DECARBONIZING MINNESOTA'S NATURAL GAS END USES

Meeting 2 – Related emissions

January 10th, 2020

McKnight Foundation

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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

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Center for Energy and Environment

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

Fresh Energy

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.

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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

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Methane is a potent greenhouse gas

	Lifetime (years)		GWP_{20}	GWP_{100}
CH_4[b]	12.4[a]	No cc fb	84	28
		With cc fb	86	34

Organization	GWP_{100}
EPA	25
MPCA	25
City of Minneapolis	28

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

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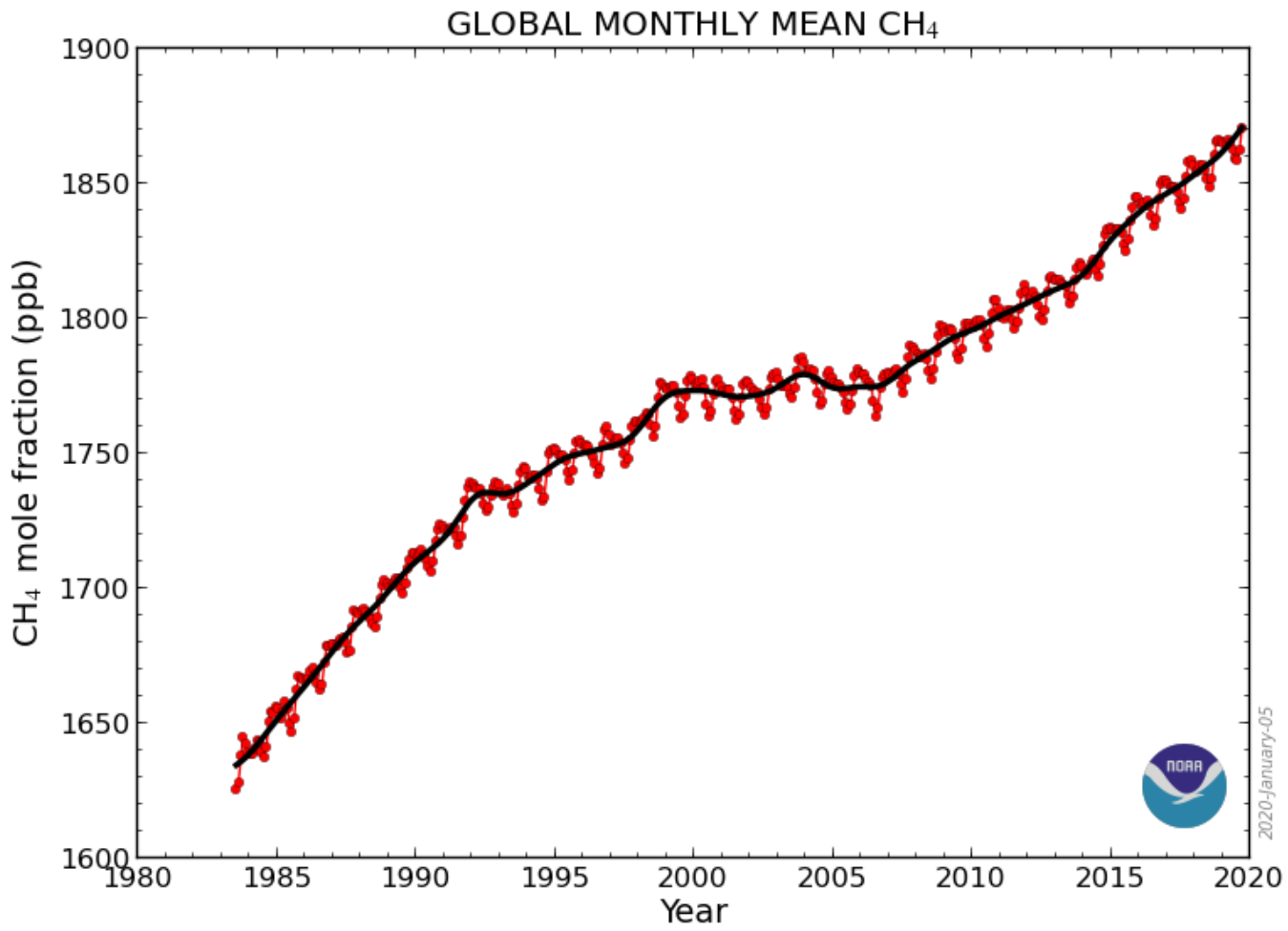
Global methane emissions are on the rise



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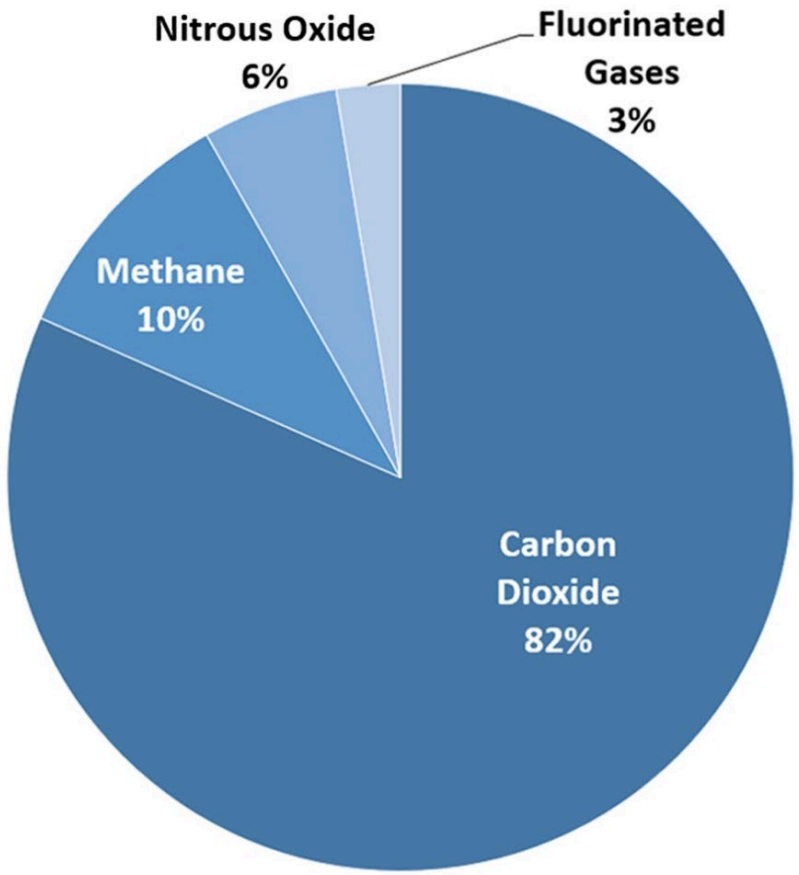
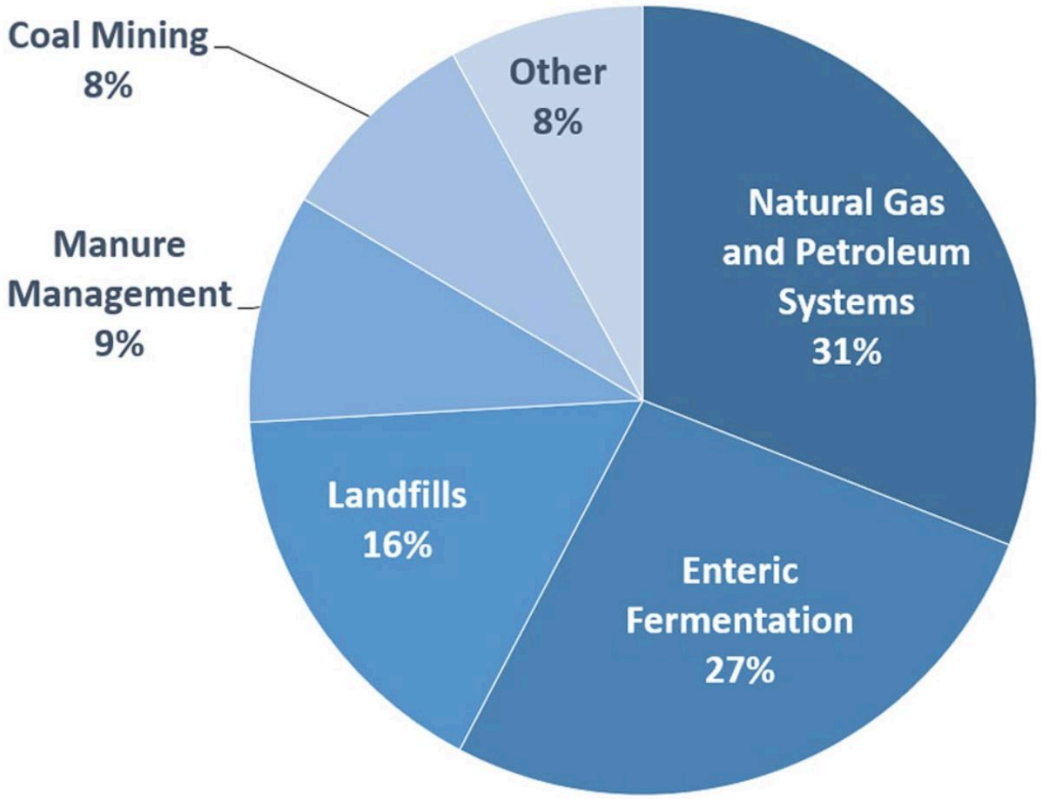
Source: NOAA Earth System Research Laboratory, Global Monitoring Division

In the US, methane emissions are greatest across oil and natural gas systems



US GHG Emissions, 2017



Methane Emissions, 2017

Source: US EPA (2019) US Inventory of GHG Gas Emissions and Sinks: 1990-2017

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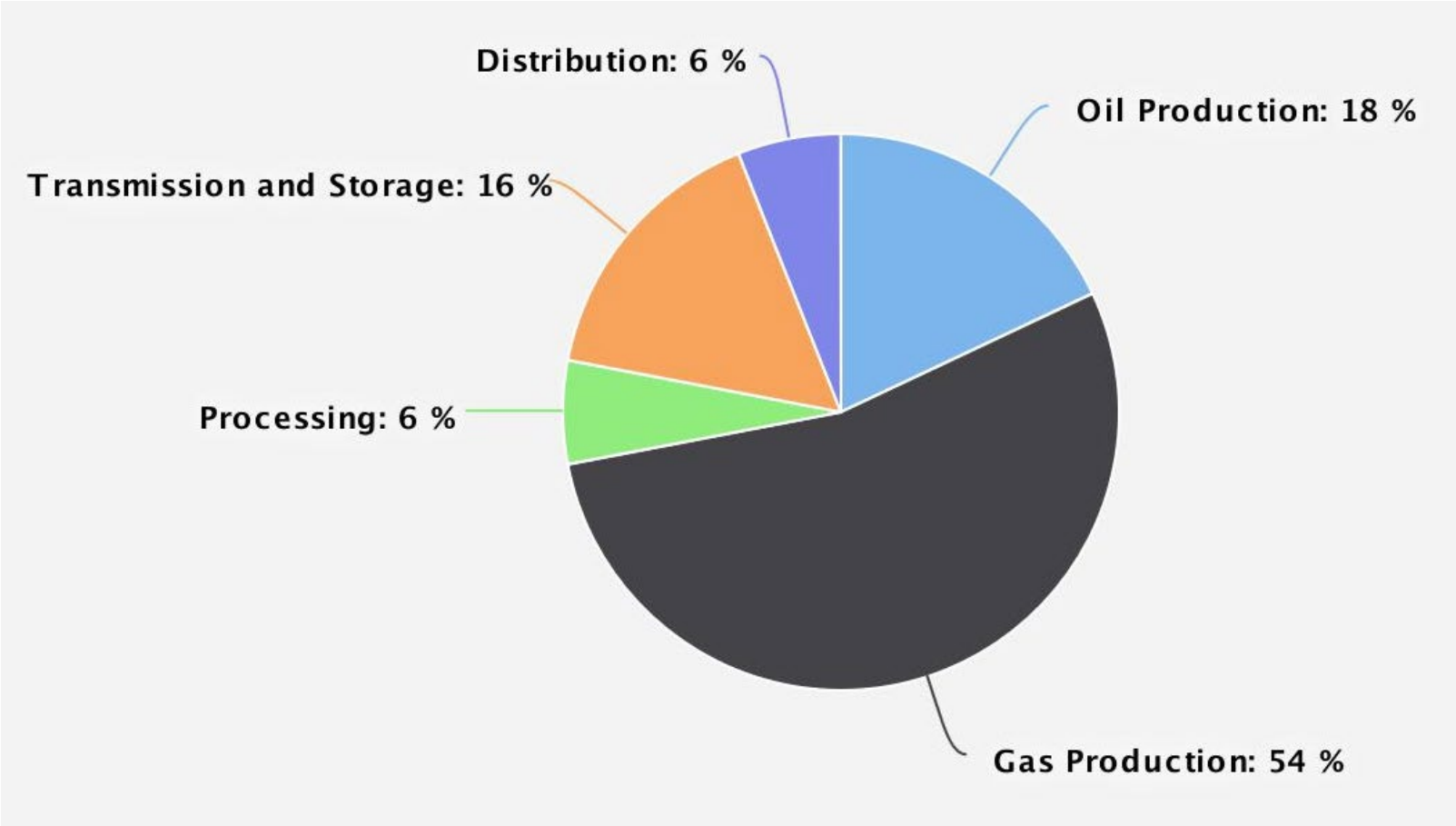
Natural gas systems dominate US methane emissions from these energy sources



Oil and Gas Methane Emissions by Segment, 2017

Source: US EPA (2019) US Inventory of GHG Gas Emissions and Sinks: 1990-2017

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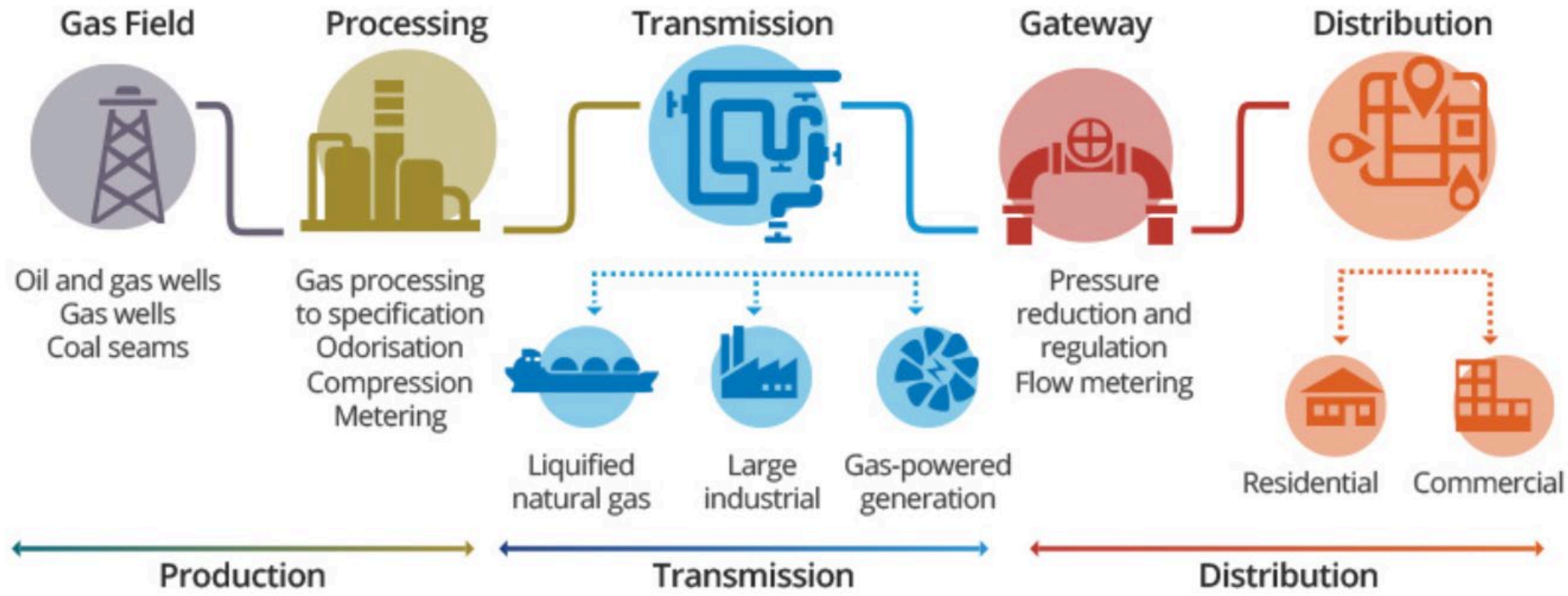
Methane leakage occurs across the natural gas process chain



AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

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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.

Sources: Alvarez et al. (2018) Assessment of methane emissions from the US oil and gas supply chain. Science. 361:6398. 186-188.
Plant et al. (2019) Large fugitive methane emissions from urban centers along the U.S. East Coast. Geophysical Research Letters. 46. 8500–8507.
Saint-Vincent and Pekney. (2020) Beyond-the-Meter: Unaccounted Sources of Methane Emissions in the Natural Gas Distribution Sector. Environmental Science & Technology. 54:1. 39-49.

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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.

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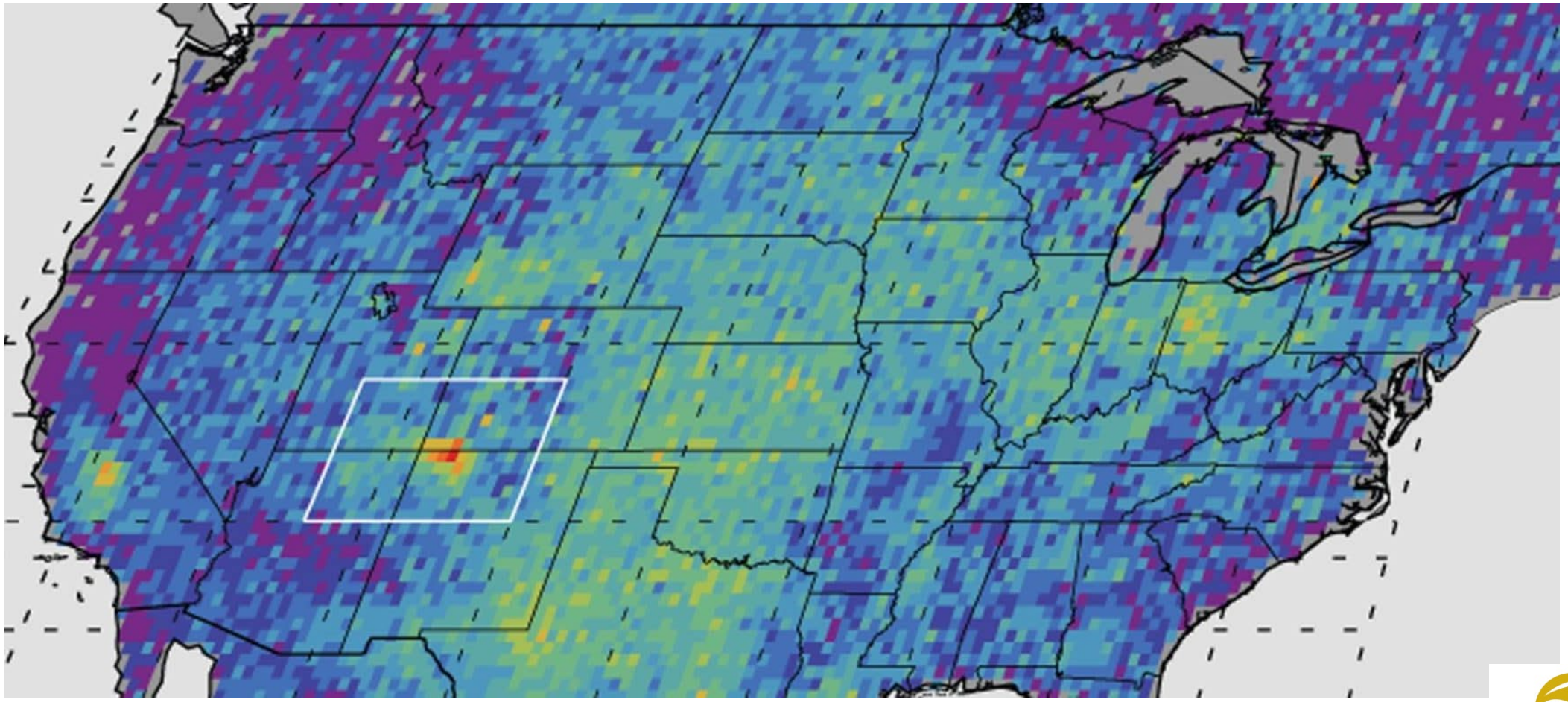
National methane emissions are associated with MN consumption



Jet Propulsion Laboratory
California Institute of Technology

Fresh Energy

Source: NASA/JPL-Caltech/University of Michigan

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)

Commercial
205.6
(14.7%)

Industrial
483.1
(34.6%)

Residential
245.5
(17.6%)

Transportation
461.4
(33.1%)

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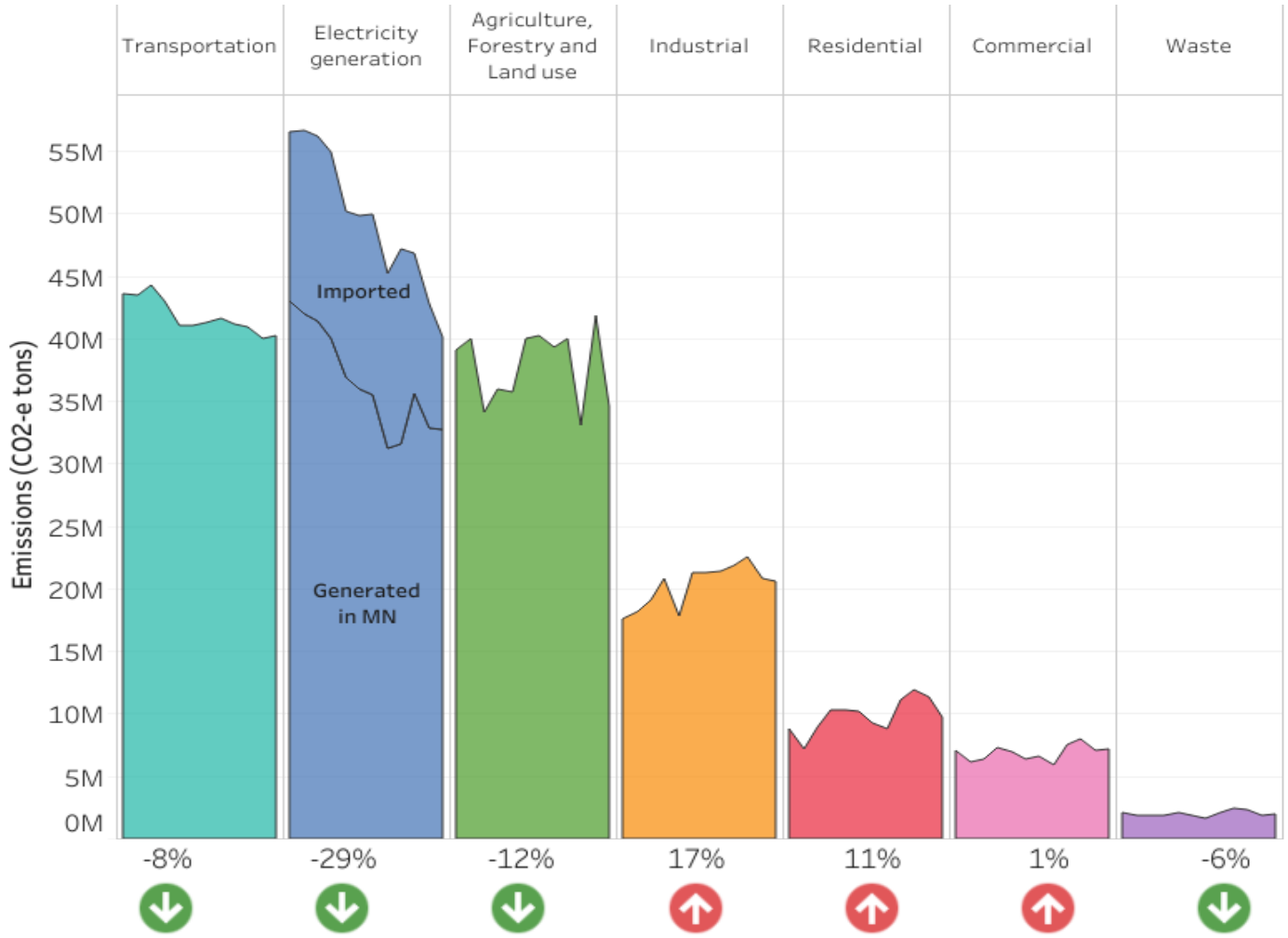
Decarbonization strategies must account for fugitive methane emissions



Emissions change (2005-2016)

MPCA

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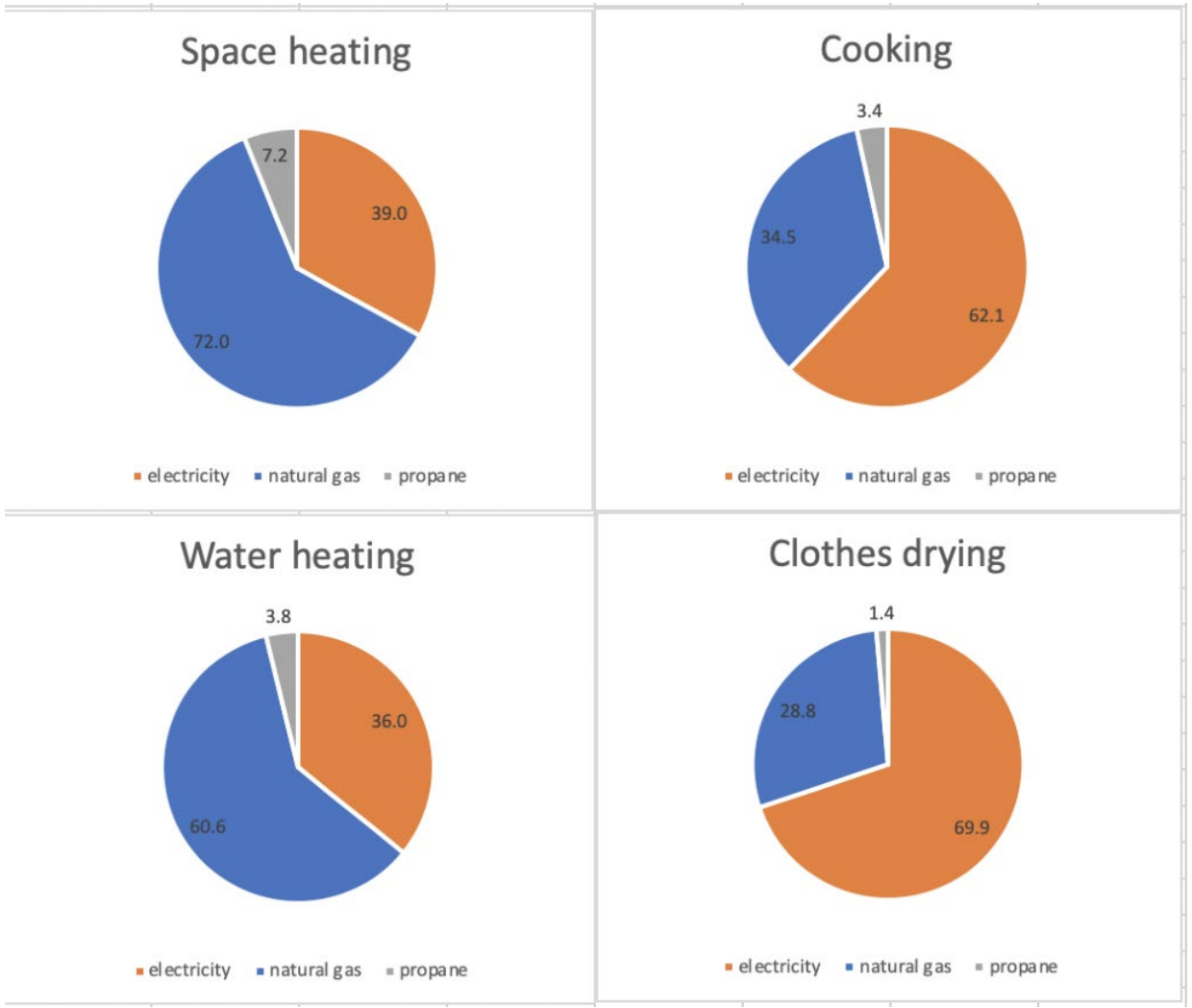
Natural gas serves various residential end-uses



Source: 2017 American Housing Survey; 2015 Residential Energy Consumption Survey (Midwest)

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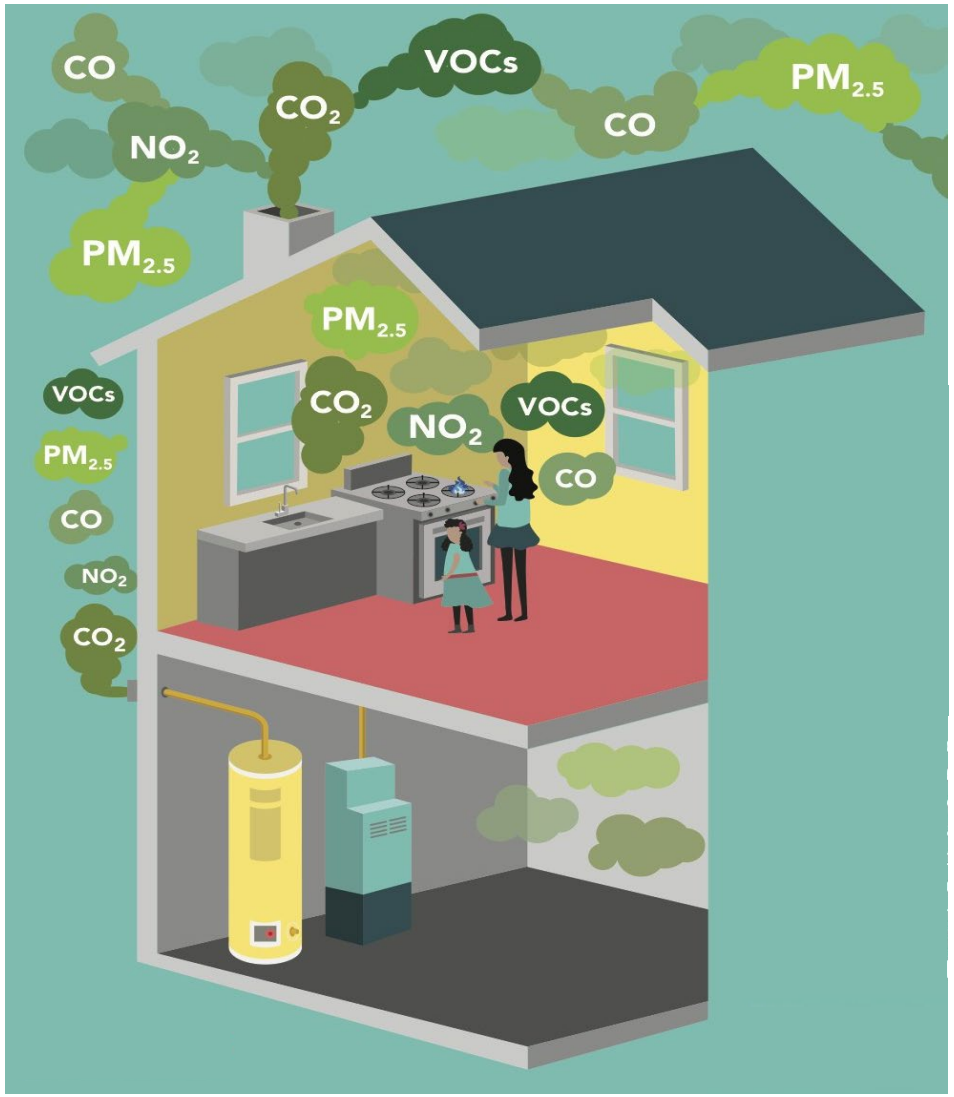
Natural gas appliances and heating devices can generate a variety of air pollutants



RESOURCE MEDIA

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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.

Sources: Logue et al. (2013) Pollutant exposures from natural gas cooking burners: a simulation-based assessment for Southern California. Environmental Health Perspectives. 122:1. 43–50.

Delp and Singer (2012) Performance Assessment of U.S. Residential Cooking Exhaust Hoods. Environmental Science & Technology. 46:11. 6167-6173.

Fresh Energy

Fresh Energy

Thanks!

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Characterizing natural gas end uses across Minnesota

Adam Zoet, Department of Commerce

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Center for Energy and Environment

COMMERCE DEPARTMENT
ENERGY RESOURCES

Decarbonizing Natural Gas Stakeholder Meeting: Characterizing End-Uses Across Minnesota

January 10, 2020

Adam Y. Zoet

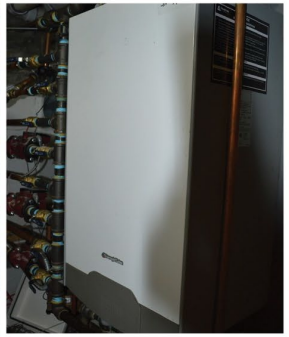
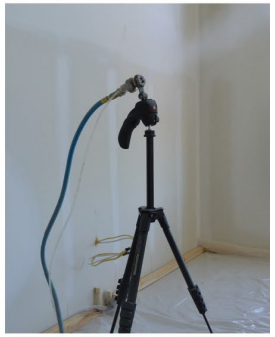
Agenda



Minnesota's Current Natural Gas Usage Baseline:

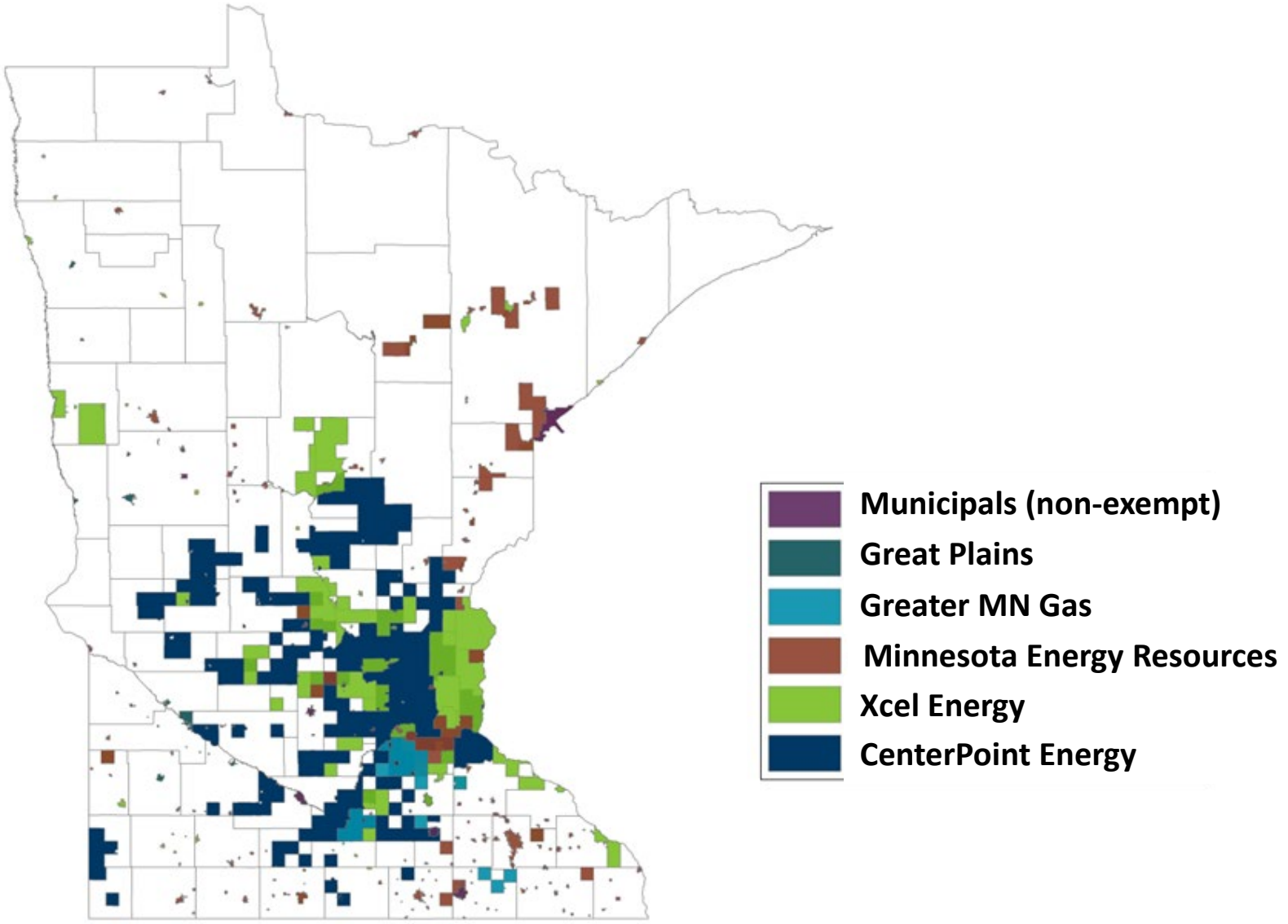
1. Where and How MN Uses Natural Gas
2. How MN Saves Natural Gas Consumption

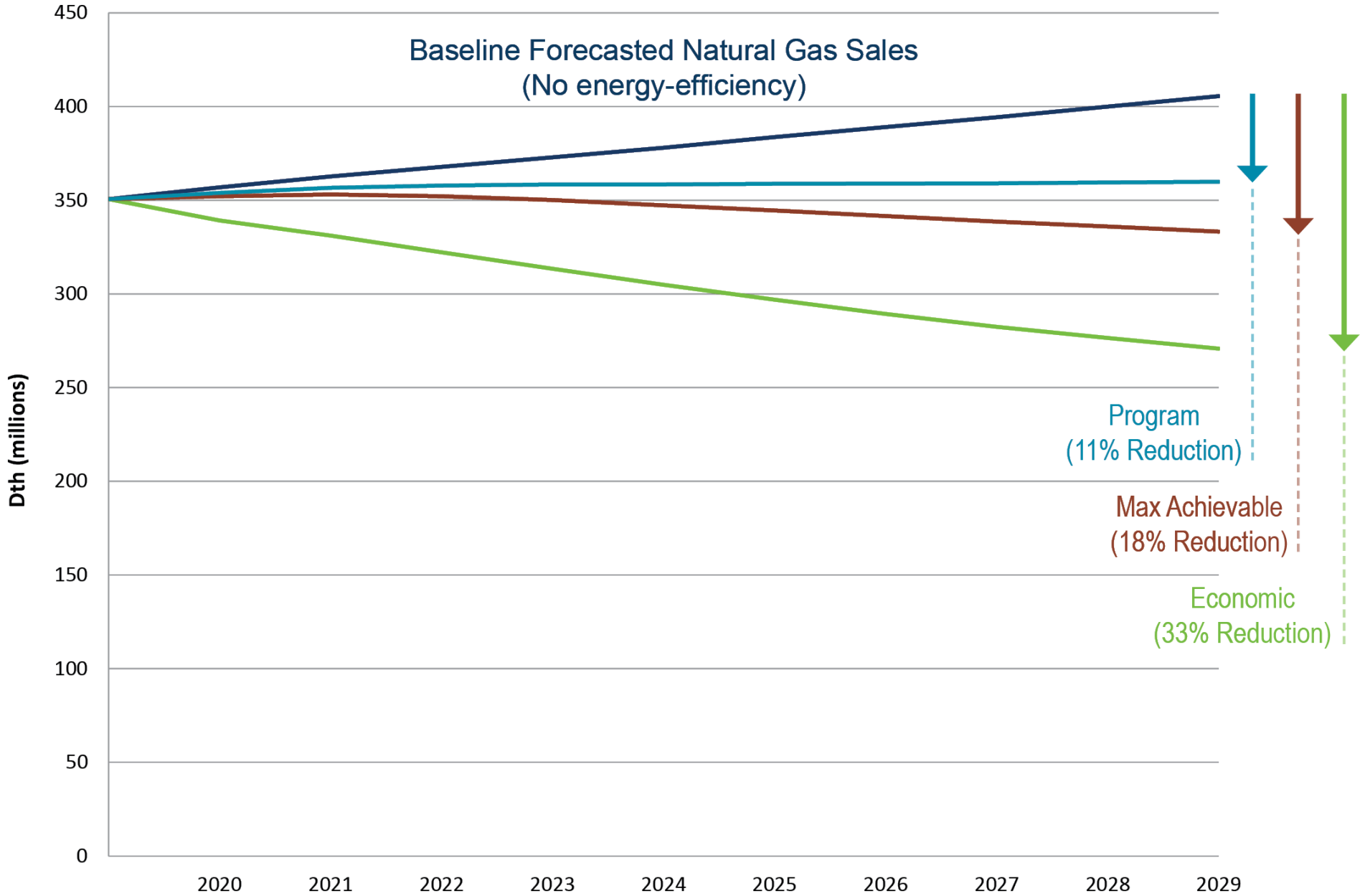


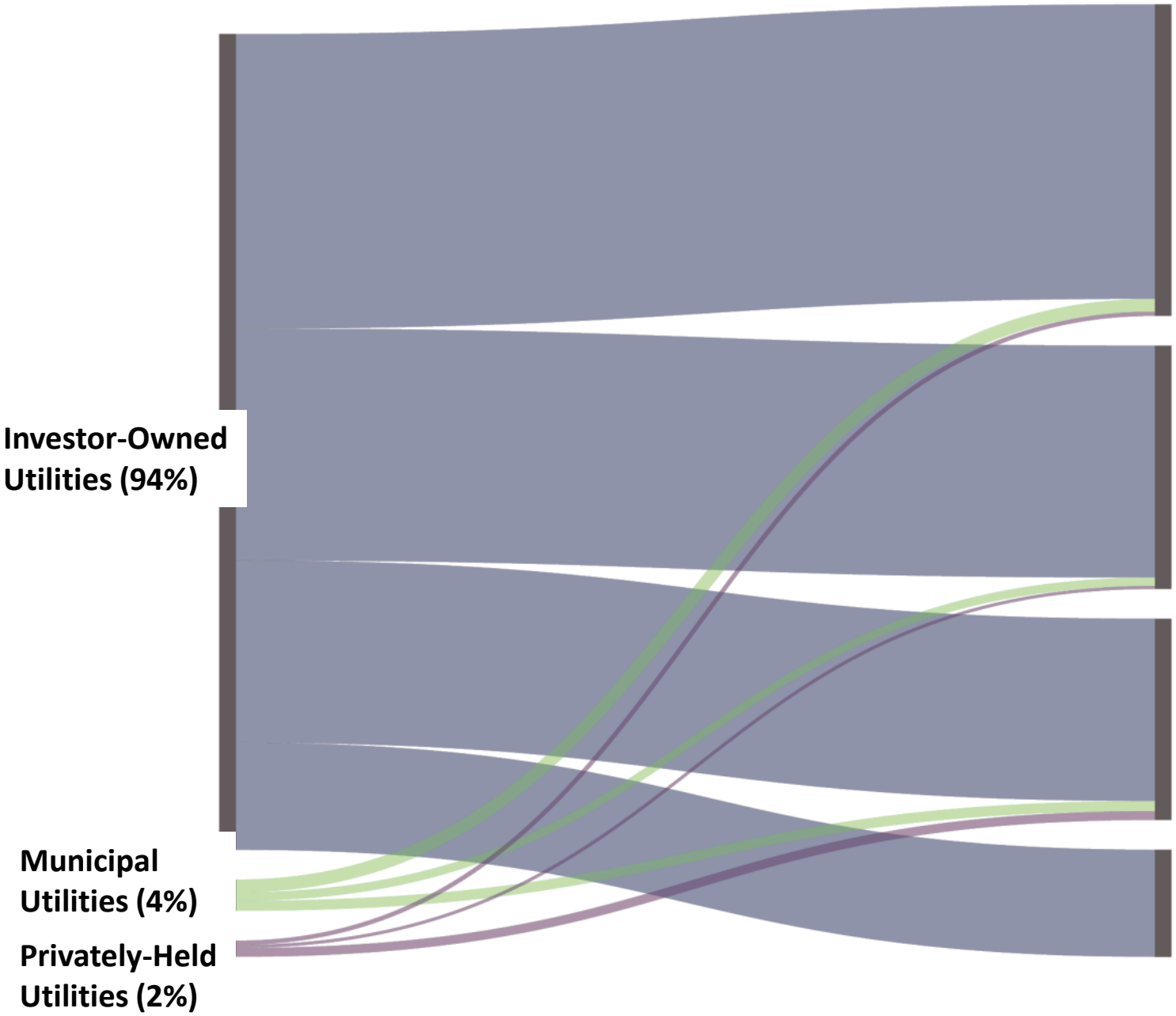



Where and How Minnesota Uses Natural Gas

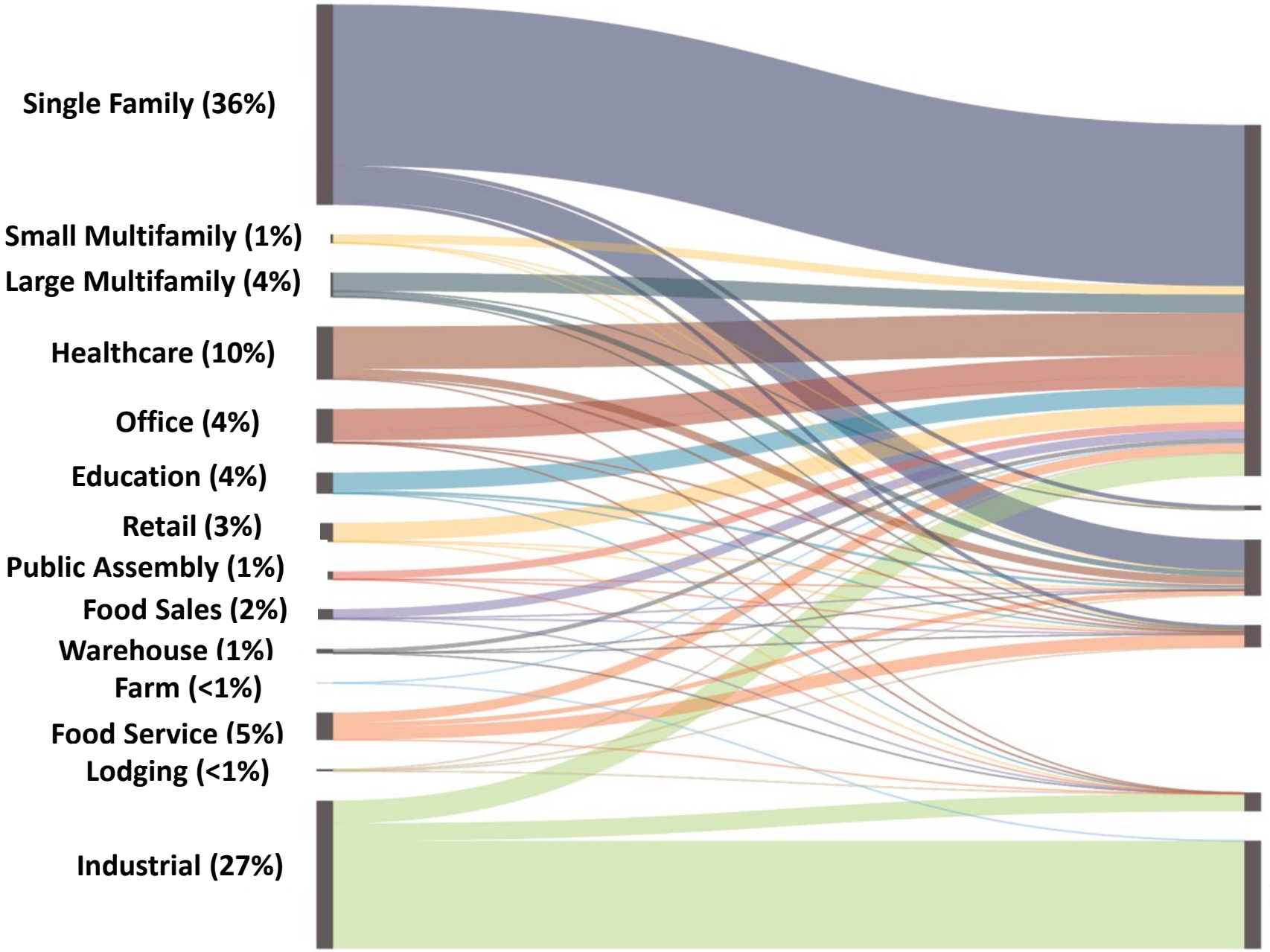
Natural Gas Utility Service Territory Map




Baseline Forecasted Natural Gas Sales
(No energy-efficiency)
Dth (millions)
450
400
350
300
250
200
150
100
50
0
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
Program
(11% Reduction)
Max Achievable
(18% Reduction)
Economic
(33% Reduction)



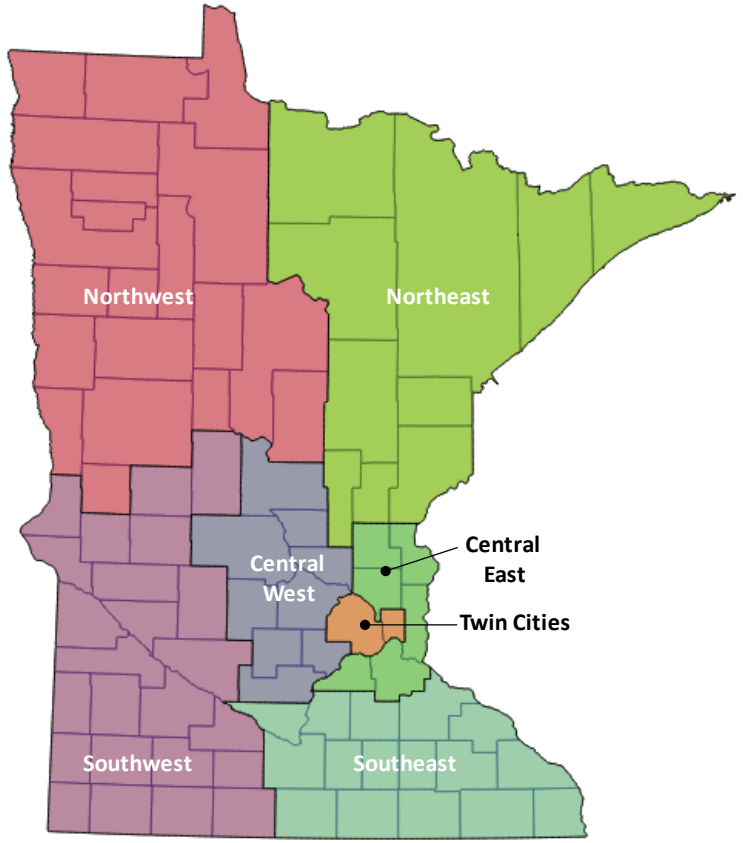
- **IOUs serve 94%** of MN's natural gas sales.
- **2/3 of residential customers** are served by natural gas utilities.
- **17% of residential customers** use electricity as their primary heating source.



- **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

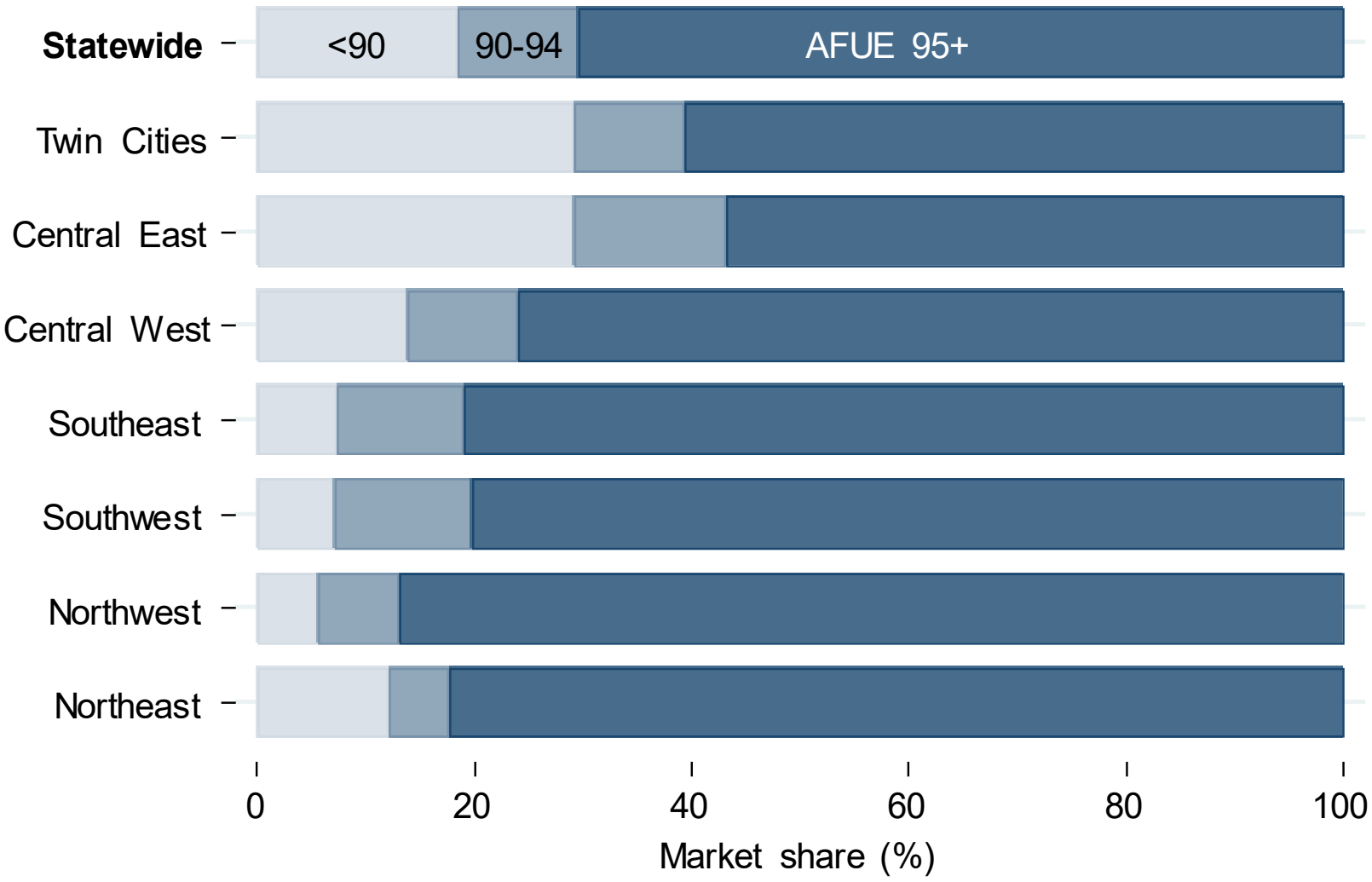
HVAC sales data regions



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

Region	Furnaces	Boilers
Twin Cities	24.6%	14.5%
Central East	22.4%	7.8%
Central West	13.9%	11.9%
Southeast	17.3%	11.4%
Southwest	6.7%	6.8%
Northwest	6.4%	9.2%
Northeast	8.7%	38.4%
Total	100.0%	100.0%

Market share for efficiency categories of furnaces in 2016, statewide and by region



How Minnesota Saves Natural Gas

History of "CIP" (Conservation Improvement Program)

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.

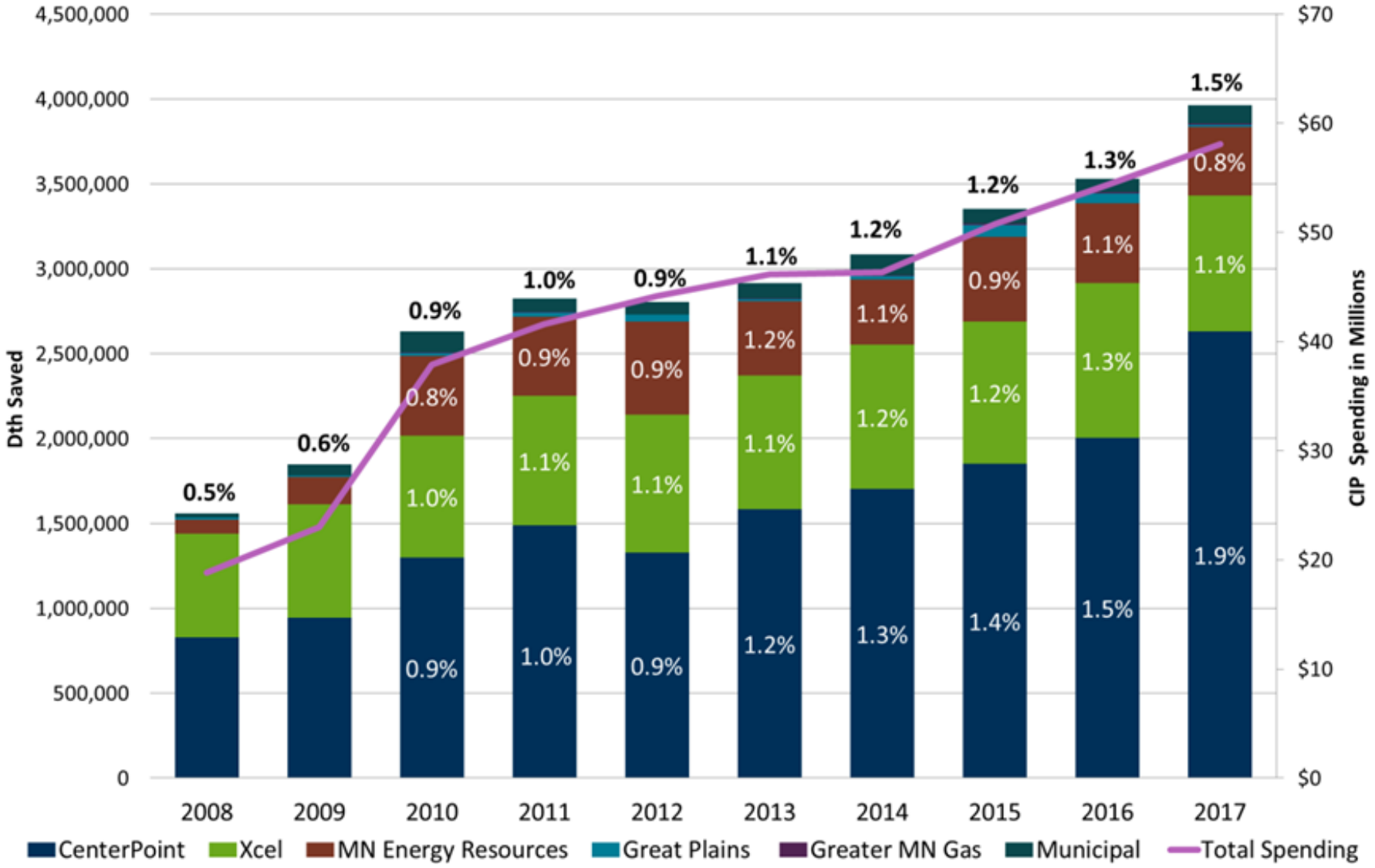
1991:
A specific level of spending was required (1.5% electric, 0.5% gas) & munis and coops were included.

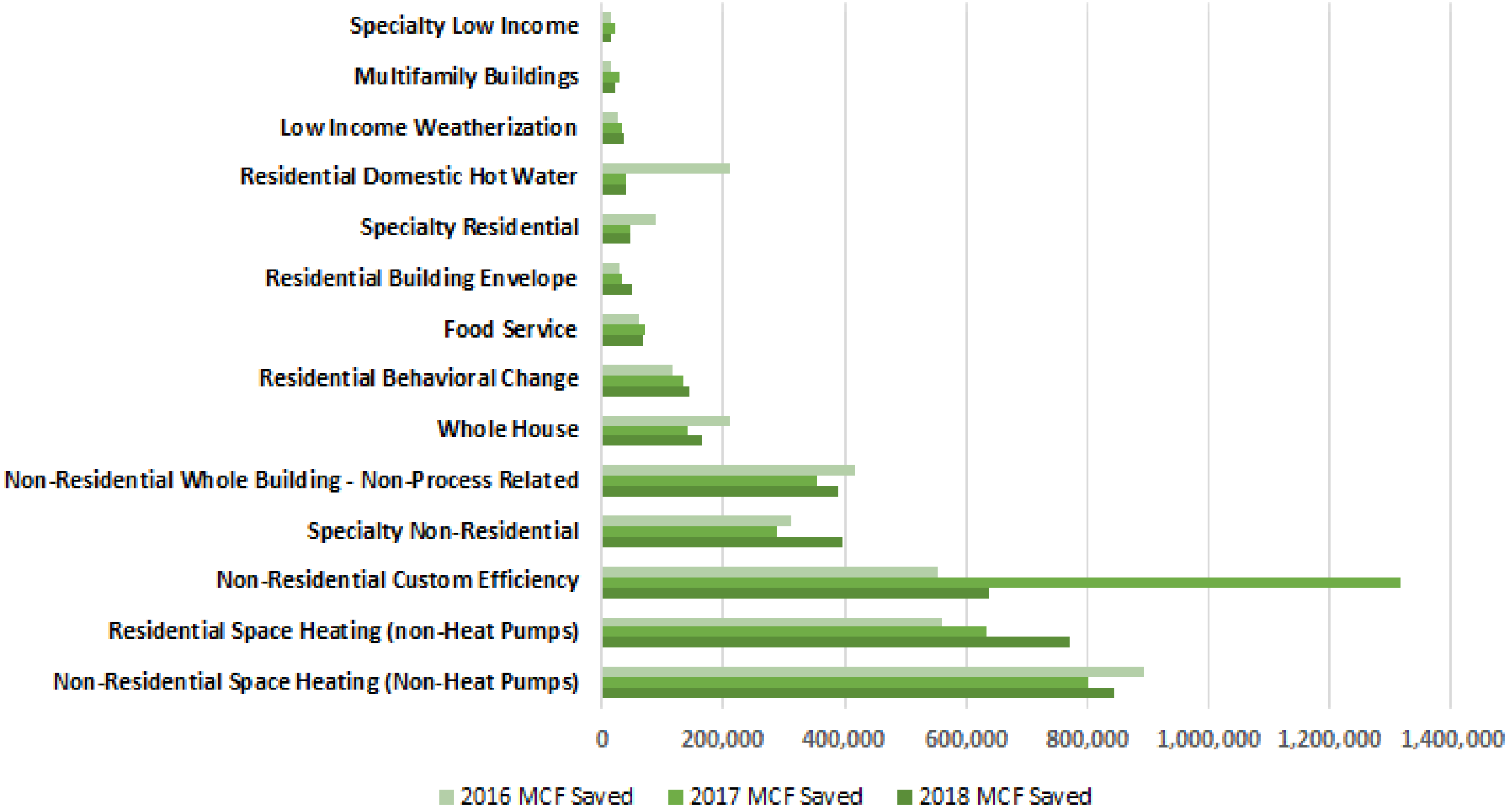
2007:
Next Generation Energy Act Passes.

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



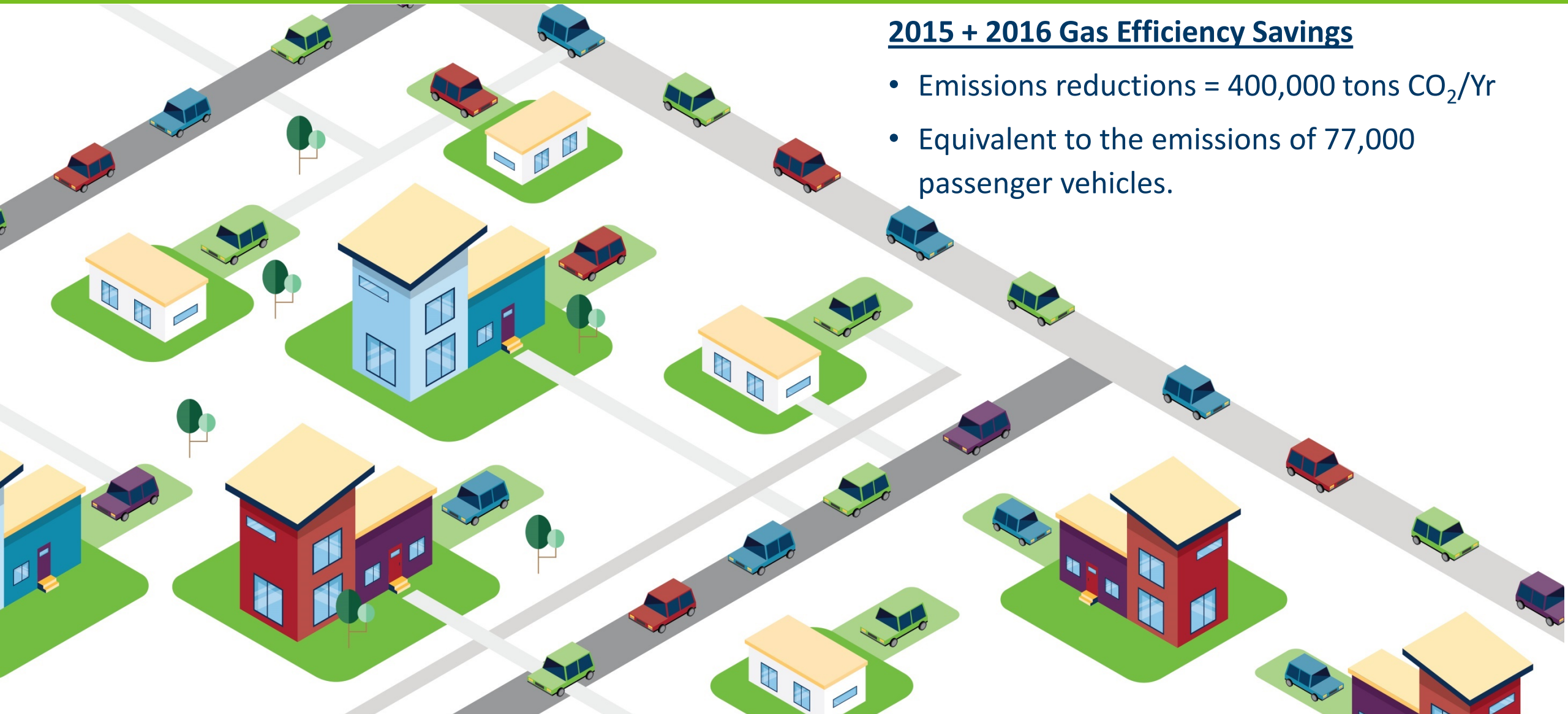

Specialty Low Income
Multifamily Buildings
Low Income Weatherization
Residential Domestic Hot Water
Specialty Residential
Residential Building Envelope
Food Service
Residential Behavioral Change
Whole House
Non-Residential Whole Building - Non-Process Related
Specialty Non-Residential
Non-Residential Custom Efficiency
Residential Space Heating (non-Heat Pumps)
Non-Residential Space Heating (Non-Heat Pumps)
0
200,000
400,000
600,000
800,000
1,000,000
1,200,000
1,400,000
2016 MCF Saved
2017 MCF Saved
2018 MCF Saved

	2018		2017		2016	
	Energy Savings (Dth)	Savings as % of Sales	Energy Savings (Dth)	Savings as % of Sales	Energy Savings (Dth)	Savings as % of Sales
CenterPoint Energy (CPE)	1,980,534	1.40%	2,632,545	1.87%	2,006,014	1.47%
Greater MN Gas (GMG)	12,137	1.18%	5,398	0.48%	9,426	2.09%
Great Plains (GP)	36,083	0.64%	13,577	0.24%	56,669	1.02%
Xcel Energy (Xcel)	913,240	1.27%	799,597	1.11%	908,472	1.31%
MN Energy Resources Corp (MERC)	509,758	0.97%	402,989	0.76%	472,000	1.09%
Total	**3,451,752**		**3,854,106**		**3,452,581**	

Cost of Efficiency in MN

State	ACEEE Ranking	Gas spending ($/therm)
Massachusetts	1	$7.39
California	2	$6.02
Rhode Island	3	$5.89
Vermont	4	$3.68
Oregon	5	$3.56
Connecticut	6	$6.17
Washington	7	$3.83
New York	7	$5.12
Minnesota	9	$1.76
Maryland	10	$9.88

Emissions Reductions from Natural Gas Efficiency



2015 + 2016 Gas Efficiency Savings

- Emissions reductions = 400,000 tons CO_2/Yr
- Equivalent to the emissions of 77,000 passenger vehicles.

Current MN Utility Program Findings

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

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Discussion:

Statewide natural gas end uses and emissions impacts

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DECARBONIZING MINNESOTA'S NATURAL GAS END USES

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City Level Perspectives on Natural Gas End Uses and Emissions Impacts

Luke Hollenkamp, City of Minneapolis
Abby Finis, Great Plains Institute

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Center for Energy and Environment

CITY OF MINNEAPOLIS

Natural Gas use in Minneapolis

Decarbonizing Natural Gas End Uses in MN

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

Minneapolis
City of Lakes

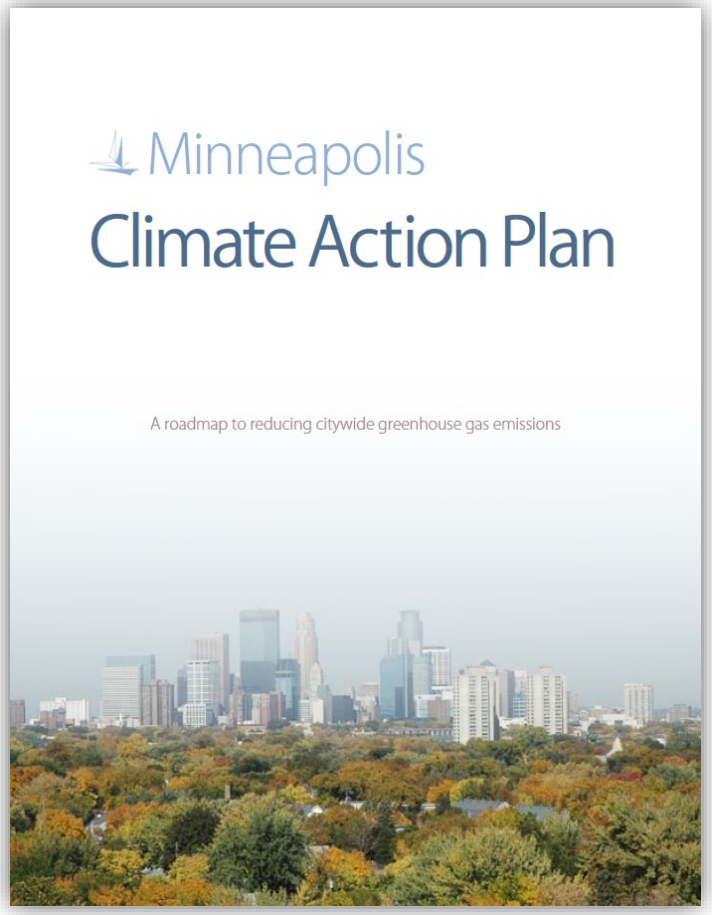
January 10, 2020

City adopted a Climate Action Plan with GHG reduction goals in 2013

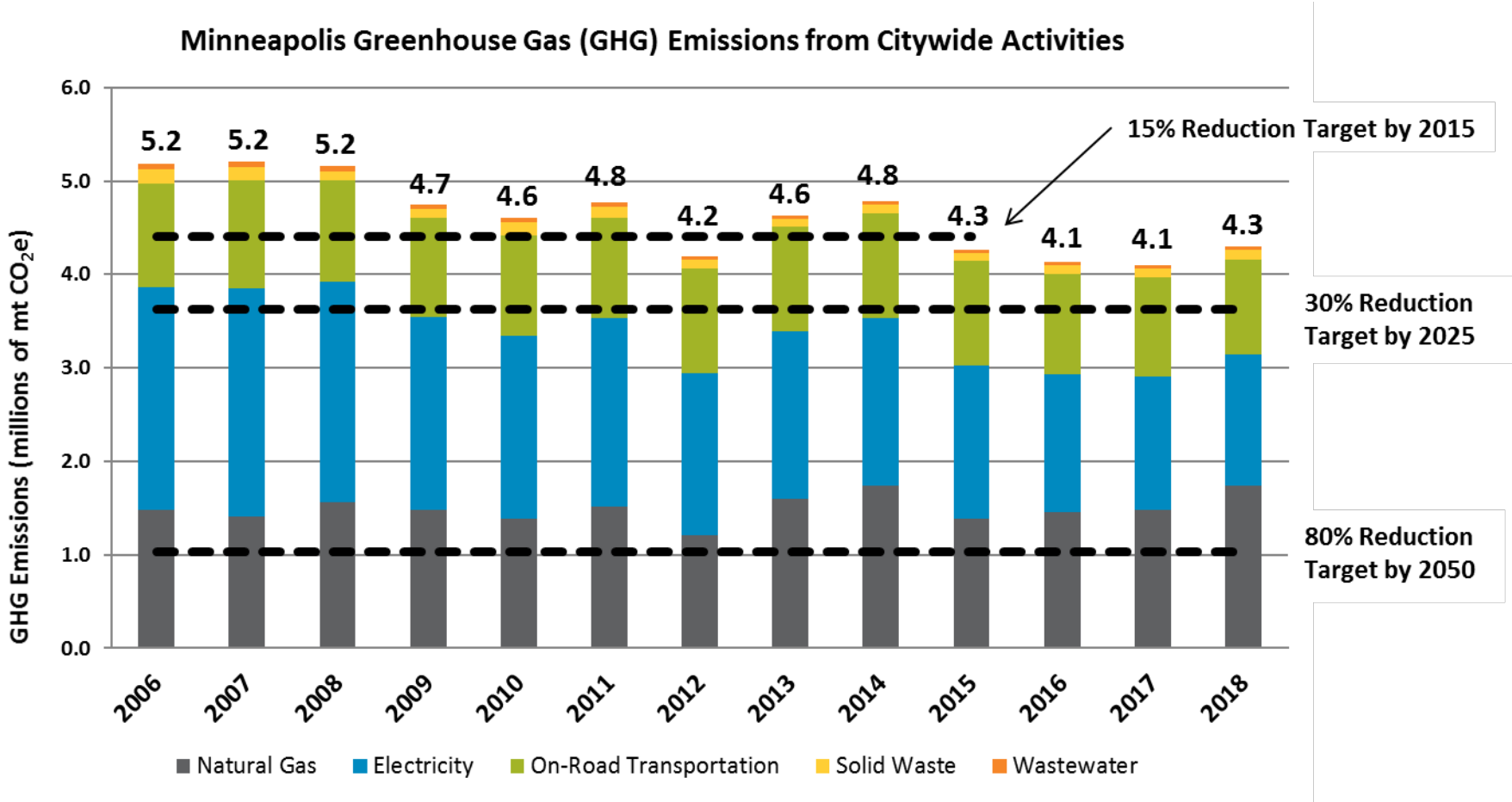
Committed to reducing community-wide greenhouse gas emissions

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

using 2006 as a baseline.

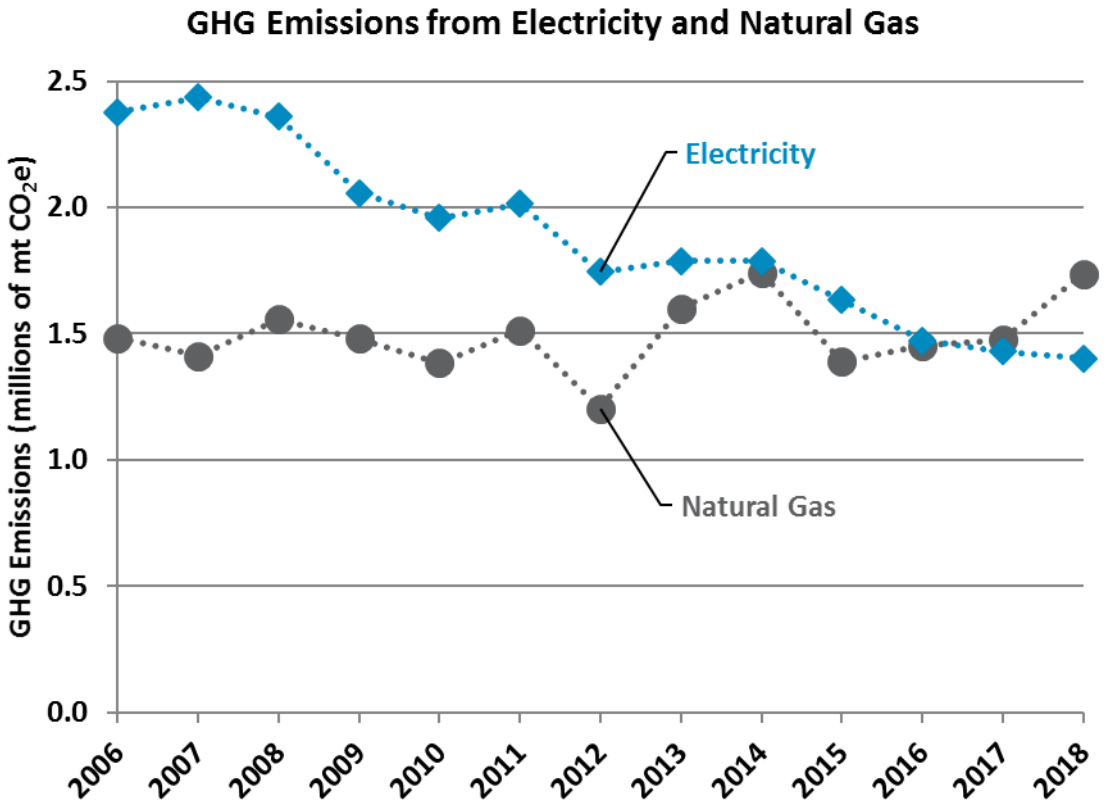


GHG Emissions are Generally Decreasing



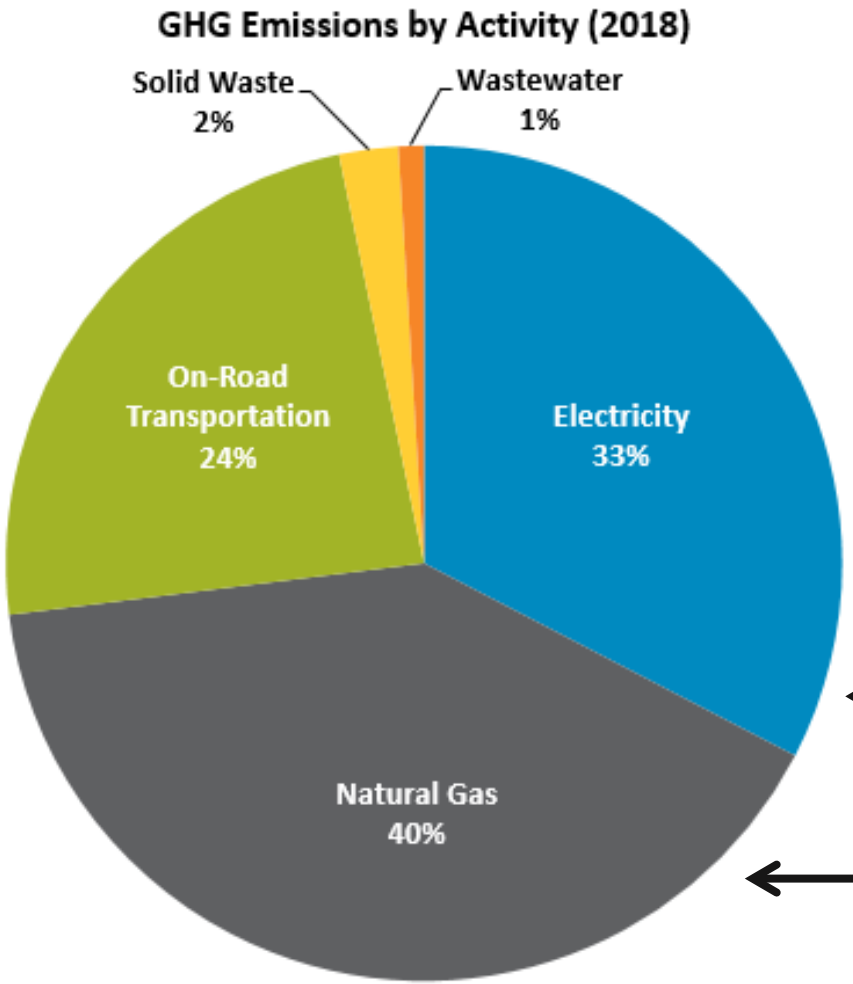
- GHG emissions decreased 17% in 2018 compared to the 2006 baseline, but rose since 2017

Natural gas emissions are now greater than electricity for the first time



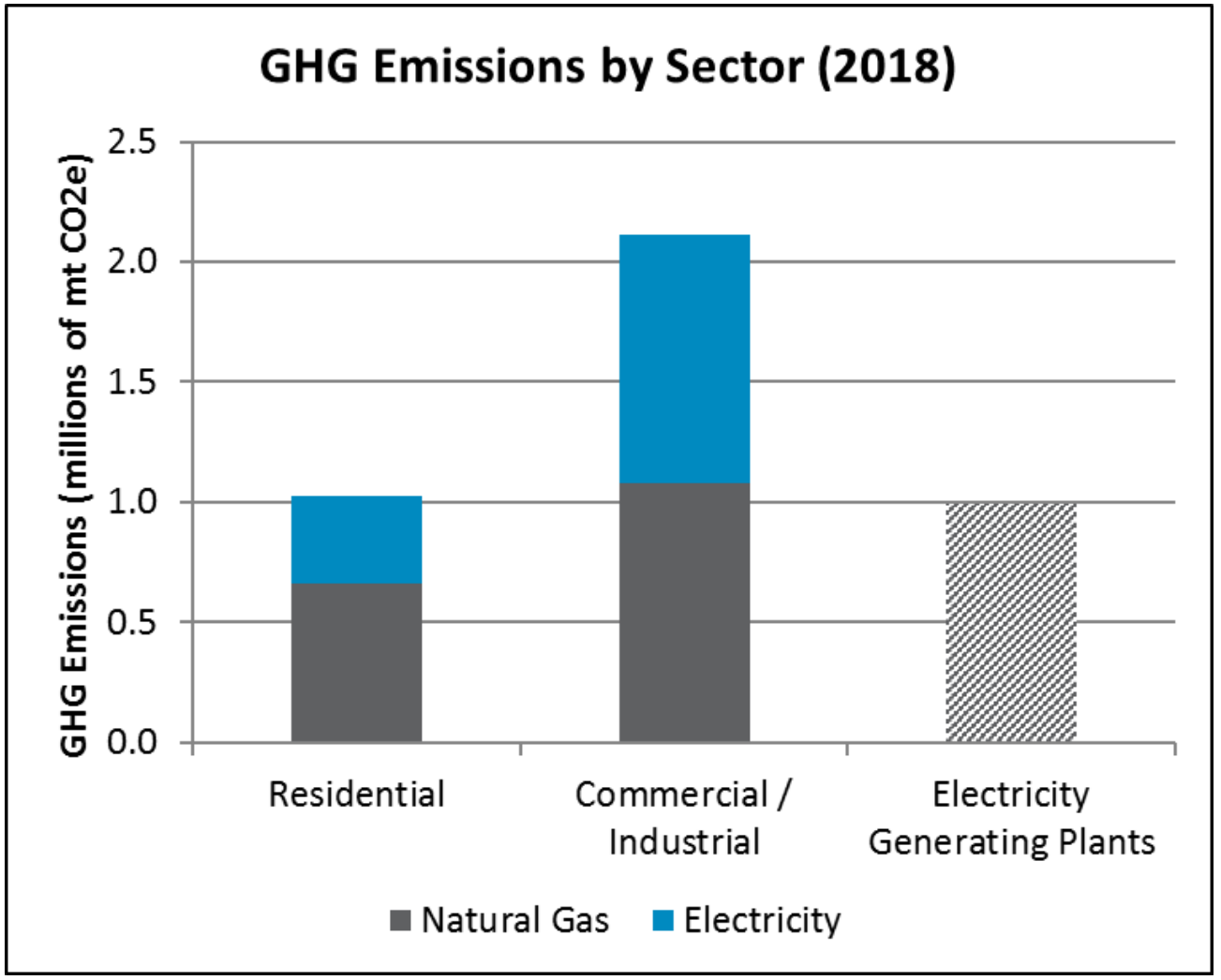
- Electricity emissions continue downward, natural gas emissions continue upward trend

Buildings continue to drive emissions

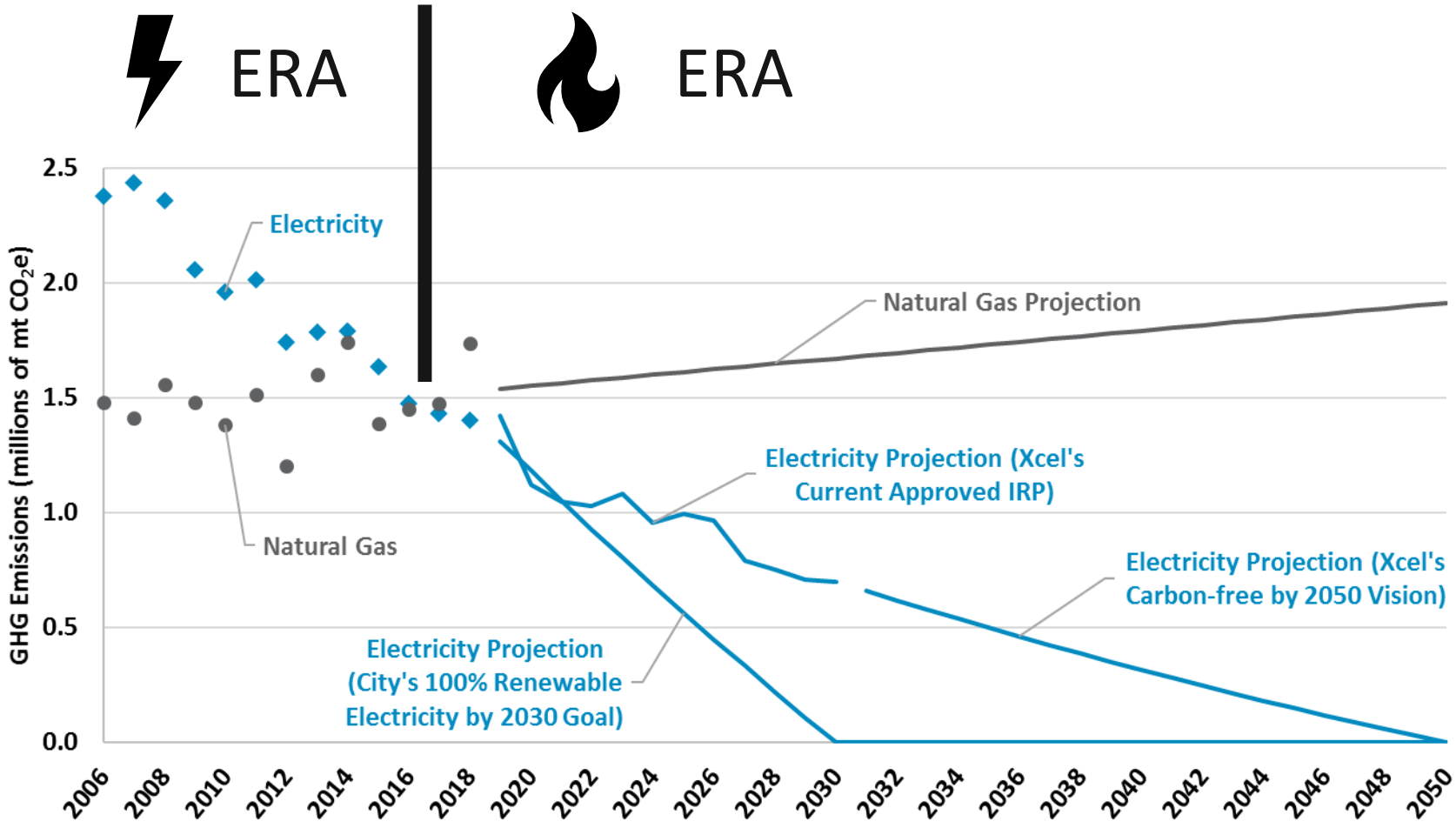


Building energy consumption is 73% of total

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

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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
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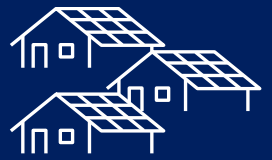
Trends in 2040 Comprehensive Plans



117 include solar requirements

36 include a resilience chapter

26 achieved SolSmart designation

31 want to complete an energy plan

55 are GreenStep Cities

32 want to complete a climate action plan

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Climate and Energy Goals

City	Climate/Energy Goals	Renewable/Solar Goal
Grand Marais	**Climate Action Plan:** Carbon Neutral by 2040	Achieve Energy Resilience, 100% renewable for city operations
Northfield	**2019 (draft) Climate Action Plan:** Carbon free by 2040	10% in-boundary renewable electricity (20 MW); carbon free electricity by 2030
Rochester	**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
St. Louis Park	**2018 Climate Action Plan:** Carbon neutral, community-wide by 2040	100% renewable electricity by 2030, 10% in-boundary (37 MW); city ops currently at 100% renewable
St. Paul	**2019 (draft) Climate Action and Resilience Plan:** Reduce emissions 50% by 2030, carbon neutral by 2050, community-wide	10% in boundary renewable electricity (200 MW)
Minneapolis	**2013 Climate Action Plan:** 80% reduction in emissions from 2005 by 2050, community-wide	100% renewable electricity by 2030 community-wide 100% renewable electricity city ops 2022

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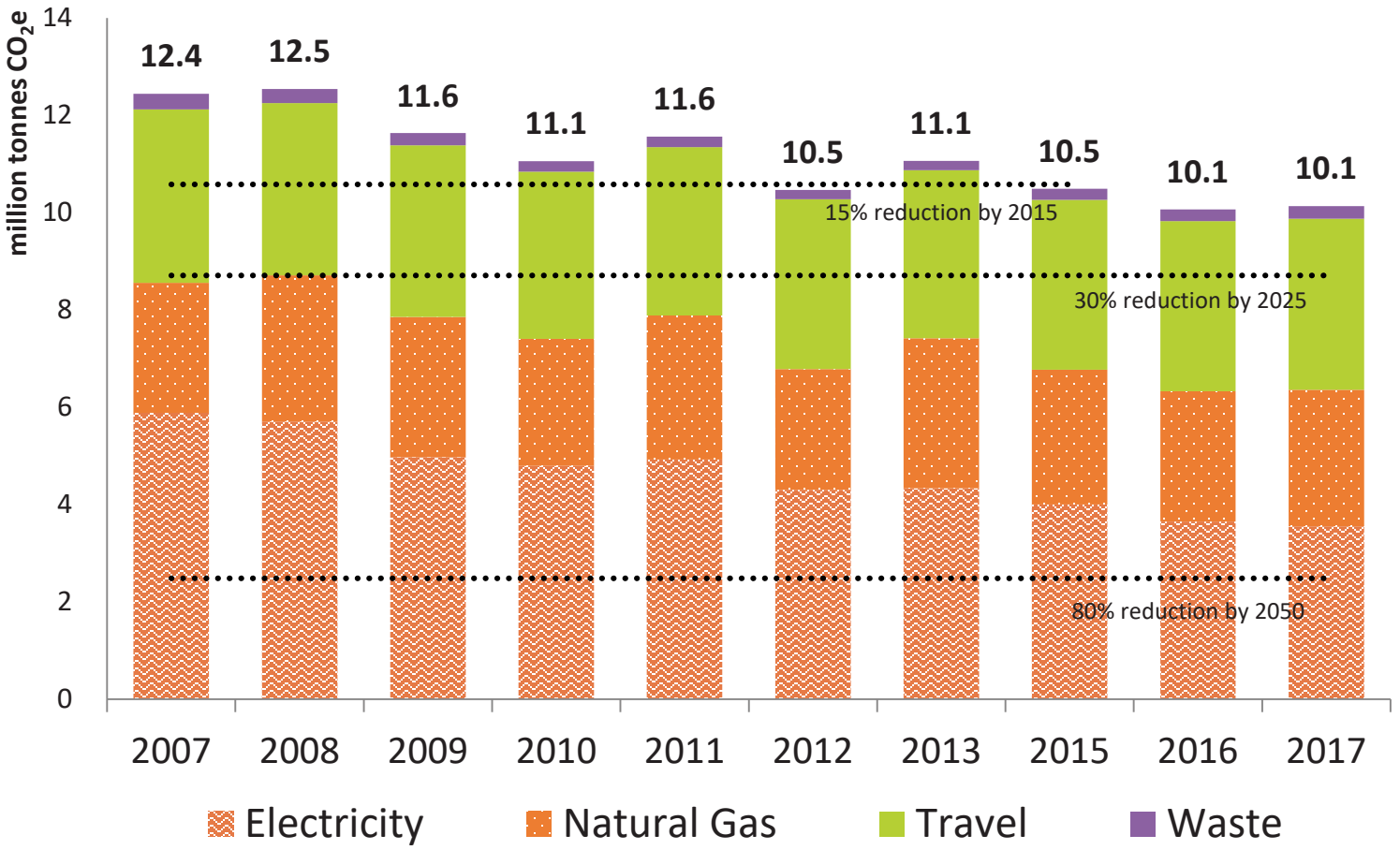
Slide Source: Regional Indicators Initiative, developed by LHB.

GREENHOUSE GAS EMISSIONS

AVERAGE



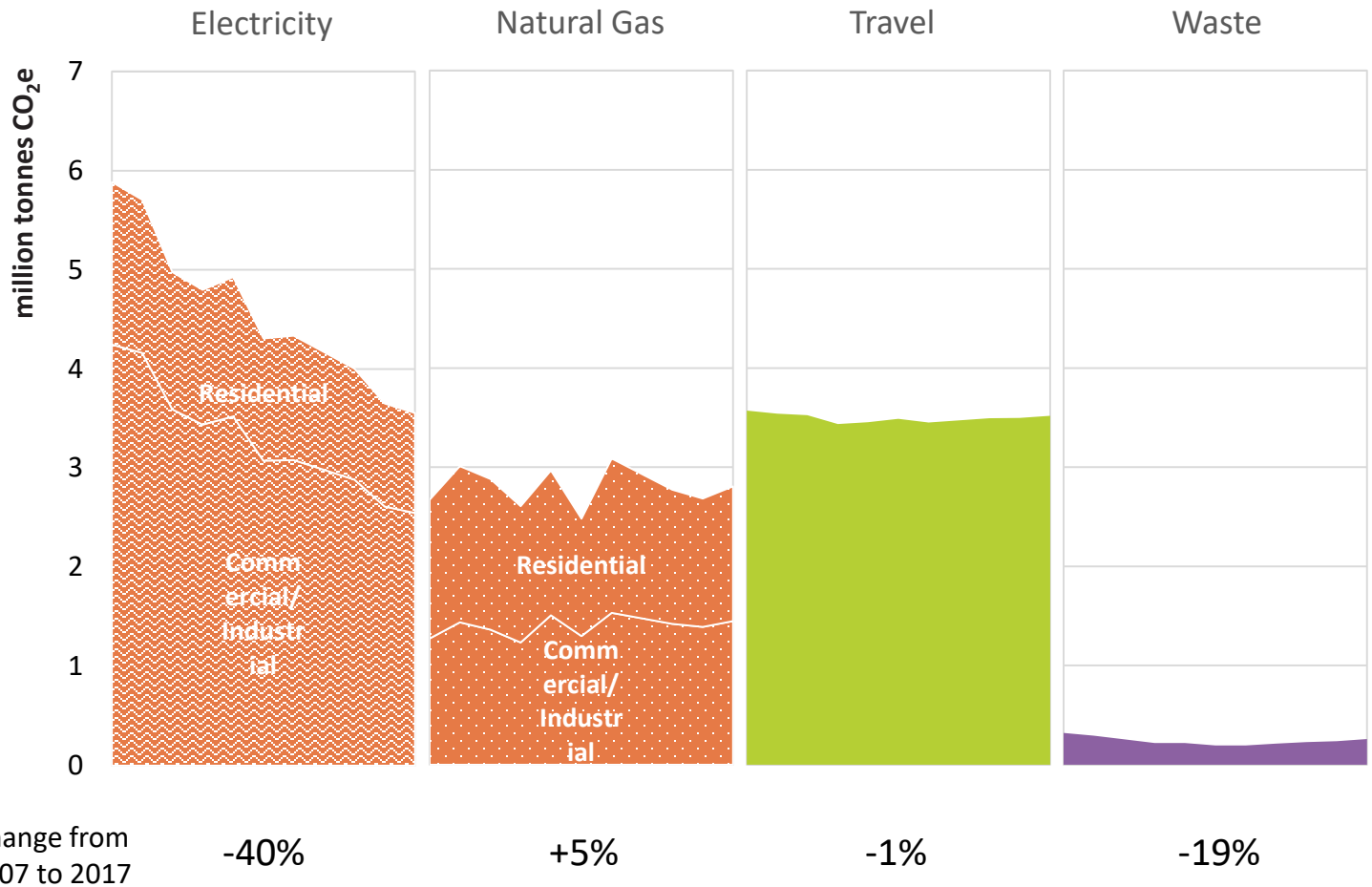
Greenhouse gas emissions have decreased by 19% since 2007. This equates to a 25% reduction per capita.

Build on this momentum.

Slide Source: Regional Indicators Initiative, developed by LHB.

GREENHOUSE GAS EMISSIONS

13 CITIES



Change from 2007 to 2017	-40%	+5%	-1%	-19%

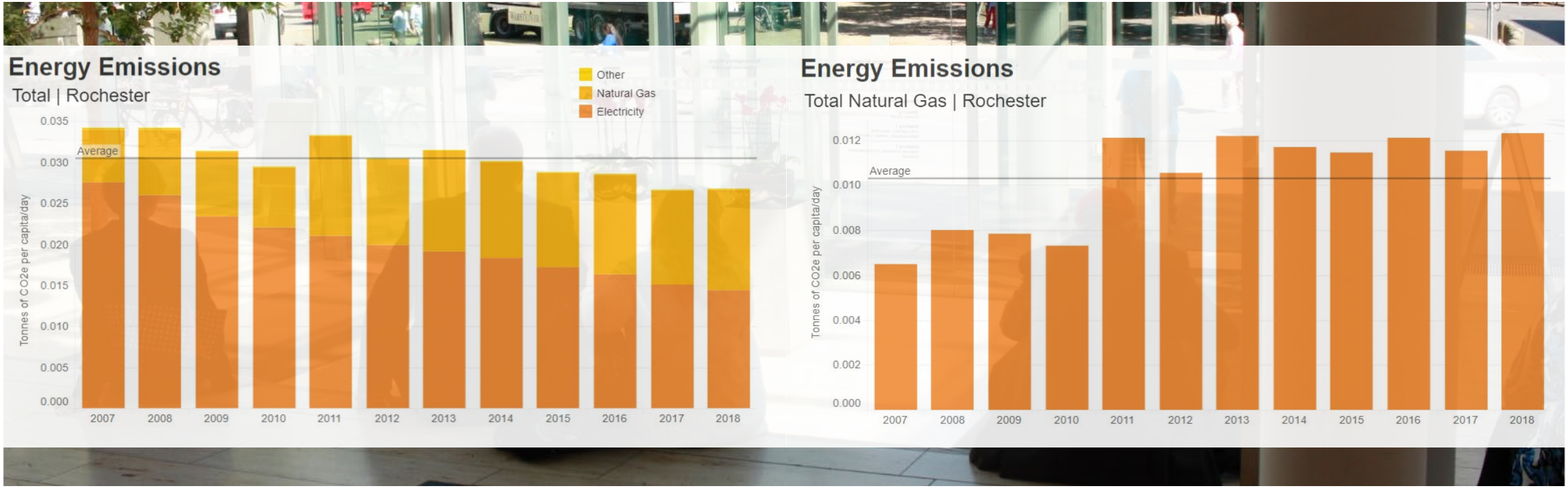
The electric sector decreased by 40% while natural gas and travel emissions remained relatively constant.

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**



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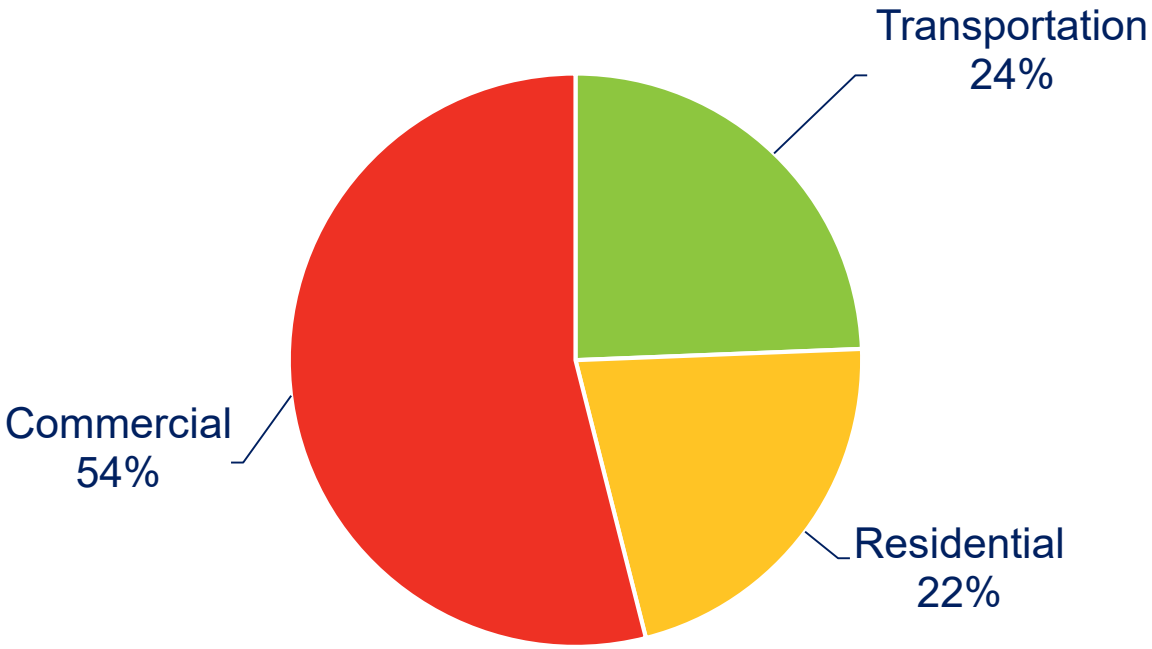
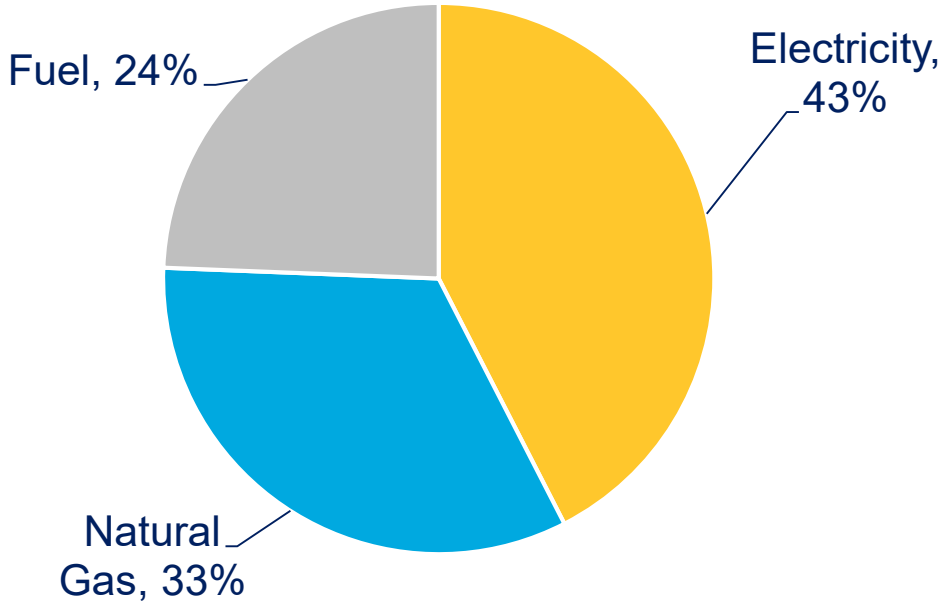
Community Emissions Profile

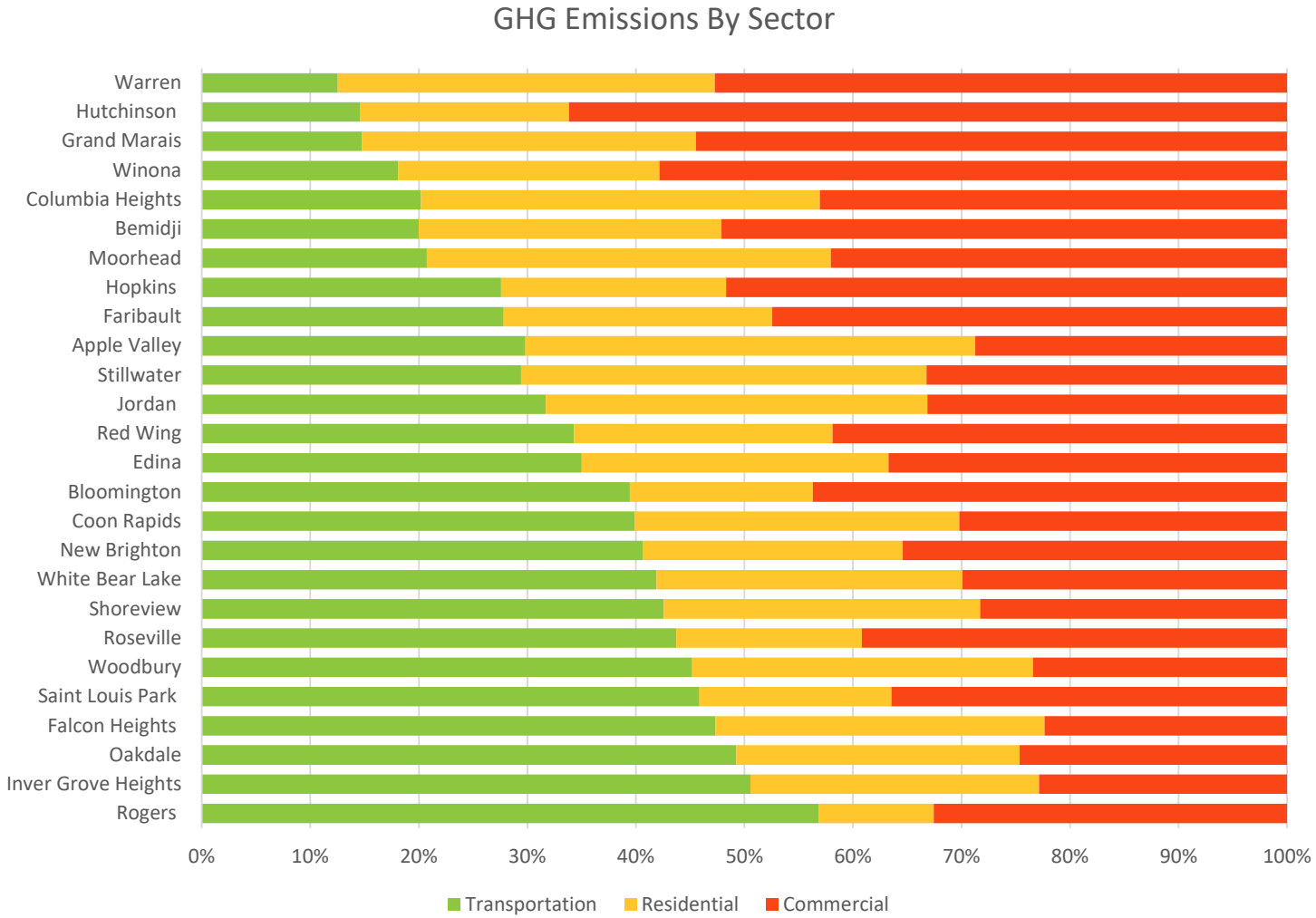
GHG Breakdown by Sector
(Tons of CO2), 2016



GHG Breakdown by Fuel Type
(Tons of C02), 2016

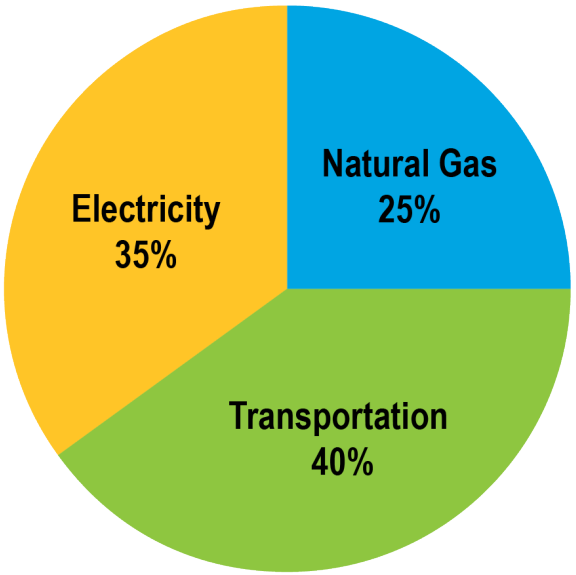


Community Emissions Profile

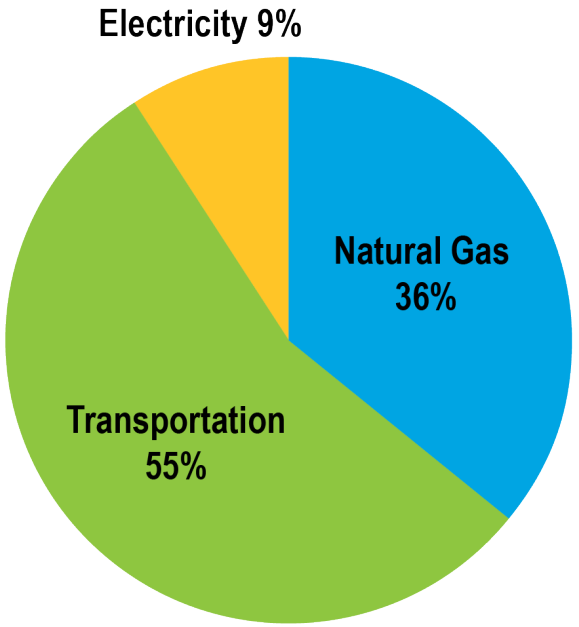


Future Emissions Profile

GHG Breakdown by Fuel Type (Tons of CO2)

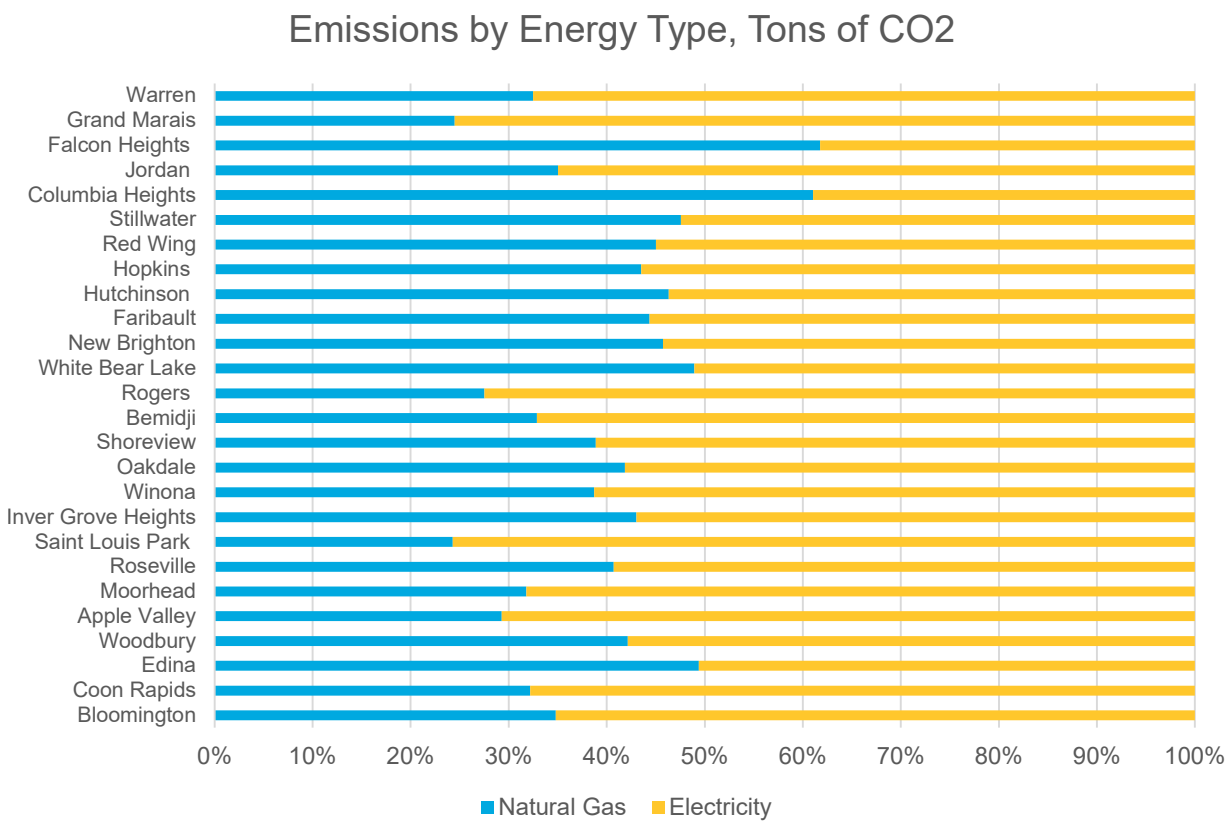


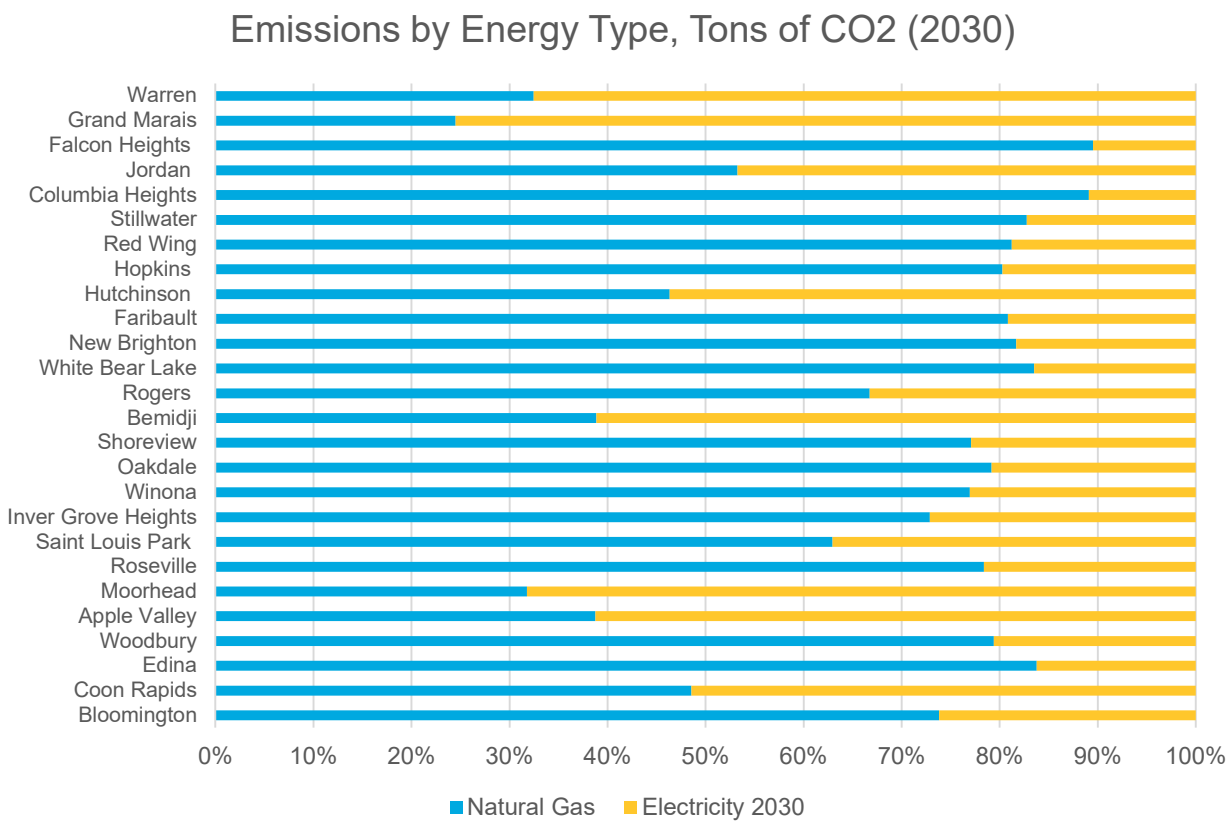
2016



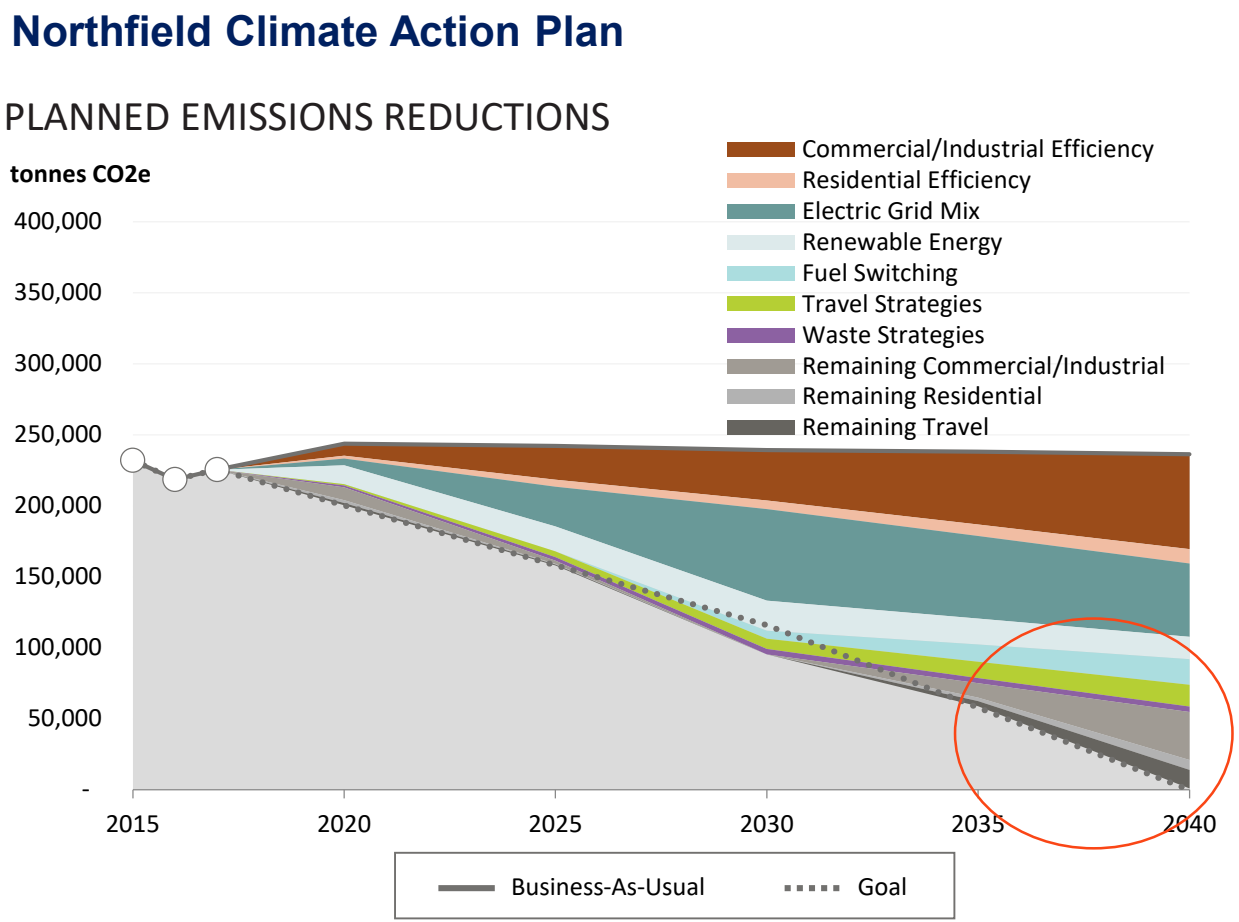
2030

Community Emissions Profile





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

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Discussion:

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

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DECARBONIZING MINNESOTA'S NATURAL GAS END USES

Meeting 2 – Related emissions

January 10th, 2020

McKnight Foundation

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THANK YOU