneficial Electrification

Decarbonizing Minnesota’s Natural Gas End Uses: Meeting 2
January 10, 2020
For 28 years, shaping and driving realistic, visionary energy policies that benefit all Minnesotans.

**Strategic Imperative:**
Fresh Energy helps to advance Minnesota’s transition to a clean energy future with:

- Dramatic, economy-wide reductions in carbon emissions;
- A thriving clean-energy economy; and
- Holistic solutions that reduce disparities and increase equity.
Emissions and pollutants associated with natural gas

- Fugitive methane emissions
  - Methane leakage and/or venting
- Natural gas combustion and indoor air quality
  - Carbon monoxide
  - Nitrogen dioxide
Methane is a potent greenhouse gas

<table>
<thead>
<tr>
<th>Lifetime (years)</th>
<th>GWP$_{20}$</th>
<th>GWP$_{100}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH$_4^b$</td>
<td>12.4$^a$</td>
<td>No cc fb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>With cc fb</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Organization</th>
<th>GWP$_{100}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPA</td>
<td>25</td>
</tr>
<tr>
<td>MPCA</td>
<td>25</td>
</tr>
<tr>
<td>City of Minneapolis</td>
<td>28</td>
</tr>
</tbody>
</table>
Global methane emissions are on the rise

Source: NOAA Earth System Research Laboratory, Global Monitoring Division
In the US, methane emissions are greatest across oil and natural gas systems.

**US GHG Emissions, 2017**
- Carbon Dioxide: 82%
- Methane: 10%
- Nitrous Oxide: 6%
- Fluorinated Gases: 3%

**Methane Emissions, 2017**
- Natural Gas and Petroleum Systems: 31%
- Enteric Fermentation: 27%
- Landfills: 16%
- Other: 8%
- Manure Management: 9%
- Coal Mining: 8%

Natural gas systems dominate US methane emissions from these energy sources.


**Oil and Gas Methane Emissions by Segment, 2017**

- **Gas Production:** 54%
- **Oil Production:** 18%
- **Transmission and Storage:** 16%
- **Processing:** 6%
- **Distribution:** 6%
Methane leakage occurs across the natural gas process chain
Production

- The amount of methane leaked from US oil and gas wells and related infrastructure in 2015 equaled about 2.3% of the country's overall natural gas output. That is much more than the 1.4% the EPA estimated.

- These fugitive emissions are equal to $2B in fuel and 13 million metric tons of methane. This is enough to fuel 10M homes for a year.

Transmission/Distribution

- In a survey of nearly 12% of the US population and 4 of the 10 most populous cities (focusing on older, leak-prone urban centers), emission estimates are more than 2x the total in the EPA inventory for these regions and are predominantly attributed to fugitive natural gas losses.

- Current estimates for methane emissions from the natural gas supply chain appear to require revision upward, in part possibly by including end-use emissions, to account for these urban losses.

Behind the Meter

- Preliminary research suggests that while individually small, the appliances and buildings that make up the residential sector could contribute significantly to national scale emissions.

- Furnaces are the most leak-prone of appliances, contributing to 0.14% of total methane emissions from the US natural gas sector.

- Combining measurements from whole house emissions and steady-state operation of appliances, residential homes and appliances could account for over 2% of the methane released from the natural gas sector.

Plant et al. (2019) Large fugitive methane emissions from urban centers along the U.S. East Coast. Geophysical Research Letters. 46. 8500-8507.
The Minnesota context

- Minnesota does not have any natural gas reserves or production.
- Minnesota's natural gas supplies come from producing areas in Canada, North Dakota, Wyoming, Montana, Kansas, Oklahoma, Texas, and New Mexico.
- Interstate natural gas pipelines that enter Minnesota, primarily from South Dakota, North Dakota, and Canada, deliver more than four times as much natural gas as is consumed in the state, and three-fourths of the natural gas that enters the state continues on to Iowa and Wisconsin on its way to markets in the Midwest and beyond.
National methane emissions are associated with MN consumption
Natural gas consumption in MN is dominated by the industrial sector

End-use consumption by sector, excluding losses
1,395.6 trillion British thermal units
(percent of total for all sectors)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Consumption</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>205.6</td>
<td>(14.7%)</td>
</tr>
<tr>
<td>Industrial</td>
<td>483.1</td>
<td>(34.6%)</td>
</tr>
<tr>
<td>Residential</td>
<td>245.5</td>
<td>(17.6%)</td>
</tr>
<tr>
<td>Transportation</td>
<td>461.4</td>
<td>(33.1%)</td>
</tr>
</tbody>
</table>
Decarbonization strategies must account for fugitive methane emissions
Natural gas serves various residential end-uses

Space heating
- Electricity: 72.0%
- Natural gas: 39.0%
- Propane: 7.2%

Cooking
- Electricity: 34.5%
- Natural gas: 62.1%
- Propane: 3.4%

Water heating
- Electricity: 60.6%
- Natural gas: 36.0%
- Propane: 3.8%

Clothes drying
- Electricity: 28.8%
- Natural gas: 69.9%
- Propane: 1.4%

Source: 2017 American Housing Survey; 2015 Residential Energy Consumption Survey (Midwest)
Natural gas appliances and heating devices can generate a variety of air pollutants.
Emerging research demonstrates the health impacts of indoor natural gas combustion

- The MN Department of Health found that natural gas cooking was reported as an asthma trigger by 35% of children and 43% of adults participating in the 2015 Minnesota Asthma Call-back Survey, making it the third and the fourth most commonly reported trigger for children and adults with asthma in the state, respectively.

- A recent study estimated that 62% and 9% of residents using natural gas stoves are regularly exposed to nitrogen dioxide and carbon monoxide levels, respectively, that exceed ambient (outdoor) air quality standards set by the EPA.

- Children and the elderly are particularly vulnerable to the adverse health effects resulting from natural gas-generated air pollutants in buildings, in part because they spend the majority of their time indoors. Children are also vulnerable because their organs and nervous systems are still developing.

- Rural, low-income, and minority residents are more vulnerable to the adverse health effects of using natural gas in buildings because they are more likely to use unvented gas cooking and heating appliances and to use gas stoves as a supplemental heat source.

Thanks!

Margaret Cherne-Hendrick, PhD  
Director, Beneficial Electrification  
cherne-hendrick@fresh-energy.org  
651-294-7193
Characterizing natural gas end uses across Minnesota

Adam Zoet, Department of Commerce
Minnesota’s Current Natural Gas Usage Baseline:

1. Where and How MN Uses Natural Gas
2. How MN Saves Natural Gas Consumption
Where and How Minnesota Uses Natural Gas
Baseline Forecasted Natural Gas Sales
(No energy-efficiency)

- Program: (11% Reduction)
- Max Achievable: (18% Reduction)
- Economic: (33% Reduction)
• **IOUs serve 94%** of MN’s natural gas sales.

• **2/3 of residential customers** are served by natural gas utilities.

• **17% of residential customers** use electricity as their primary heating source.
• Single Family = Over 1/3 Gas Sales.
  • 2 largest end-uses: Space heating + domestic hot water.

• Commercial Segment = Remaining 1/3 of Gas Sales.
  • Space heating = over 50% consumption.
  • Domestic hot water + cooking = most of the remainder.

• Industrial Segment = Almost 1/3 of Gas Sales.
  • Largest end-use: Process heating.
HVAC Sales Data from D+R International

Regional market shares for furnaces and boilers (2013-2016).

<table>
<thead>
<tr>
<th>Region</th>
<th>Furnaces</th>
<th>Boilers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twin Cities</td>
<td>24.6%</td>
<td>14.5%</td>
</tr>
<tr>
<td>Central East</td>
<td>22.4%</td>
<td>7.8%</td>
</tr>
<tr>
<td>Central West</td>
<td>13.9%</td>
<td>11.9%</td>
</tr>
<tr>
<td>Southeast</td>
<td>17.3%</td>
<td>11.4%</td>
</tr>
<tr>
<td>Southwest</td>
<td>6.7%</td>
<td>6.8%</td>
</tr>
<tr>
<td>Northwest</td>
<td>6.4%</td>
<td>9.2%</td>
</tr>
<tr>
<td>Northeast</td>
<td>8.7%</td>
<td>38.4%</td>
</tr>
<tr>
<td>Total</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Market share for efficiency categories of furnaces in 2016, statewide and by region

- **Statewide**:
  - <90%
  - 90-94%
  - AFUE 95+

- **Twin Cities**:
  - <90%
  - 90-94%
  - AFUE 95+

- **Central East**:
  - <90%
  - 90-94%
  - AFUE 95+

- **Central West**:
  - <90%
  - 90-94%
  - AFUE 95+

- **Southeast**:
  - <90%
  - 90-94%
  - AFUE 95+

- **Southwest**:
  - <90%
  - 90-94%
  - AFUE 95+

- **Northwest**:
  - <90%
  - 90-94%
  - AFUE 95+

- **Northeast**:
  - <90%
  - 90-94%
  - AFUE 95+
How Minnesota Saves Natural Gas
1980: PUC directed to initiate a pilot to demonstrate the “feasibility” of investments in EE.

1983: Utilities with revenues greater than $50 million were required to operate at least 1 conservation program. Required “significant” investment.

1989: All Public utilities were required to operate conservation improvement programs. Oversight transferred from PUC, low-income requirements added.

1991: A specific level of spending was required (1.5% electric, 0.5% gas) & munis and coops were included.


2010: 1.5% Savings Goal for Utilities takes Effect

2017: Munis and Coops meeting a specific threshold exempted from CIP.
MN EE Achievements – Natural Gas
<table>
<thead>
<tr>
<th></th>
<th>2018</th>
<th>2017</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Energy Savings (Dth)</td>
<td>Savings as % of Sales</td>
<td>Energy Savings (Dth)</td>
</tr>
<tr>
<td>CenterPoint Energy (CPE)</td>
<td>1,980,534</td>
<td>1.40%</td>
<td>2,632,545</td>
</tr>
<tr>
<td>Greater MN Gas (GMG)</td>
<td>12,137</td>
<td>1.18%</td>
<td>5,398</td>
</tr>
<tr>
<td>Great Plains (GP)</td>
<td>36,083</td>
<td>0.64%</td>
<td>13,577</td>
</tr>
<tr>
<td>Xcel Energy (Xcel)</td>
<td>913,240</td>
<td>1.27%</td>
<td>799,597</td>
</tr>
<tr>
<td>MN Energy Resources Corp (MERC)</td>
<td>509,758</td>
<td>0.97%</td>
<td>402,989</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,451,752</strong></td>
<td><strong>3,854,106</strong></td>
<td><strong>3,452,581</strong></td>
</tr>
</tbody>
</table>
## Cost of Efficiency in MN

<table>
<thead>
<tr>
<th>State</th>
<th>ACEEE Ranking</th>
<th>Gas spending ($/therm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts</td>
<td>1</td>
<td>$7.39</td>
</tr>
<tr>
<td>California</td>
<td>2</td>
<td>$6.02</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>3</td>
<td>$5.89</td>
</tr>
<tr>
<td>Vermont</td>
<td>4</td>
<td>$3.68</td>
</tr>
<tr>
<td>Oregon</td>
<td>5</td>
<td>$3.56</td>
</tr>
<tr>
<td>Connecticut</td>
<td>6</td>
<td>$6.17</td>
</tr>
<tr>
<td>Washington</td>
<td>7</td>
<td>$3.83</td>
</tr>
<tr>
<td>New York</td>
<td>7</td>
<td>$5.12</td>
</tr>
<tr>
<td><strong>Minnesota</strong></td>
<td><strong>9</strong></td>
<td><strong>$1.76</strong></td>
</tr>
<tr>
<td>Maryland</td>
<td>10</td>
<td>$9.88</td>
</tr>
</tbody>
</table>
Emissions Reductions from Natural Gas Efficiency

2015 + 2016 Gas Efficiency Savings

- Emissions reductions = 400,000 tons CO₂/Yr
- Equivalent to the emissions of 77,000 passenger vehicles.
Minnesota has a strong foundation of effective CIP programs

- Minnesota currently has some of the lowest cost and best performing programs in the country
- Utilities in Minnesota – both IOUs and COUs – have been proactive in designing and implementing comprehensive, effective, and innovative program models

Partnerships have helped increase program effectiveness

- Deep relationships with trade allies have helped utilities deliver programs
- Smaller utilities face additional challenges in implementing programs, but the most successful COU programs involve cooperation among utilities
- Some utilities have achieved enhanced performance through joint natural gas-electric programs
Discussion:

Statewide natural gas end uses and emissions impacts
DECARBONIZING MINNESOTA’S NATURAL GAS END USES

Meeting 2 – Related emissions

January 10th, 2020
McKnight Foundation
City Level Perspectives on Natural Gas End Uses and Emissions Impacts

Luke Hollenkamp, City of Minneapolis
Abby Finis, Great Plains Institute
Natural Gas use in Minneapolis

Decarbonizing Natural Gas End Uses in MN

Luke Hollenkamp - City Coordinator’s Office, Division of Sustainability

January 10, 2020
City adopted a Climate Action Plan with GHG reduction goals in 2013

Committed to reducing community-wide greenhouse gas emissions

• 15% by 2015
• 30% by 2025
• 80% by 2050

using 2006 as a baseline.
GHG Emissions are Generally Decreasing

- GHG emissions decreased 17% in 2018 compared to the 2006 baseline, but rose since 2017
Natural gas emissions are now greater than electricity for the first time

- Electricity emissions continue downward, natural gas emissions continue upward trend
Buildings continue to drive emissions

GHG Emissions by Activity (2018)

- Natural Gas 40%
- On-Road Transportation 24%
- Electricity 33%
- Wastewater 1%
- Solid Waste 2%

Building energy consumption is 73% of total
Commercial / Industrial sector dominates emissions
New era: Natural gas emissions are biggest barrier to City’s GHG goals

- Tailwinds for electricity, headwinds for natural gas
- Highlights strategic importance on natural gas focus
Takeaways from 2018 Update

GHG emissions are down 17% overall since 2006

Natural gas emissions are now the largest source and are trending up

Buildings, particularly commercial and industrial, continue to drive emissions and are not resilient to weather extremes

Current trends
  • Potentially will not achieve City’s 2025 GHG goal
  • Will not achieve City’s 2050 GHG goal at current pace unless gas emissions drop more than 50%

Strategic importance for City and partners to dramatically reduce gas use and adopt alternatives
Takeaways from 2018 Update

GHG emissions are down 17% overall since 2006

Natural gas emissions are now the largest source and are trending up

Buildings, particularly commercial and industrial, continue to drive emissions and are not resilient to weather extremes

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Strategic importance for City and partners to dramatically reduce gas use and adopt alternatives
DECARBONIZING MINNESOTA’S NATURAL GAS END USES:
City-level Perspectives

McKnight Foundation
January 10th, 2020

Abby Finis | Senior Energy Planner
afinis@gpisd.net
Trends in 2040 Comprehensive Plans

- 117 include solar requirements
- 26 achieved SolSmart designation
- 55 are GreenStep Cities
- 36 include a resilience chapter
- 31 want to complete an energy plan
- 32 want to complete a climate action plan
# Climate and Energy Goals

<table>
<thead>
<tr>
<th>City</th>
<th>Climate/Energy Goals</th>
<th>Renewable/Solar Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Marais</td>
<td><strong>Climate Action Plan:</strong> Carbon Neutral by 2040</td>
<td><strong>Achieve Energy Resilience,</strong> 100% renewable for city operations</td>
</tr>
<tr>
<td>Northfield</td>
<td>2019 (draft) <strong>Climate Action Plan:</strong> Carbon free by 2040</td>
<td>10% in-boundary renewable electricity (20 MW); carbon free electricity by 2030</td>
</tr>
<tr>
<td>Rochester</td>
<td>2017 <strong>Energy Action Plan:</strong> Supports state goal to reduce GHG emissions 80% by 2050</td>
<td>Mayoral proclamation for community to attain 100% renewable electricity by 2031</td>
</tr>
<tr>
<td>St. Louis Park</td>
<td>2018 <strong>Climate Action Plan:</strong> Carbon neutral, community-wide by 2040</td>
<td>100% renewable electricity by 2030, 10% in-boundary (37 MW); city ops currently at 100% renewable</td>
</tr>
<tr>
<td>St. Paul</td>
<td>2019 (draft) <strong>Climate Action and Resilience Plan:</strong> Reduce emissions 50% by 2030, carbon neutral by 2050, community-wide</td>
<td>10% in boundary renewable electricity (200 MW)</td>
</tr>
<tr>
<td>Minneapolis</td>
<td>2013 <strong>Climate Action Plan:</strong> 80% reduction in emissions from 2005 by 2050, community-wide</td>
<td>100% renewable electricity by 2030 community-wide  100% renewable electricity city ops 2022</td>
</tr>
</tbody>
</table>
GREENHOUSE GAS EMISSIONS

AVERAGE

Greenhouse gas emissions have decreased by 19% since 2007. This equates to a 25% reduction per capita.

Build on this momentum.
The electric sector decreased by 40% while natural gas and travel emissions remained relatively constant.

Keep pushing electricity while finding solutions for natural gas and travel.
Natural Gas Emissions

2017 Energy Action Plan: Supports state goal to reduce GHG emissions 80% by 2050

Mayoral proclamation for community to attain 100% renewable electricity by 2031
Community Emissions Profile

GHG Breakdown by Sector (Tons of CO2), 2016
- Commercial: 54%
- Residential: 22%
- Transportation: 24%

GHG Breakdown by Fuel Type (Tons of CO2), 2016
- Electricity: 43%
- Natural Gas: 33%
- Fuel: 24%
Future Emissions Profile

GHG Breakdown by Fuel Type (Tons of CO2)

2016
- Electricity 35%
- Natural Gas 25%
- Transportation 40%

2030
- Electricity 9%
- Natural Gas 36%
- Transportation 55%
Community Emissions Profile

Emissions by Energy Type, Tons of CO2

- Warren
- Grand Marais
- Falcon Heights
- Jordan
- Columbia Heights
- Stillwater
- Red Wing
- Hopkins
- Hutchinson
- Faribault
- New Brighton
- White Bear Lake
- Rogers
- Bemidji
- Shoreview
- Oakdale
- Winona
- Inver Grove Heights
- Saint Louis Park
- Roseville
- Moorhead
- Apple Valley
- Woodbury
- Edina
- Coon Rapids
- Bloomington

Emissions by Energy Type, Tons of CO2 (2030)

- Warren
- Grand Marais
- Falcon Heights
- Jordan
- Columbia Heights
- Stillwater
- Red Wing
- Hopkins
- Hutchinson
- Faribault
- New Brighton
- White Bear Lake
- Rogers
- Bemidji
- Shoreview
- Oakdale
- Winona
- Inver Grove Heights
- Saint Louis Park
- Roseville
- Moorhead
- Apple Valley
- Woodbury
- Edina
- Coon Rapids
- Bloomington
Advanced Thermal Strategies

1. Fuel Switching
2. Combined Heat and Power
3. Ground/Air-source Heat Pumps
4. District Heating
5. Renewable Natural Gas
6. Carbon offsets
7. Emerging Technologies
Discussion:

Challenges and opportunities based on how natural gas end uses vary across the state
THANK YOU