Meeting Minnesota's Heating Needs

Jamie Fitzke, CenterPoint Energy
Dr. Joel Lynch, CenterPoint Energy

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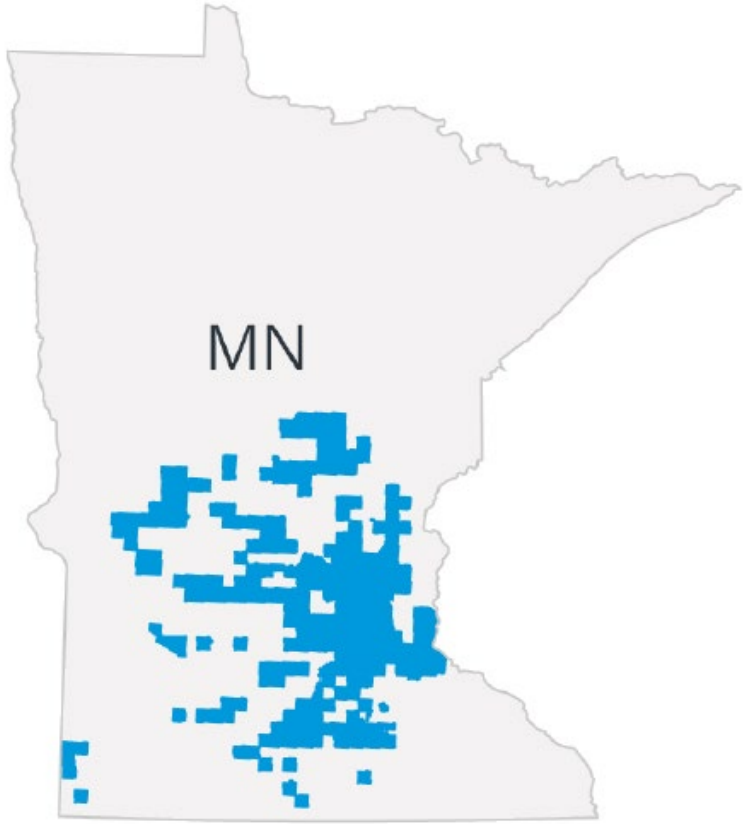
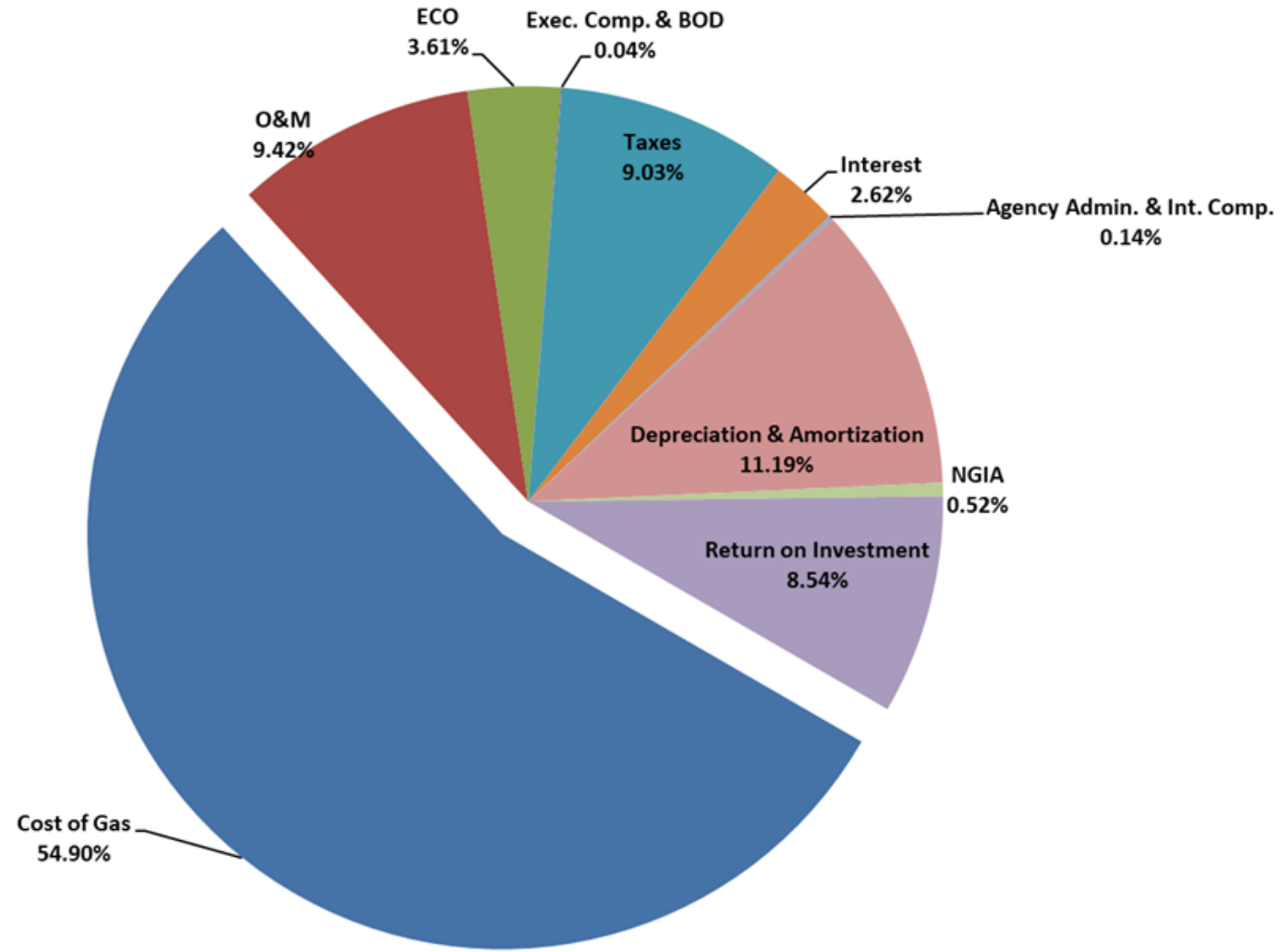
CenterPoint® Energy

Minnesota operations

- Largest natural gas utility in Minnesota
- **14,000-mile** pipeline system
- Approx. **940,000 customers** and **260+** communities
- **1,200+ employees**
  - Headquartered in Minneapolis, with regional offices in Alexandria, Brainerd, Mankato & Willmar
  - IBEW Local 949, OPEIU Local 12, United Association of Gas Workers Local 340

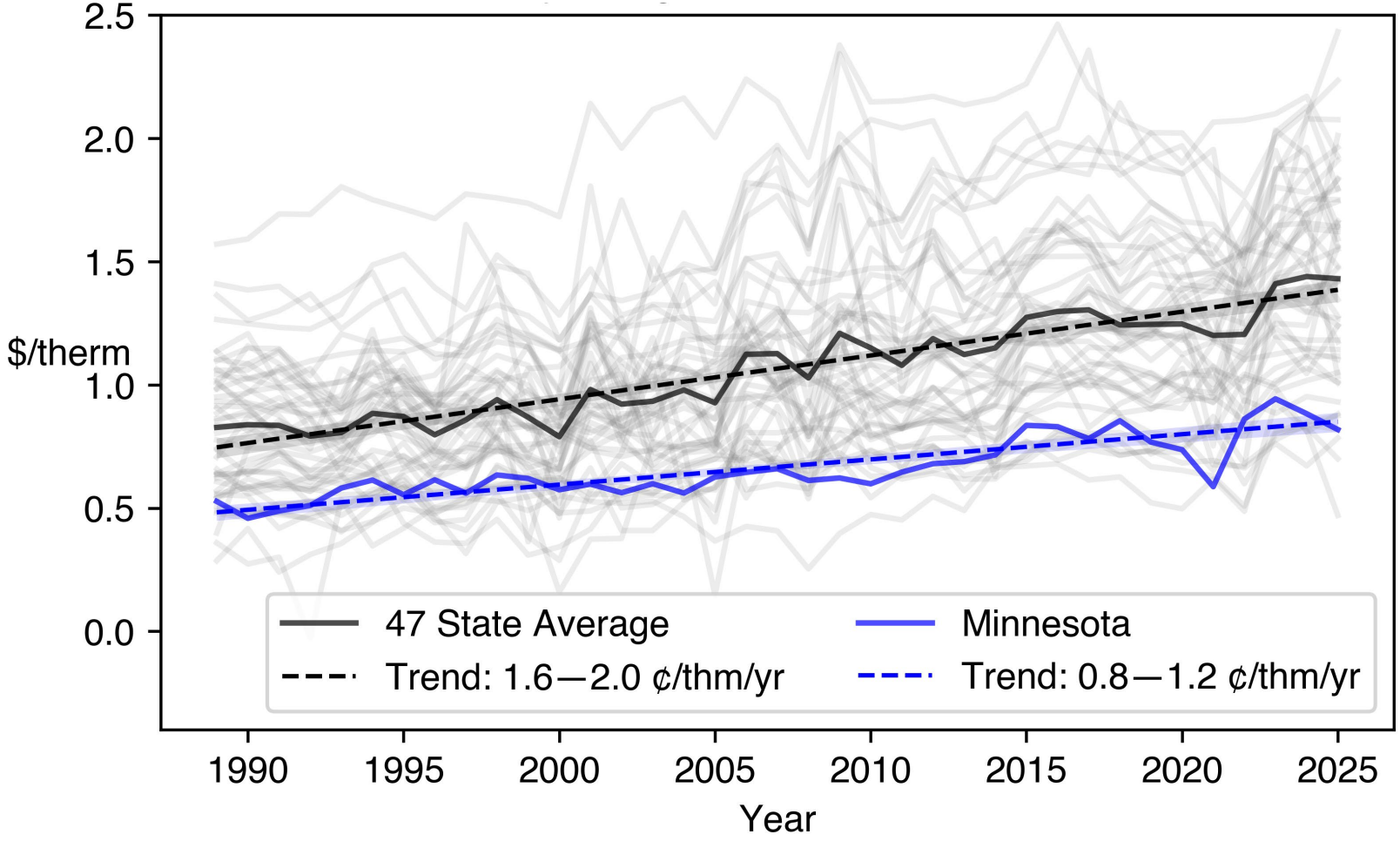


CenterPoint Energy 2025 Billable Dollar



Approximately 55% of every dollar paid by custom is the cost of natural gas – which is a pass-through charge with no "mark up".

Natural Gas Utility Non-Commodity Cost Over Time, Adjusted for Inflation



Source: EIA.gov, Difference between Residential Natural Gas Prices (ng_pri_sum_a_EPG0_PRS_DMcf_m.htm) and Citygate Prices (ng_pri_sum_a_EPG0_PG1_DMcf_m) calibrated with Heat Content Tables (ng_cons_heat_a_epg0_vgth_btucf_m). Trends exclude 2021 data with outlier commodity prices. Inflation adjustments to Dec-2025 using BLS CPI data, series (CUUR0000SA0). Heat Content before 2013 set to 2013 national average.

Peak Heating with Natural Gas:
The Missing Piece in MN's Electrification Puzzle

Author:

Joel Lynch, PhD
Energy Efficiency Engineer
CenterPoint Energy

About the Author:

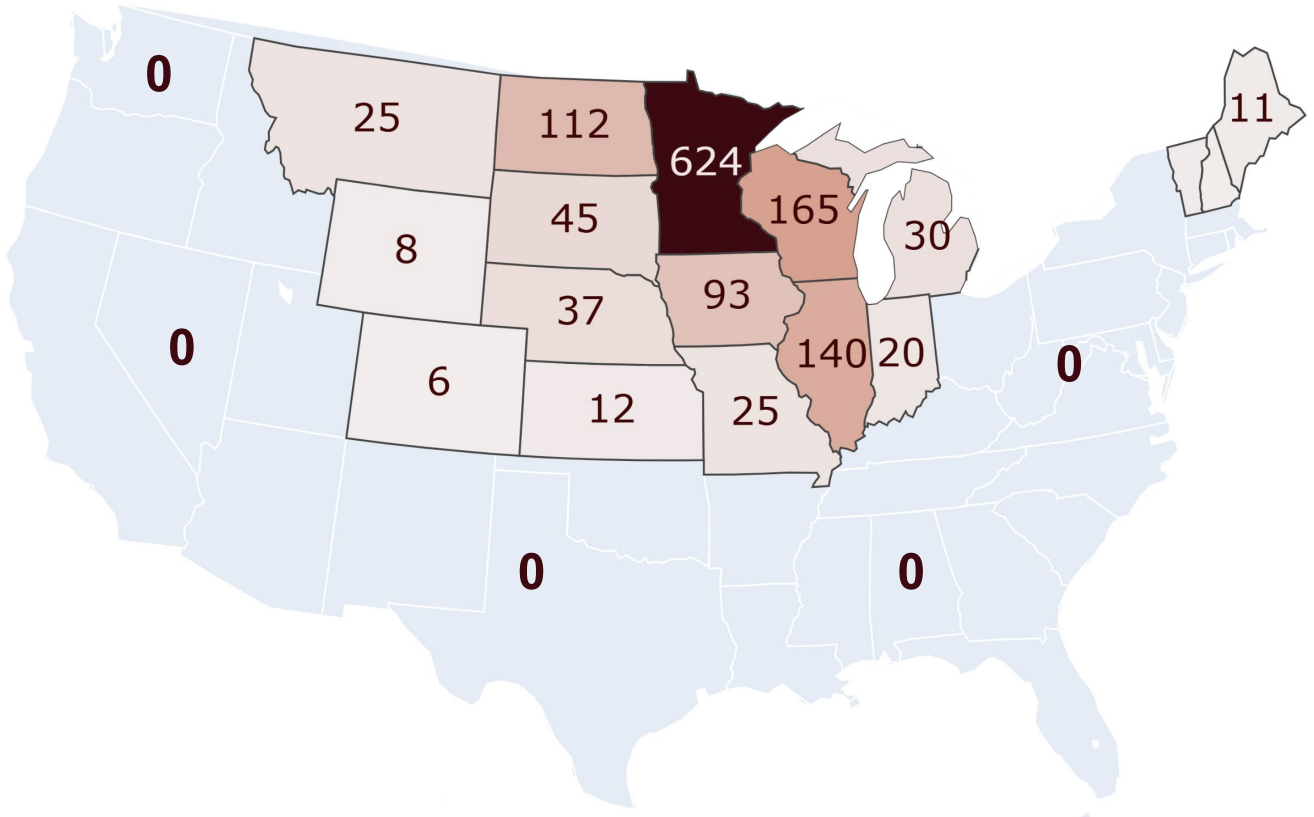
- Joined CenterPoint Energy in January 2025
- Performs technical analysis for CenterPoint's ECO program
- Doctorate in Mechanical Engineering from Iowa State University
- Teaching & research background in thermofluids and combustion with applications in defense, fossil-free fertilizer production

Minnesota is Special!

- Minnesota's large population in an extreme climate are unique among the lower 48 states
- Natural gas utilities deliver 2-4 times more energy during cold months than the state's total electric generating capacity
- Additionally, ASHP efficiency and renewable production face unique challenges during Minnesota's coldest weather

Million Person-Days of Sub-Zero Weather, 2017-2026

(Derived from NOAA Climate Prediction Center's population-weighted daily-average state HDD records and census.gov state population data)



MN: 5.68 million people × 110 days below zero = 624

How Much New Electric Generation Would Be Needed to Replace Natural Gas?

1. **Peak Gas Demand**

   Without natural gas, MN's electric grid would peak on coldest days, driving new capacity requirements

2. **Electric Equivalence**

   ASHP's can reduce demand, but efficiency (COP) degrades with lower temperatures.

3. **Electric Gen. Capacity Factor**

   Renewable assets don't perform at nameplate capacity in cold weather.

This work builds on existing research, refining all three factors.

Three main pieces of the puzzle:

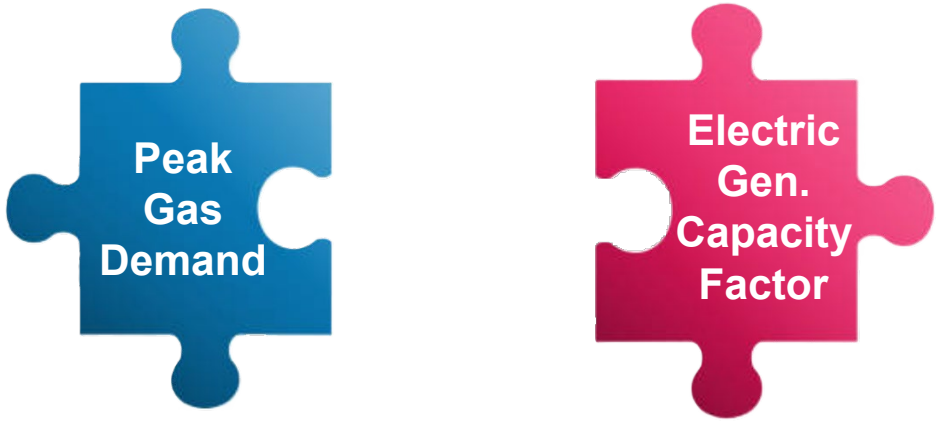
We do not address electrification of propane/fuel oil, T&D losses, grid-firming/reserve requirements, and new electric demand from EV's & data centers

What Do We Already Know?

Buonocore et al. 2022

https://doi.org/10.1038/s41598-022-15628-2

- Study in the journal *Nature*
- Found 100% electrification would require United States to add up to 28x current wind capacity or 303x solar

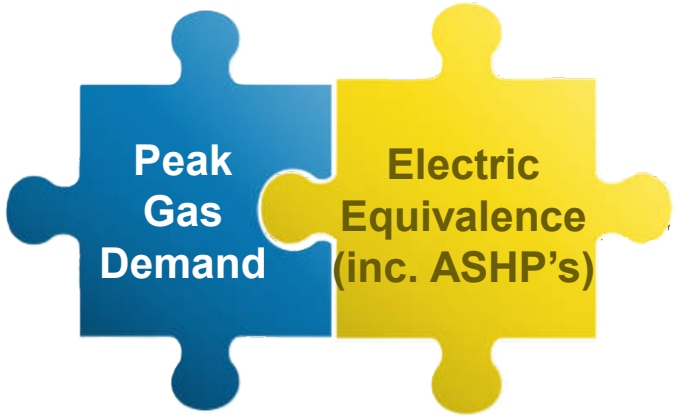


Covered all gas end-uses, but not specific to MN and used theoretical COP reference values

Synapse Energy Economics, 2024 Report

www.synapse-energy.com/minnesota-building-decarbonization-analysis

- Examined Residential and Commercial electrification, including predictions of equipment costs & utility rate dynamics
- MN peak-loads would increase from 14.2 GW to 27.5 GW by 2050 with 97% electrification



Specific to MN, but neglects industrial gas electrification and only estimates demand (not capacity)

What new information are we adding?

1. Peak day gas, obtained from EIA calibrated with daily data from CenterPoint Energy
2. COP values specific to Minnesota building stock and weather
   - COP for each sector (not just ASHP units) and mapped to hourly temperature data
   - Obtained from 2025 NLR (NREL) ComStock & ResStock datasets for 5 levels of electrification
3. Minnesota-specific capacity factor data for renewables

We combined these improvements to provide a range of conservative estimates for renewables and/or nuclear with 100% electrification

Summary of Results

On peak Minnesota days:

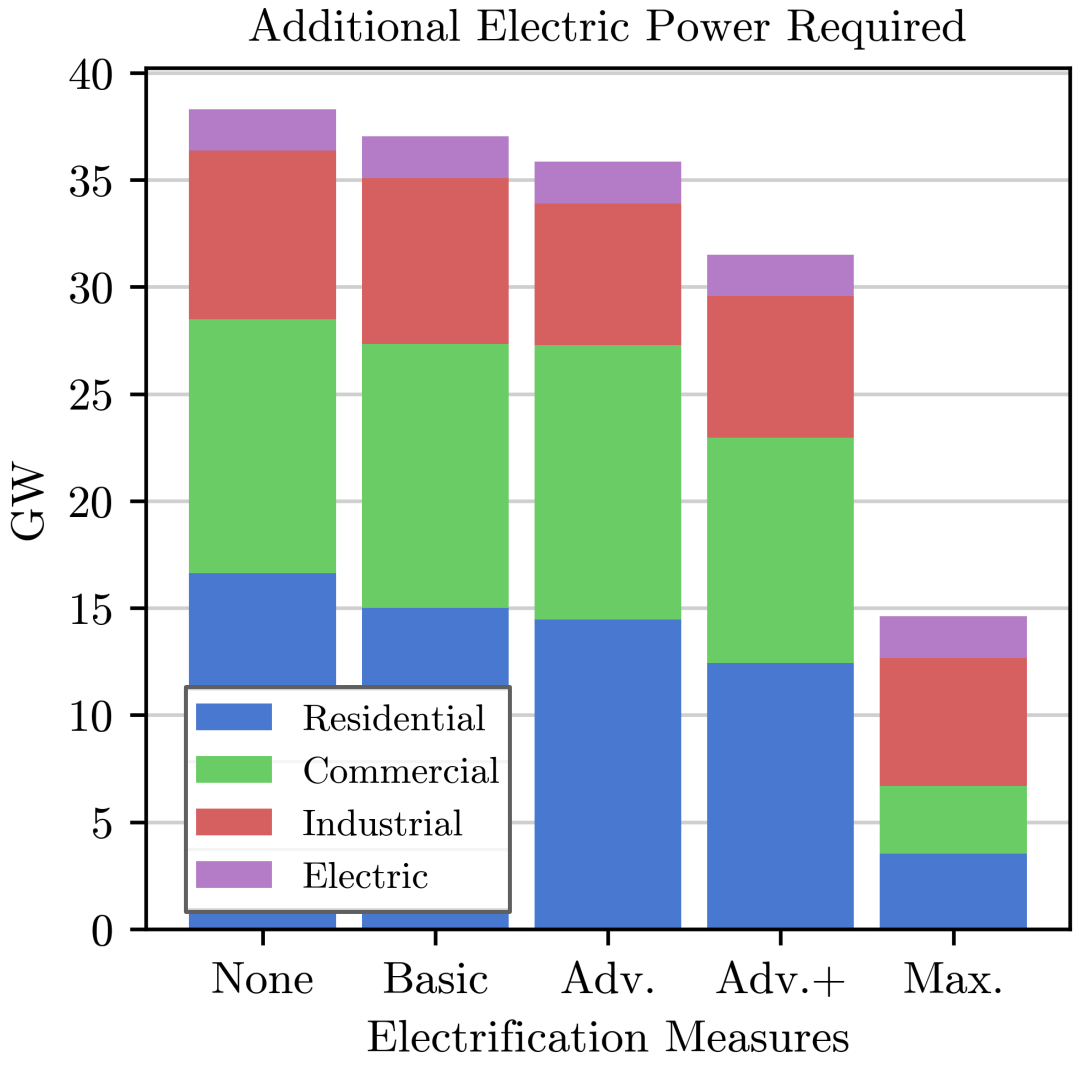
- Gas space heating throughput is up to 40 GW
- Equivalent to 36 GW of electric
- ASHP's and other measures can reduce this load by up to 20%*

With ASHP electrification measures**, MN's electric equivalent of gas demand are:

- Peak day: 29.6 – 35.1 GW
- Average day: 15.5 – 26.3 GW

** As predicted with 2025 ResStock/ComStock datasets. <10% is achievable with ASHP's alone.*

*** Measures described in Appendix. Maximum scenario reflects 100% adoption of ground-sourced heat pumps (GHSP)*

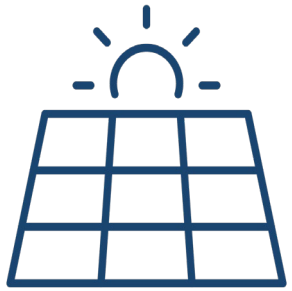


New Capacity Requirements for Electrification

Minnesota would need to invest in one, or combination, of the following to replace peak day January natural gas heating load:

Increase Minnesota's existing electric generation by 4.2 – 5.0x

New 3.5 MW wind turbines 24,000 – 28,000



New 10 MW solar farms 35,000 – 41,000

AP1000 nuclear plants 29 – 34

**This information is based on data collected from the Energy Information Association and the National Lab of the Rockies ResStock and ComStock datasets and represents usage by customers of all natural gas utilities and electric utilities in Minnesota.*
***These figures are based on calculation of required January capacity additions: 29.6 – 35.1 GW during peak gas day.*
****Figures are calculated based on customer adoption of efficient cold climate air source heat pumps across residential, commercial, and industrial sectors where feasible.*
*****Note: these figures do not account for non-utility delivered fuels used by Minnesotans.*


Q&A

Appendix

Electrification Measures

Electric Equivalent (inc. ASHP's)

- Upgrade measures from ComStock/ResStock were grouped together to obtain a range of "sector" COP values during peak day/month weather

		No Measure	Basic	Advanced	Advanced+	Maximum
Res.	ResStock ID	-	(1)	(3)	(13)	(15)
	Description	Elec. Res.	Min. Eff. ASHP	ccASHP	ccASHP+Env.	GSHP
	HP Specs.	-	HSPF1 9.2	HSPF1 13	HSPF1 13	EER 20.5
			50%, 5°F	90%, 5°F	90%, 5°F	COP 4
	Other Measures	-	-	-	Various[1]	Various[1]
Com.	ComStock ID	-	(15)	(55)	(58)	(63)
	Description	Elec. Res.	HP Boiler	+ HP RTU	+ HP RTU	GSHP[4]
	HP Specs.	-	COP 2.85, 47°F	COP 2.11, 0°F	COP 2.11, 0°F	COP > 3
			$T > -5$°F			
	Other Measures	-	-	LEDs	Various[2]	Envelope[3]
Ind.	Description	Elec. Res.	4.7% ASHP	32% ASHP	32% ASHP	32% GSHP
	HP Specs.	-	COP 2	COP 2	COP 2	COP 4

Table 3: Additional summer capacity required to replace January peak natural gas heating load (excluding electricity generation). Adapted from methods in Table 3.

		No Measures		Basic		Advanced		Advanced+		Maximum	
		Day	Month	Day	Month	Day	Month	Day	Month	Day	Month
Multiples of Current MN Capacity:	Electric Grid[1]	5.2	3.0	5.0	3.2	4.9	2.3	4.2	1.9	1.9	1.4
	Renewables	18	10	18	10	17	7.4	15	6.1	6.4	4.4
	Carbon Free	14	6.0	13	6.3	13	4.5	11	3.7	3.4	2.7
	Wind	23	12	22	12	22	8.9	19	7.3	7.7	5.3
	Solar	378	225	364	236	352	170	307	139	147	101
	Nuclear	55	15	53	16	52	12	45	9.5	7.4	6.9
Multiples of Power Plants	Sherco Solar[2]	470	324	454	341	438	245	382	201	169	146
	AP1000 Reactor[3]	36	25	34	26	33	19	29	15	13	11
	Solar Pipeline[4]	39	27	37	28	36	20	32	17	14	12
Power Units	Wind Turb.[5] /10^3	29	20	28	21	27	15	24	12	10	9.0
	Solar Panels[6] /10^6	1069	738	1032	775	997	556	869	457	385	331

[1] Assuming current mix of January capacity factors
[2] 910 MW
[3] 1,100 MWe
[4] 11 GW in development
[5] 3.5 MW each
[6] Standard 400W panel