

Economical Urban Decarbonization

COST AND FEASIBILITY OF TECHNOLOGIES AVAILABLE TO GAS COMPANIES

PREPARED BY:

FRANK GRAVES

JOSH FIGUEROA

RAGINI SREENATH

STEVE THUMB

JULIE YOON

DREW KASSMAN

JAMES HERRIGEL

JOHN GONZALEZ

OCTOBER 2026



Context and Purpose

The Illinois Commerce Commission (ICC) initiated Future of Gas proceedings in early 2024. In response, Brattle collaborated with the Chicago gas companies Peoples Gas Light (PGL) and North Shore Gas (NSG) on identifying decarbonization technologies, evaluating their costs, performance and fit, and exploring business models for ways the gas companies could be involved in fostering legislative goals for decarbonization of the Illinois economy.

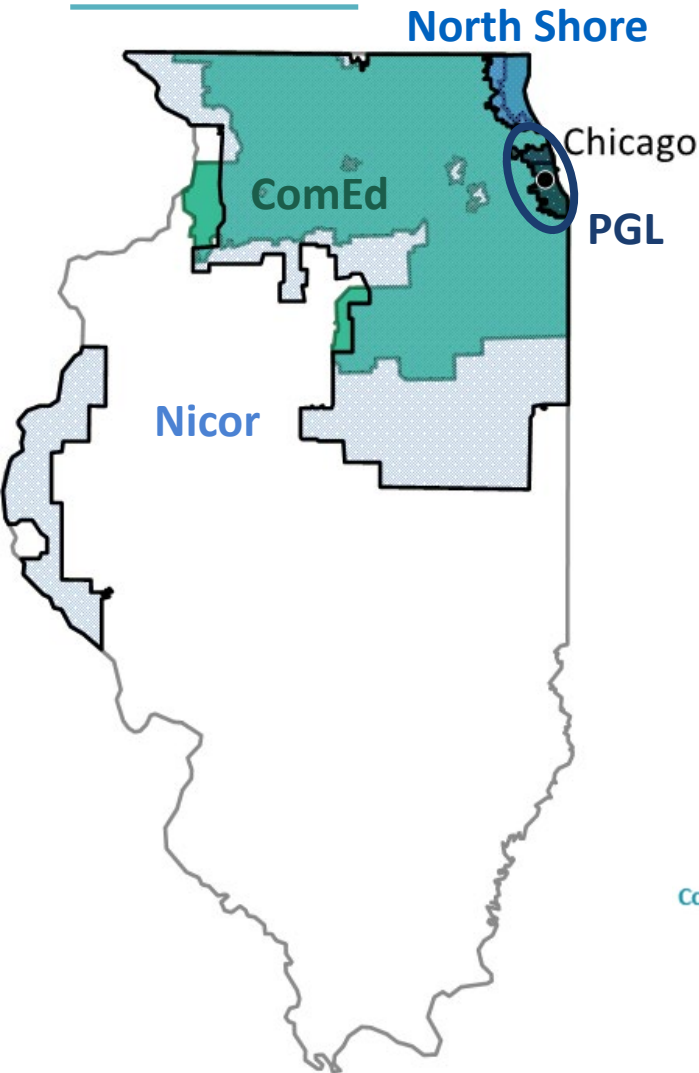
The findings of those analyses generalize to other urban settings, so are summarized here for consideration in other policy debates about the future of gas.

Gas decarbonization planning requires a long-term (20+ years) perspective (hence tools and data) on matters gas companies do not normally consider, along with a granular understanding of the demographic and operational complexities of the gas system service territory so that any suggested plans are realistic in terms of:

- Environmental **cost-effectiveness**,
- Customer **affordability** (of appliances and utility bills),
- **Administrative complexity**,
- **Pacing** under realistically **feasible enforcement or incentivization** mechanisms , and
- **Utility systems adaptation** (gas and electric) to preserve quality of service and reliability.

This presentation highlights our tools and findings, which include 25-year scenarios for Business-as-Usual (BAU) conditions with no decarbonization goals, full decarbonization by electrification, and a partial, hybrid Economic Decarbonization Scenario (EDS) with efforts capped when customer conversion costs exceed the social cost of carbon. The use of decarbonization to avoid pipe repairs and expansion (NPAs) is also evaluated.

Background: The Chicago area is largely served by Peoples Gas Light (PGL)



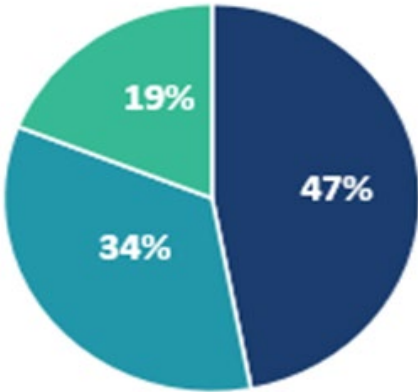
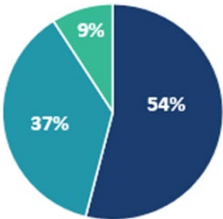
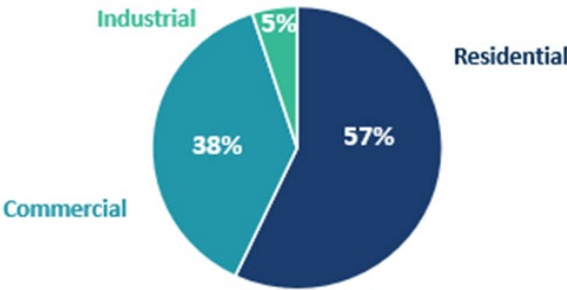
PGL’s service territory corresponds closely to the legal boundaries of the City of Chicago, with the rest of the metro area served by its affiliate North Shore Gas and the ex-urban portions by Nicor Gas and a bit of Ameren, while Commonwealth Edison (ComEd) provides the electrical service.

About 80% of homes and businesses in Chicago are heated using gas, with space heating comprising about 70% of PGL’s residential and commercial throughput.

PGL
1.5B therms
889,000 Customers
2024 Revenue: \$1.4B
Mains miles: 4,678
~1,000 miles of remaining leak prone pipe

North Shore
309M therms
204,000 Customers
2024 Revenue: \$197M
Main miles: 2,360
Relatively new system

Nicor
4.4B therms
2.08M Customers
2024 Revenue: \$2.3B
Mains miles: 33,616
Several thousand miles of remaining steel mains

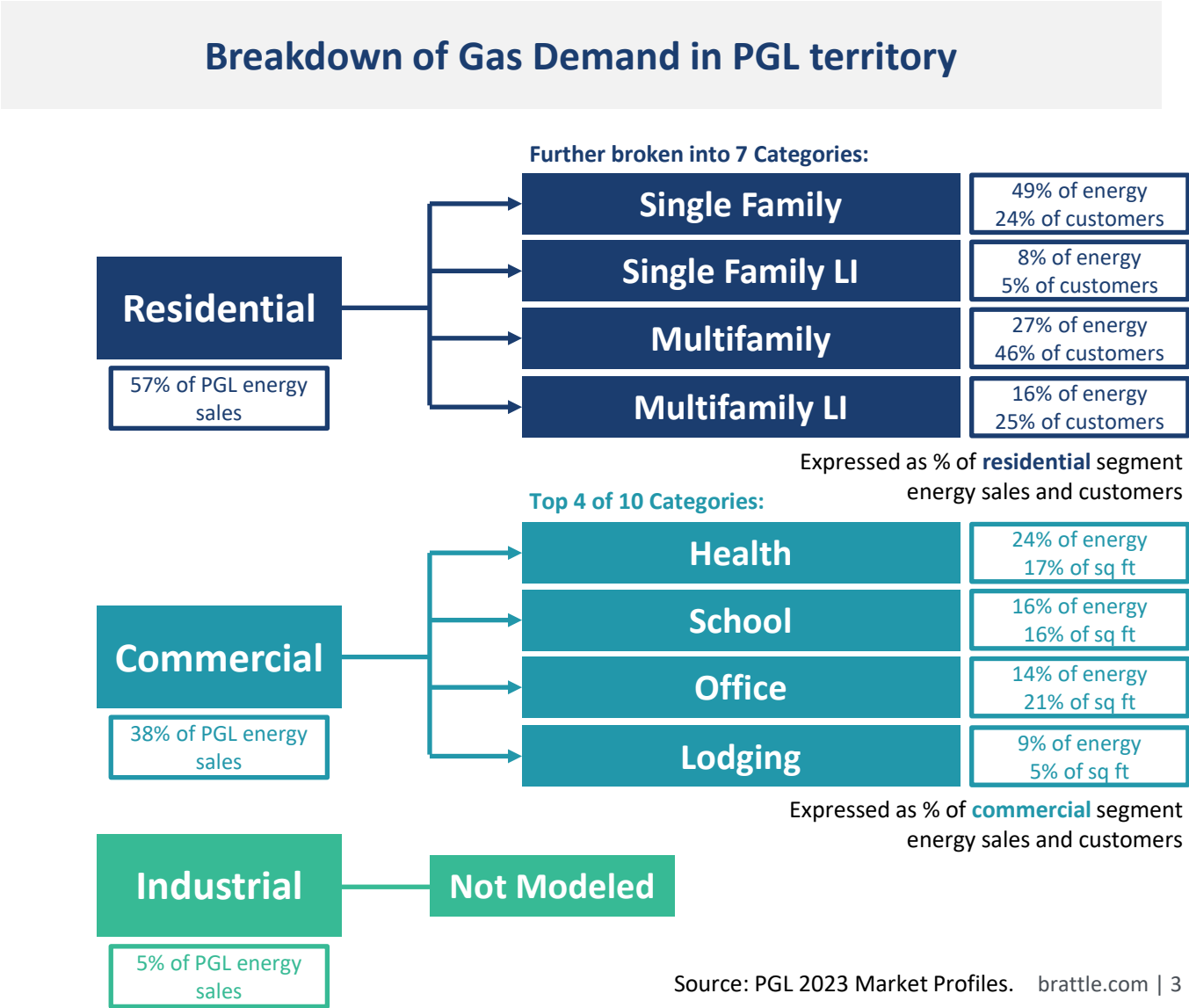


ComEd has 4.1M customers and sold 85 TWh in 2024 ([ICC](#)).

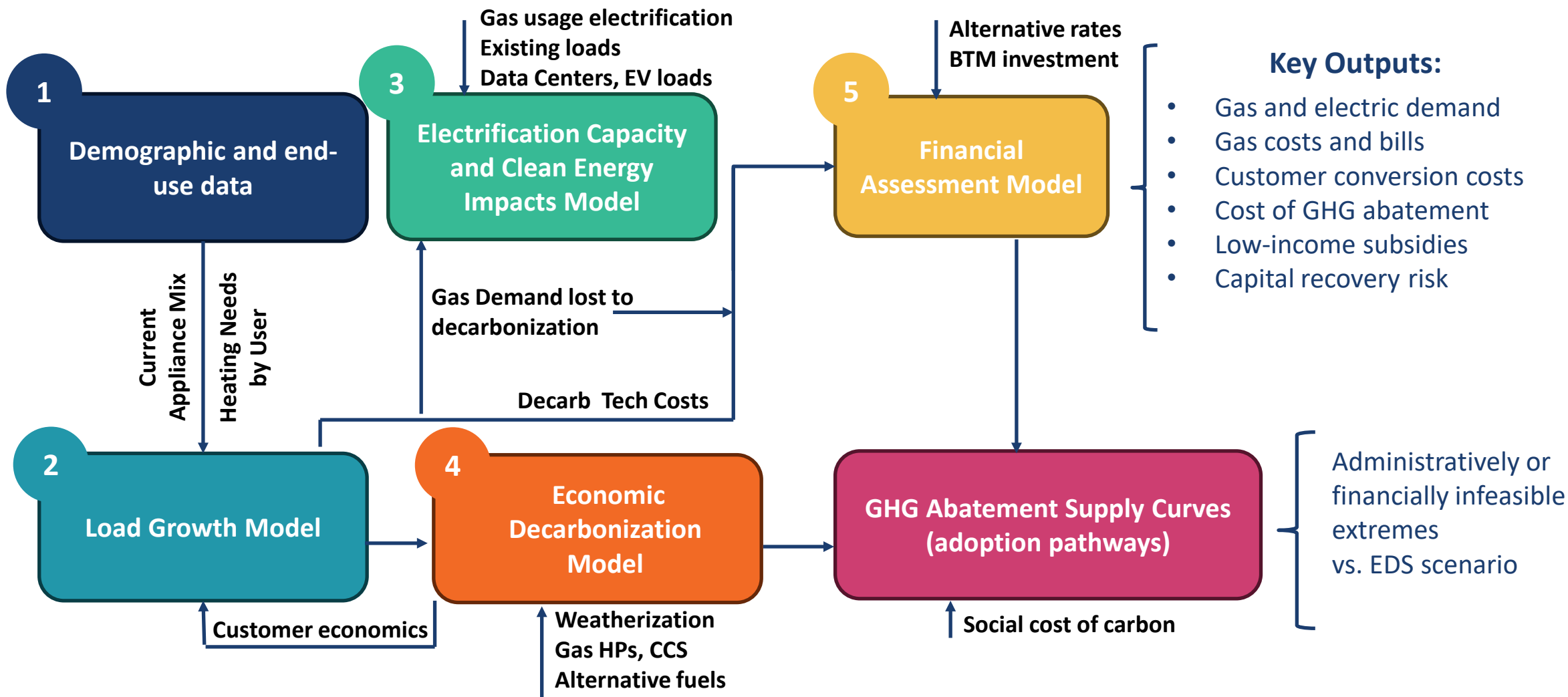
PGL and NS therms and therm usage by customer type from PGL; customers and revenue from [ICC](#).
Nicor therms, customers, revenue from [ICC](#), therm usage by customer type from [BDC](#).

Brattle examined near-term and long-term gas demand for each type of building in PGL’s territory for different levels and means of decarbonization

- 2025 base-year system demand was calibrated to PGL rate case and EE studies on building types, demographics, and shares of end-use appliances.
 - Near-term 2026-2030 projections reflect slight expected customer growth based on PGL econometric analysis.
 - Longer term BAU results thru 2050 are extrapolations of the near-term trends.
- Appliances assumed to be replaced at end of normal life (20 years).
 - In BAU, they are replaced in-kind with modest efficiency upgrades.
 - In decarb scenarios, appliances replaced by various cleaner techs (all electric, or NPAs < \$200/ton abatement cost).



The analysis incorporates several sequential and iterative modeling elements, to understand the implications of decarb strategies on costs and demand



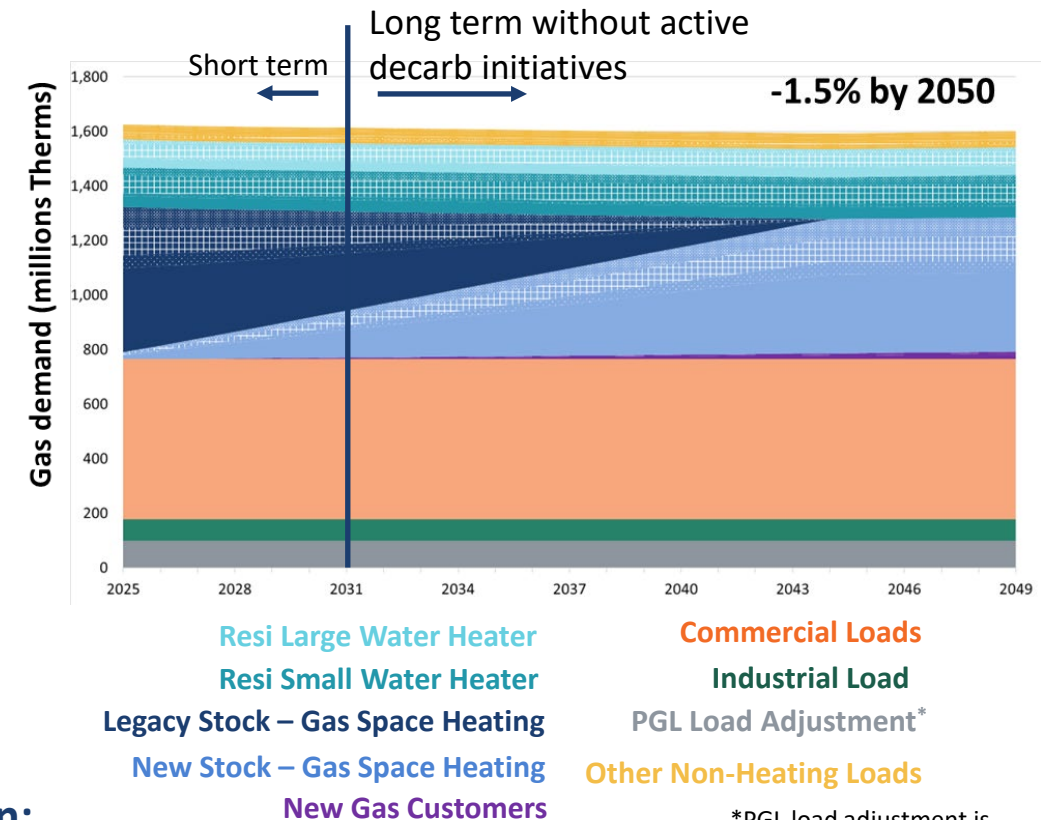
Gas demand declines only marginally under business-as-usual, due to efficiency improvements

Overall, both the long-term and the short-term outlook for PGL under BAU is a very modest decline, both in overall load and customer mix.

- Slight drop in residential use per customer due to normal appliance turnover to more efficient newer models, and modest customer-driven weatherization at historic pace.
- Commercial customers not very active in energy management improvements; assumed to stay flat into foreseeable future absent decarbonization incentives or mandates.
- (This outlook assumes outside vendors or other utilities do not cause material changes in usual customer behavior).

It is difficult to accomplish significant decarbonization in the short run:

- Due to current modest EE program sizes, need for pilot studies to test customer acceptance and behavior with new techs and pricing adjustments, and need for new regulatory protocols (e.g., BTM involvement, gas-electric coordination, changes in obligation to serve, etc.) to allow innovative customer engagement.
- Long-term decarb scenarios assume such preconditions can be developed by 2030.



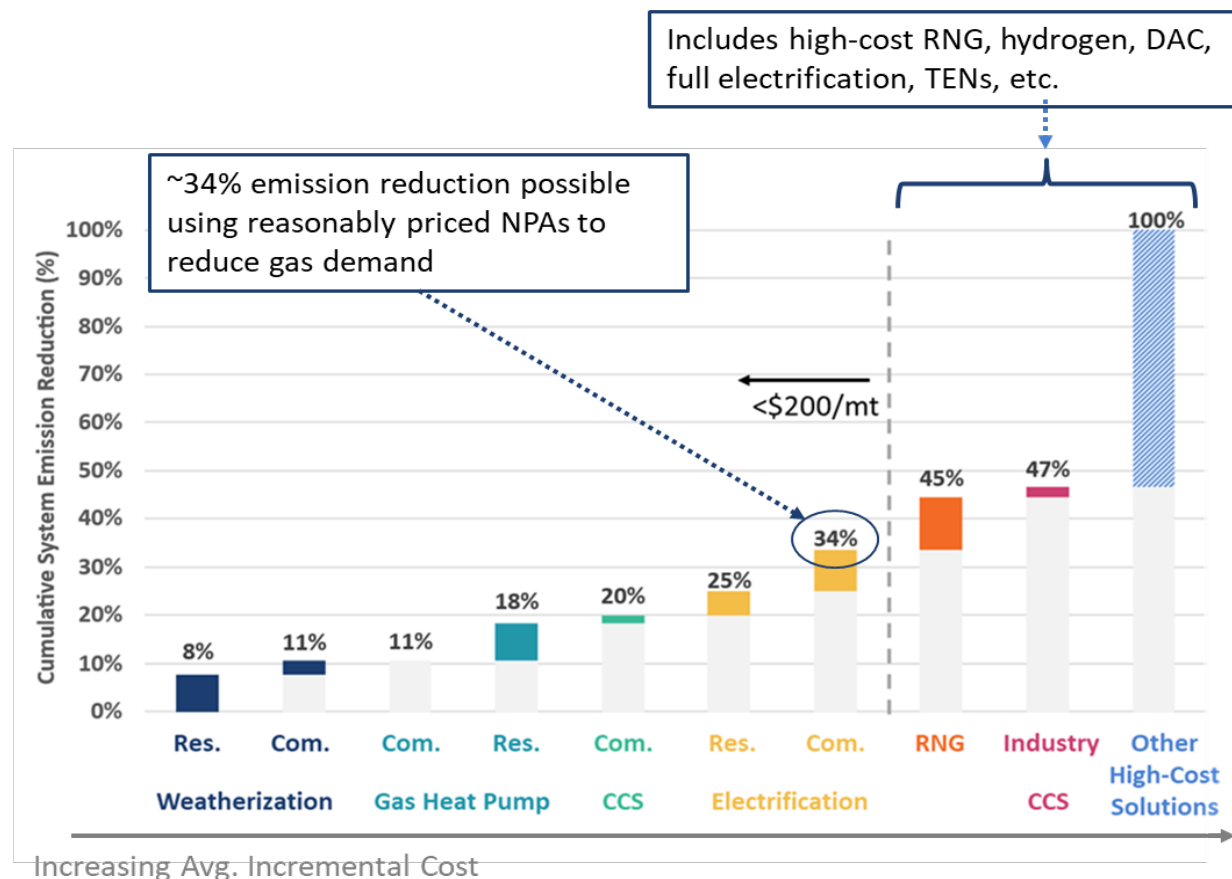
*PGL load adjustment is to match actual past PGL load to normalized test year load

For individual clean techs, as well as across them all, there tends to be a sharp “elbow” in the avoidable costs of decarbonization

- **Evaluated techs include** weatherization, HVAC electrification (ASHPs), hot water and cooking electrification, TENS, gas EE technologies (gas HPs and small-scale carbon capture), clean fuels (RNG, H₂), industrial CCS, and direct air capture (DAC).
- Cost per customer and cost per ton of avoided CO₂ for each tech vary greatly with age and condition of buildings and with how much retrofitting is necessary.
 - Nearly all can be circumstantially cheap or expensive, but some (to the right of dashed line) tend to be predominantly above the “social cost of carbon” (herein treated as \$200/mt CO₂).
 - In particular, electrification requiring large retrofits, RNG, and H₂, can be quite expensive.

There is no “one size fits all,” nor average cost findings that can be extrapolated to the whole market.

NPAs rank-ordered on typical costs in Chicago area.



Findings: Space Heating HP Electrification is often expensive

Residential and Commercial space heating electrification are only economical (< \$200/mt CO₂) in a portion of select home/building categories.

- Residential carbon abatement costs vary based on equipment used to electrify homes (ex: ASHP vs. PWHP) and existing therm usage.
- Retrofit needs for commercial buildings vary greatly; “Low-Cost” electrification reflects retrofits in buildings with existing rooftop units (RTUs, common in non-skyscraper buildings).
- Costs of carbon reductions measured after all homes/buildings weatherized prior to electrifying.

Electrification of other gas appliances was also evaluated, with water heating most promising, cooking less so.

Residential Space Heating Electrification Carbon Abatement Costs

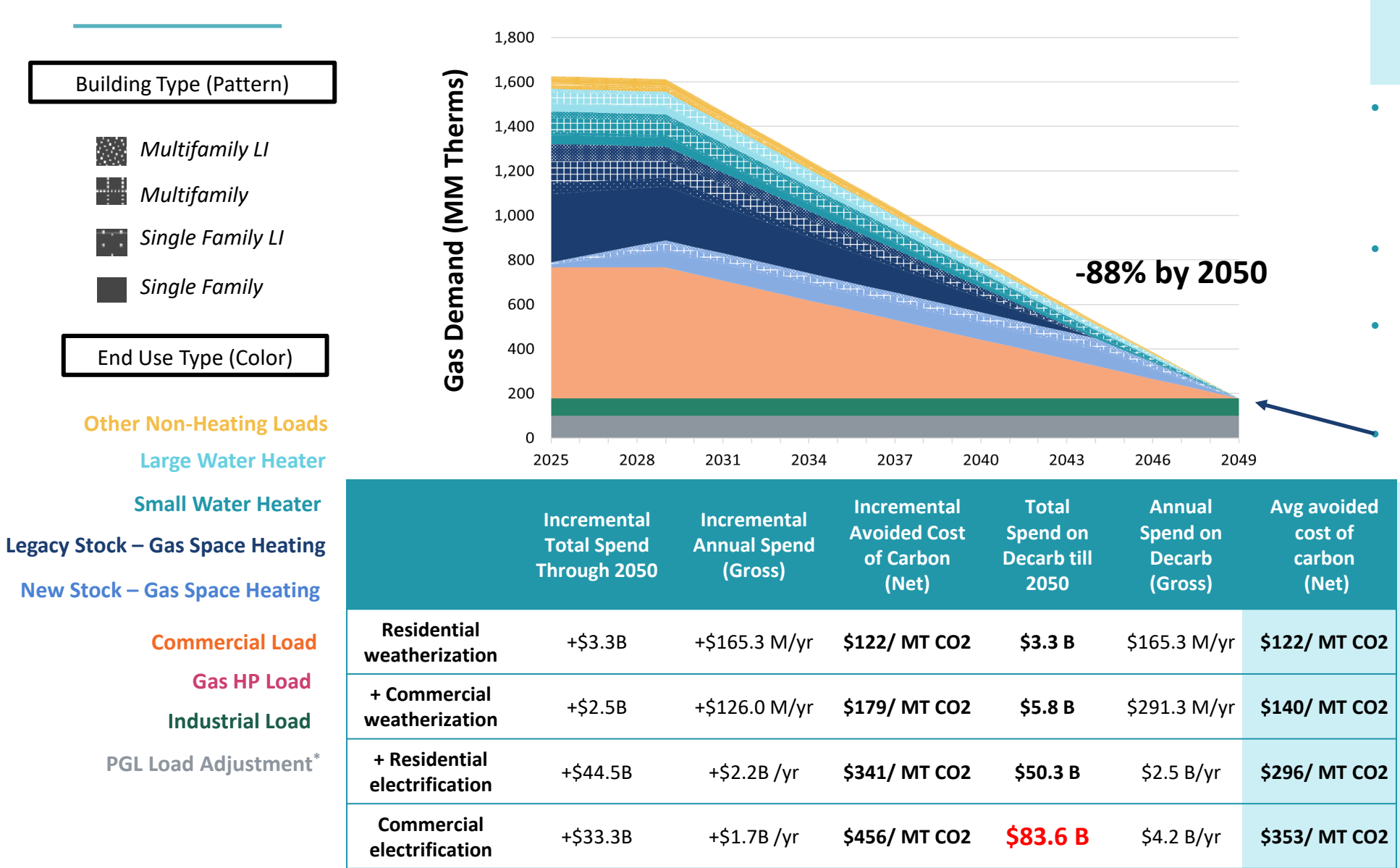
		Standard SF	Chicago Bungalows		2-4 Units		5-20 Units	Large Apt Buildings
	Type	---	Basic	Deep Shell	Basic	Deep Shell	---	---
Net Carbon Abatement Cost (\$/mt CO ₂)	High	\$460	\$730	\$700	\$240	\$220	\$580	\$650
Net Carbon Abatement Cost (\$/mt CO ₂)	Medium	\$280	\$310	---	\$150	---	\$230	\$650
Net Carbon Abatement Cost (\$/mt CO ₂)	Low	\$170	\$230	---	\$240	---	\$570	\$650
% of Category with <\$200/mt CO ₂	%	21%	0%	0%	60%	0%	0%	0%

Commercial Space Heating Electrification Carbon Abatement Costs

		Office	Health	School	Lodging	College	Food Service	Retail	Food Sales	Warehouse	Misc.
Net Carbon Abatement Cost (\$/mt CO ₂)	High	\$550	\$935	\$480	\$590	\$1,070	\$720	\$320	\$855	\$1,165	\$745
Net Carbon Abatement Cost (\$/mt CO ₂)	Low	\$160	\$190	\$350	\$260	\$535	\$390	\$100	\$345	\$450	\$190
% of Category with <\$200/mt CO ₂	%	80%	20%	0%	0%	0%	0%	55%	0%	0%	20%

Note: Figures assume clean grid; cells in green have abatement cost below the assumed SCC of \$200/ton.

100% PGL Residential and Commercial Electrification would largely eliminate emissions (reducing gas usage by 88%), but it has very high total and marginal customer costs



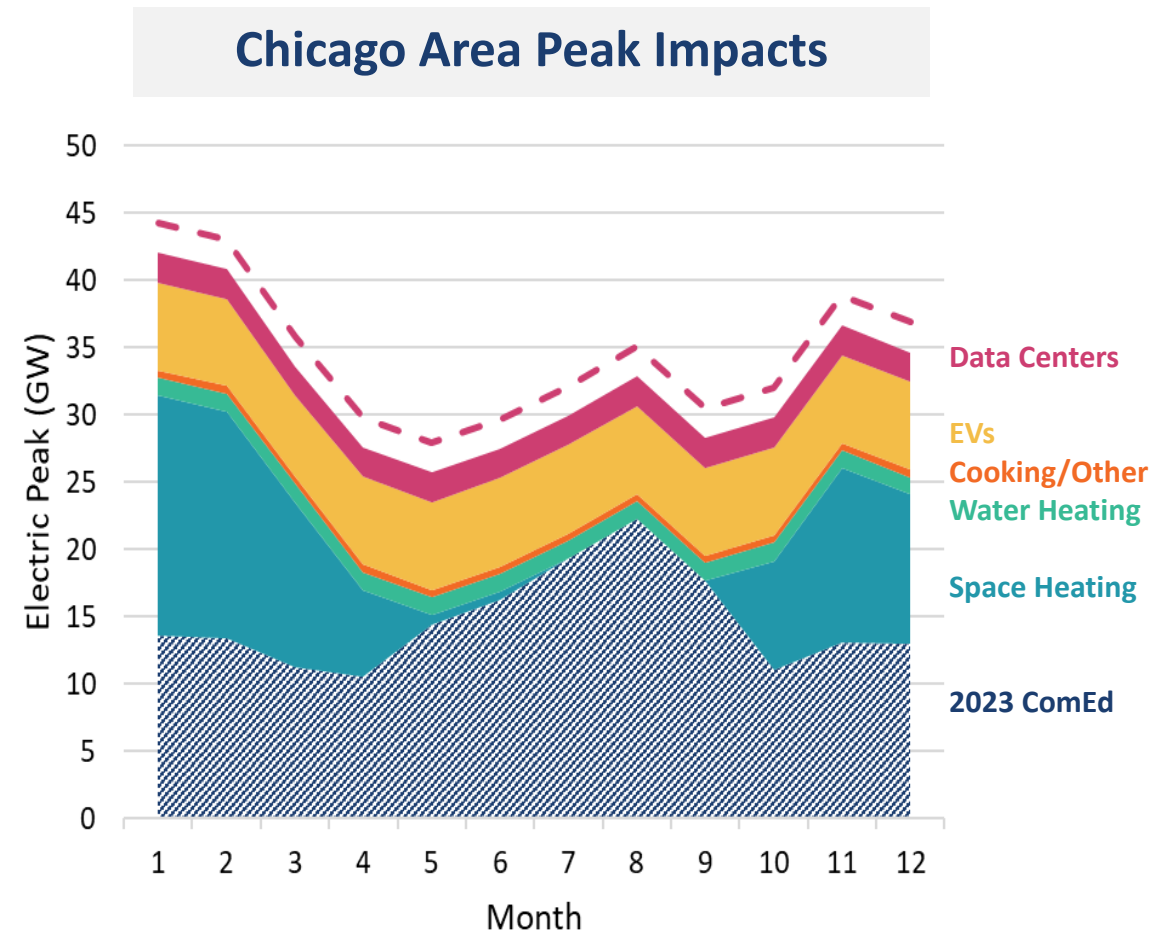
- Key Assumptions
- Residential and Commercial customers fully electrified (after weatherization) at 5%/yr starting 2031; no constraints for SCC.
 - Any electrified customers fully lost from gasco.
 - “Swiss cheese” style electrification; no mandates or neighborhood coordination.
- Remaining industrial customers could be decarbonized with RNG or H₂ (not evaluated here).*

Total PGL undiscounted end-use conversion costs of **\$83.6B**; this does not include the rest of Chicago nor any costs from impacts on electric system.

Full-scale electrification would require very substantial expansion and expenditures for a clean grid to serve the city's roughly doubled load

Even if broad-scale electrification appears to be the most plausible approach to fully decarbonizing the area ... *its costs and system requirements are extremely prohibitive:*

1. For customer appliance conversion costs -- which reach **\$80-90 Billion for PGL customers** alone, about **2x that for all Chicago** gas customers. Very large subsidies would be required. Marginal abatement costs approach \$400-1000/ton of CO₂ reduced.
2. For resulting gas bills -- growing exponentially as gas demand attenuates, requiring significant low-income customer protections, stranded cost mechanisms and/or exit fees, revised capital planning and depreciation, new rate design, etc.
3. For the electric power system's ability to provide clean power -- and satisfy the much greater winter peaking loads. Combining degasification loads with demands from data centers, EVs, and general load growth, Chicago area **peak and energy demands roughly double**.
 - Need around **40GW of renewable gen + 20-30GW storage** plus expanded T&D.
 - Upstream expansion costs could reach **\$200B** for just the incremental Chicago loads.



EDS -- An alternative, more economical approach sets the extent of target emissions reductions by balancing the costs against benefits of CO₂ abatement

1

A pragmatic approach stopping at the SCC of \$200/mt CO₂ achieves about 35% decarbonization of Chicago end-use for 18% of the customers' costs of full decarb via electrification – we call this the Economic Decarbonization Scenario (EDS).

- Full electrification has an average customer cost of carbon abatement of \$353/ton with marginal costs approaching \$1,000/ton.
- In contrast, EDS averages \$111/ton and requires only \$15B in PGL customers' end-use conversion costs, relying mostly on *weatherization and EE* plus niche electrification.
- Upstream electrification needs under EDS are almost non-consequential – no shift to a new winter peak, only a small increase in total power demand (so no strain on grid to also meet new data center loads or cleaning up its fossil capacity).

2

Gas rates and bills under EDS are very tractable. PGL loses ~1/3 of its sales volume (compared to BAU in 2050), but customer rates rise only a bit faster than inflation and customer annual bills are nearly flat.

Decarb participation is not a financial harm to the gasco: PGL can more than make up for lost gas sales income by owning or financing part of the customers' equipment and even some electrification (which also facilitates customer adoption).

3

For Chicago (and similar dense, urban networks), pipe avoidance is very difficult despite these decarb measures.

There is very little planned PGL pipe expansion for growth (just repairs), and the system's mesh and density are such that reduced load does not reduce the need for old iron pipe replacement. Conversely, avoidable pipe expenditures would not save enough to pay for much electrification. Gradual electrification ("Swiss cheese") does not support any meaningful reductions in pipe replacement. Mandated, complete, locally synchronized electrification would do so, but experience shows this requires massive social engineering and up to 10 years to coordinate.

Under EDS, PGL's 2050 gas demand and resulting emissions decline by 35% while costing customers 72% less than full electrification

Building Type (Pattern)

Multifamily LI

Multifamily

Single Family LI

Single Family

End Use Type (Color)

Other Non-Heating Loads

Large Water Heater

Small Water Heater

Legacy Stock – Gas Space Heating

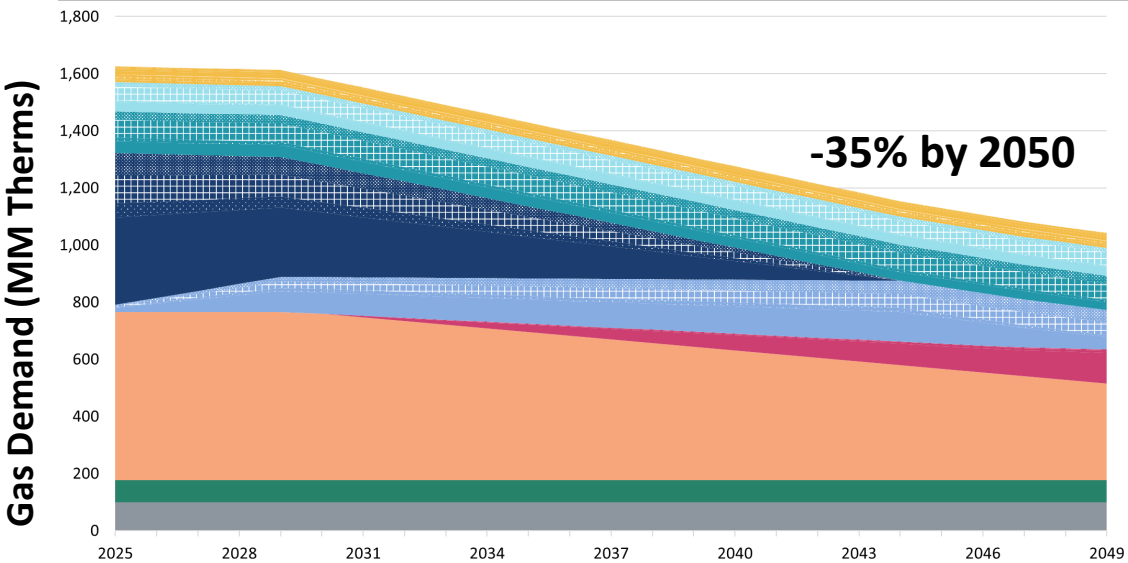
New Stock – Gas Space Heating

Commercial Load

Gas HP Load

Industrial Load

PGL Load Adjustment*



EDS Load Results	Resi Therms reduced (millions)	% Resi Load Reduction	% Total PGL Load Reduction	Comm thms Reduced (millions)	% Comm Load Reduction	% Total PGL Load Reduction	Total Customer Conversion Costs	Incremental Net \$/mt CO ₂
Weatherization	129.5	15.0%	8.0%	49.4	8.4%	3.0%	\$4.3B	\$115
Gas HPs	126.0	14.6%	7.7%	0	0%	0%	\$4.2	\$80
CarbinX	---	---	---	26.4	4.5%	1.6%	\$0.5B	\$78
Electrification	80.5	9.3%	4.9%	139.2	23.7%	8.5%	\$6.4B	\$130
Gas appliance upgrades	16.7	1.9%	1.0%	---	---	---	---	---
Total	352.7	40.8%	21.6%	215.0	36.6%	13.2%	\$15.4B	\$111 (avg.)

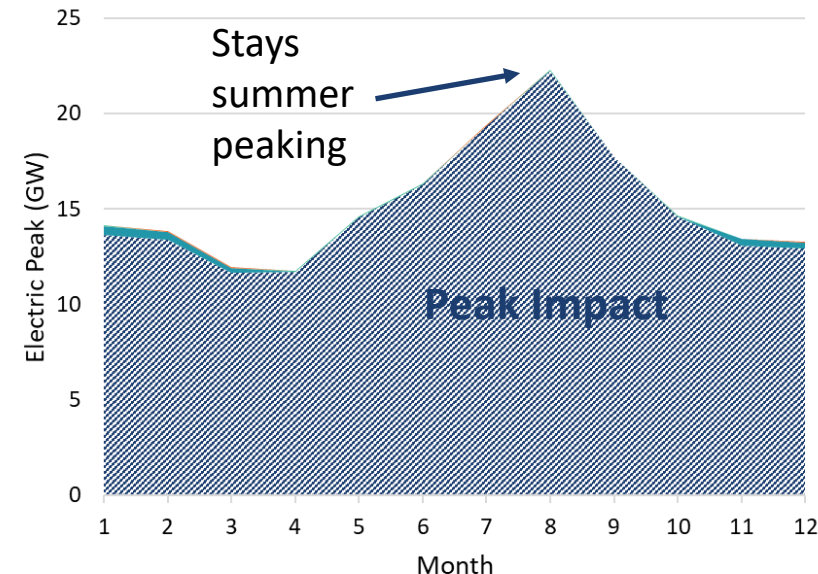
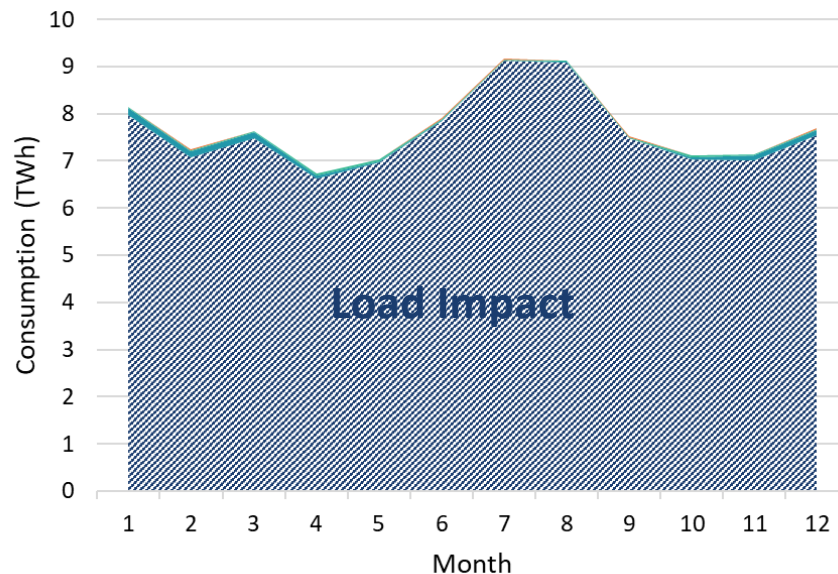
- Key Results
- Of 35% total load reductions, 62% come from residential and 38% come from commercial.
 - Total undiscounted customer equipment expenditures are **\$15.4B**
 - Essentially no incremental electric grid capacity needed (see next slide)
 - Average net cost of carbon abatement is \$111/ton, well below the SCC**

Electrification burdens under Economic Decarbonization Scenario are small

In sharp contrast to full electrification, pursuing only lower-cost NPAs (< SCC) almost eliminates growth requirements on the electric grid.

- Under EDS, the Chicago residential sector electrifies 87 million therms and the Chicago commercial sector electrifies 34 million therms (vs 3.2 billion and 1.7 billion therms under full electrification, respectively), or only about 3% of complete electrification.
- Result is no incremental ComEd system peak load, and even gross new load has an own-peak of only around 0.5GW (vs. about 20 GW gross (own-peak of new equipment) and 11 GW net (coincident peak) for full electrification of the city).

2050 Residential & Commercial Gas Electrification, Economic Decarbonization Scenario



In addition to much lower customer conversion costs, there are significant climate and energy policy advantages of targeting this Economic Decarbonization Scenario



1. Can be started almost immediately, leading to earlier carbon reduction (which is more valuable than later).



2. A practical and feasible alternative – affordable in utility bills, largely administratively compatible with existing regs and practices.



3. Imposes almost no burden on electric power expansion; does not require a clean grid.

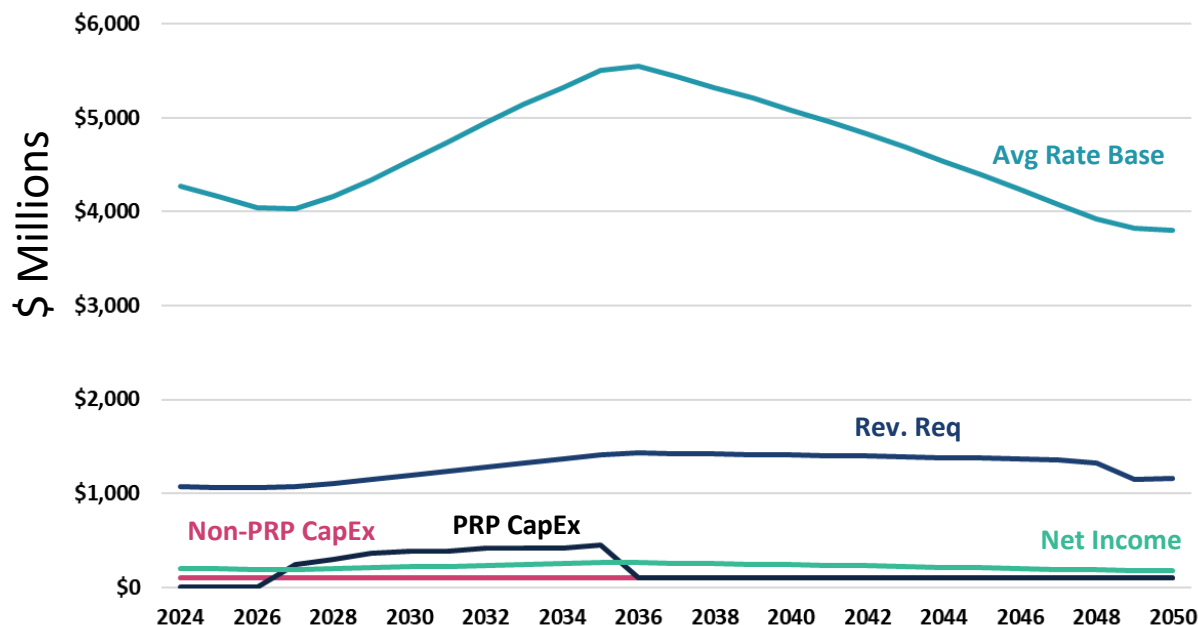


4. Continues to be valuable even if/when full electrification becomes more realistic.

A long-term cost-of-service financial model was built to depict changes from BAU under decarbonization approaches

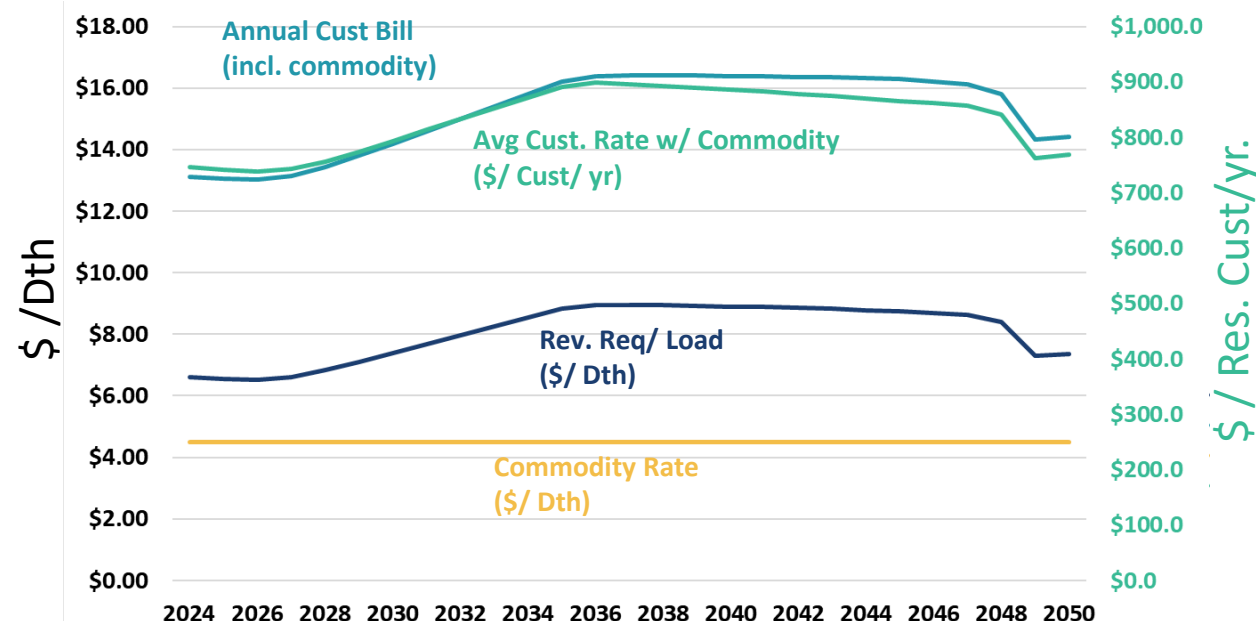
Under BAU, there are no material long term bill impacts after an interim increase for completing the Pipe Replacement Program (PRP).

BAU PGL Financial Metrics



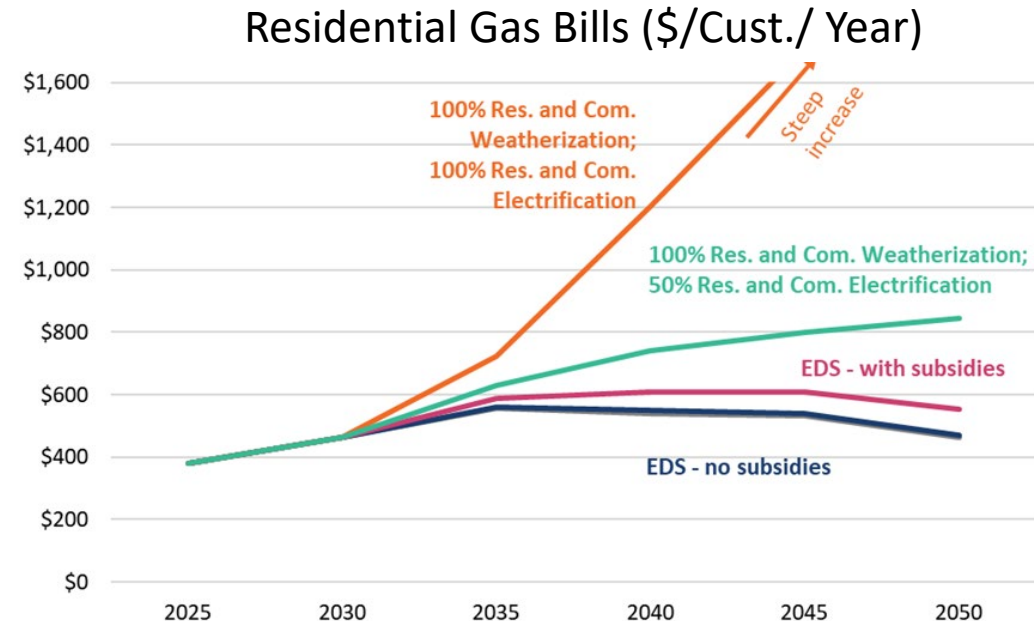
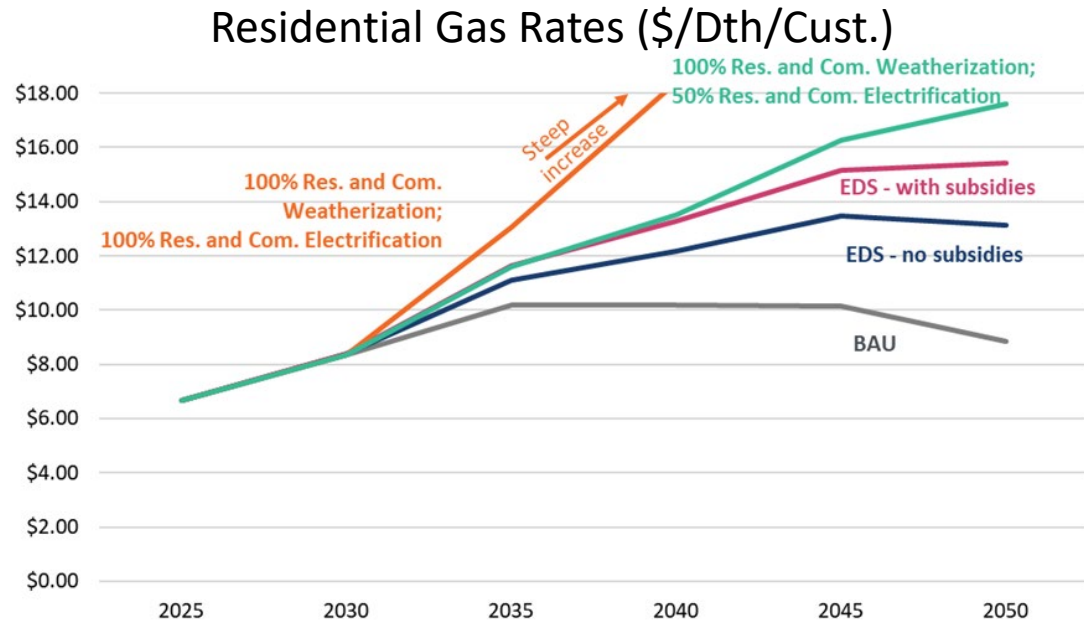
- Pipe Replacement CapEx for DI/CI upgrades occur 2027-2035.
- Net income is target RoE * equity rate base in each year.
- No load forecast adjustments made for the rise and fall of average costs.
- Model calibrated to 2023 PGL regulatory filings and financial statements.

BAU Customer Financial Metrics



- BAU customer count and total sales are nearly flat over whole horizon.
- Rates use current allocations of 73% to Resi and 27% to Comm.
- Rate design for resi uses 72% of rev req (excl. commodity) to variable charge, 28% to fixed (per customer) charge.

Under EDS, customers' rates would only increase by around 15–40% by 2050 depending on subsidization levels (0.5–1.4%/year)



However, EDS gas bills would stay fairly flat and nearly identical to BAU because customer usage would be going down to offset the rising unit costs, and the number of customers paying fixed customer charges is relatively constant.

- By contrast, a scenario with **50% electrification** involves persistent and accelerating bill growth.
- **Full electrification** involves hyperbolic growth in gas bills to the dwindling customer base, which would create untenable bills for customers and significant stranded assets on the system.
- **Subsidization** of low income weatherization and heat pumps, and utility financing of a portion of commercial HPs and CarbinX costs, only slightly raise rates and bills, but provide substantial financial offset to lost loads. brattle.com | 15

Achieving significant gas decarbonization will require expanding laws and regulatory practices to allow more activity, flexibility, and innovation

Achieving even the more limited decarb under EDS would require foundational authorizations and policy clarifications that need to start soon, in order to be substantially underway in a few years and feasible for accomplishment by 2050 (e.g., *EDS involves processing around 70k PGL customers per year*).

- Increase in gasco EE budgets and authorized scope of customer use-management
- Allowed behind-the-meter (BTM) participation; gasco appliance ownership and leasing arrangements
- Cross-utility billing (from gasco to electric co for gasco-mediated electrification)
- Subsidy sizing and eligibility for low-income customers and technology incentivization
- CIS upgrades (new types of services, much more differentiated customers)
- Billing determinant elaboration (relative shares of customer types, and variation within class)

For full decarbonization via electrification, much larger changes are needed:

- Substantial incentives, prices, penalties or mandates
- Very large subsidies and low-income customer protection
- Stranded cost recovery mechanisms, accelerated depreciation
- Neighborhood coordination processes and conversion mandates
- Gasco relief from obligation to serve

Recommended FoG steps to foster economical GasCo decarbonization

- **Develop agreed assumptions about costs, availability and performance of available decarbonization technologies, and how those parameters might improve over time, for use in compliance plans.**
- **Require decarb potential to be evaluated by sector (e.g. residential by type of housing, industrial by scale, type and condition of heat processes used, etc.) to develop abatement cost supply curves.**
- **Establish formal economic benefit thresholds for selecting acceptable decarb approaches, e.g., SCC plus other environmental benefits.**
- **Assess customer ability-to-pay for the extent of decarb approaches that pass the cost-benefit test; identify subsidies needed to protect vulnerable customers and assure equitable adoption paths.**
- **Identify sources of necessary subsidies or incentives and establish willingness to apply them at those levels:**
 - e.g., Carbon pricing and revenue rebating, tax credits, outright targeted subsidies, socialization of costs across utility customers; direct adoption mandates and coordination protocols.
 - Only pursue decarbonization to the extent there is agreed funding and incentivization for the target attainment.
- **Specify clean electrification goals as derived from the feasible customer conversion modeling**
 - Temper decarb goals and pace with any limits on plausible clean electrification that is affordable and reliable.
- **Revise legislative and regulatory protocols to support innovative and flexible customer support for decarb expenditures**, including new rate designs, cross subsidies, BTM involvement, revised obligation to serve, stranded cost recovery, performance accounting, etc.; establish long term planning tools for simulating the use of these innovations.

• Appendices:

Chicago-area power requirements for full electrification

Details on NPA costs and applicability

Financial modeling

Comparison to other studies and policy implementation issues

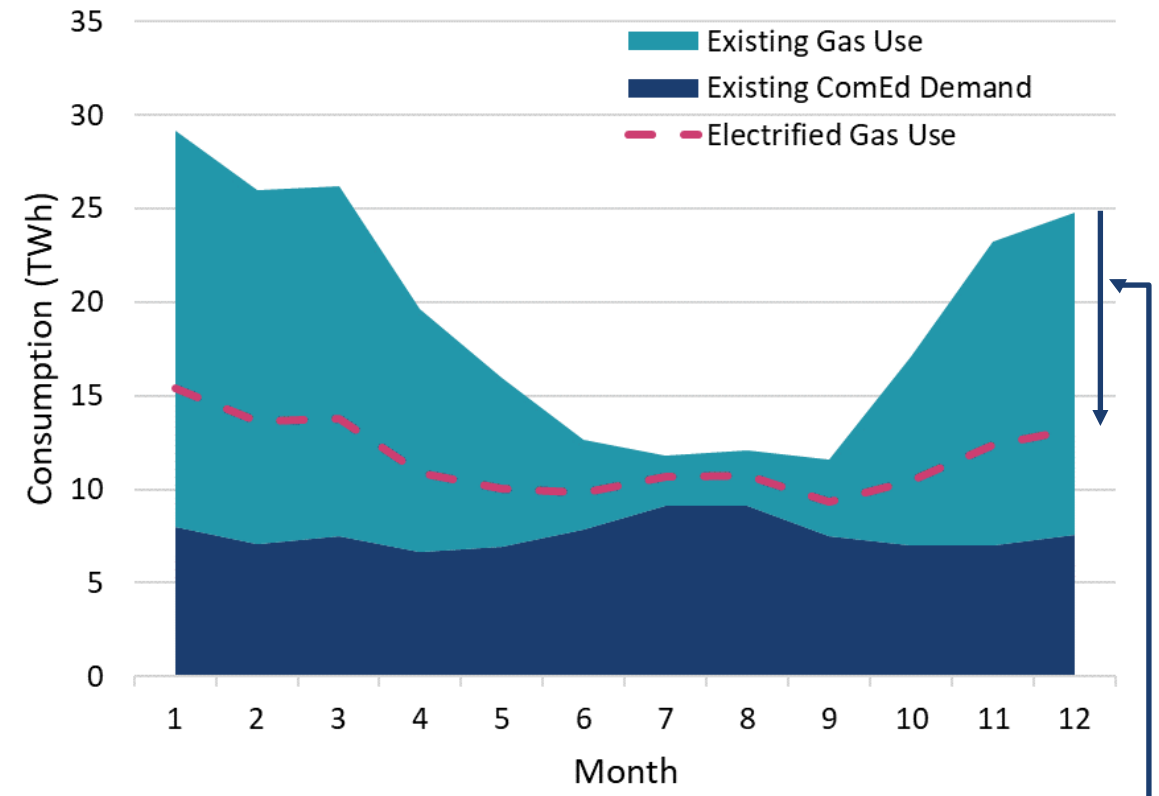
Power System Implications of Chicago-Area Decarbonization via Electrification

A detailed End-Use Electrification Model was developed to assess system needs on an hourly basis from electrifying Chicago-area gas appliances.

Electrification model takes existing residential and commercial appliance loads for PGL, NSG, Nicor and translates them into equivalent delivered *hourly* and monthly electricity requirements. We then use those results to:

- Estimate annual electrification load shape impacts using historical weather conditions (degree days) and temperature-based COP factors for ASHPs.
- Estimate the hourly system peak using existing ComEd loads after gas conversions, plus potential additional electric loads (esp. AI data centers and EVs).
- Estimate emissions savings and cost per avoided ton of CO₂ from electrification, depending on how clean the electricity is from the grid:
 - Best case – already 100% clean (mostly shown herein).
 - More realistic actual starting point – 450 pounds CO₂/MWh from marginal gas unit.

Chicago Energy Consumption



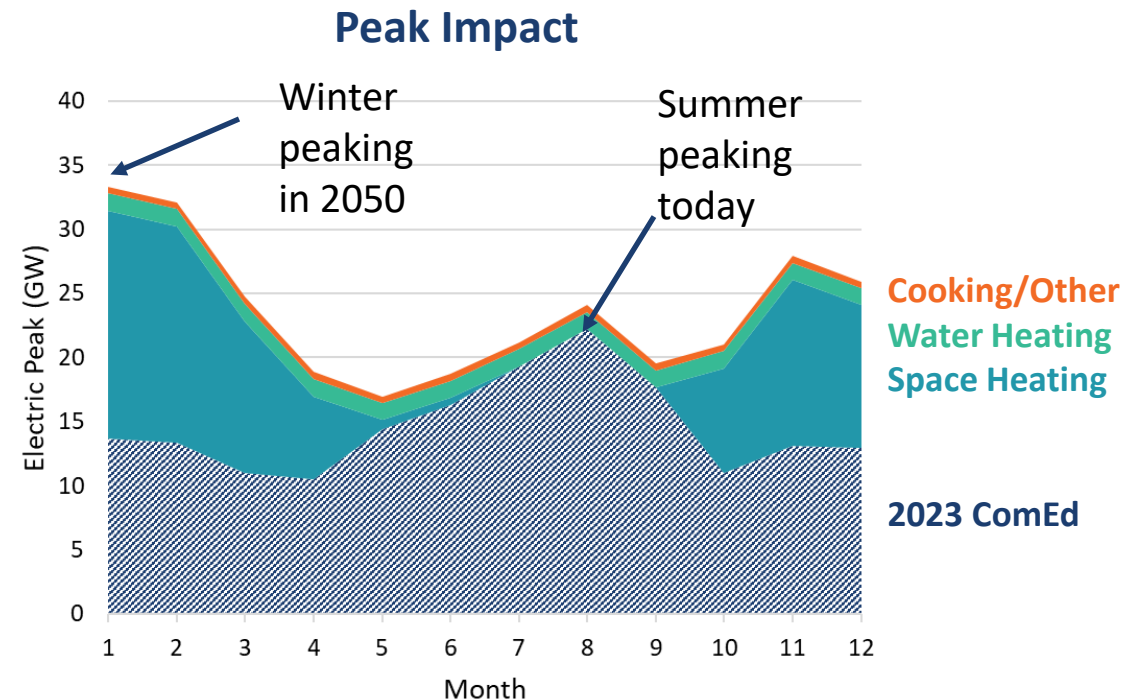
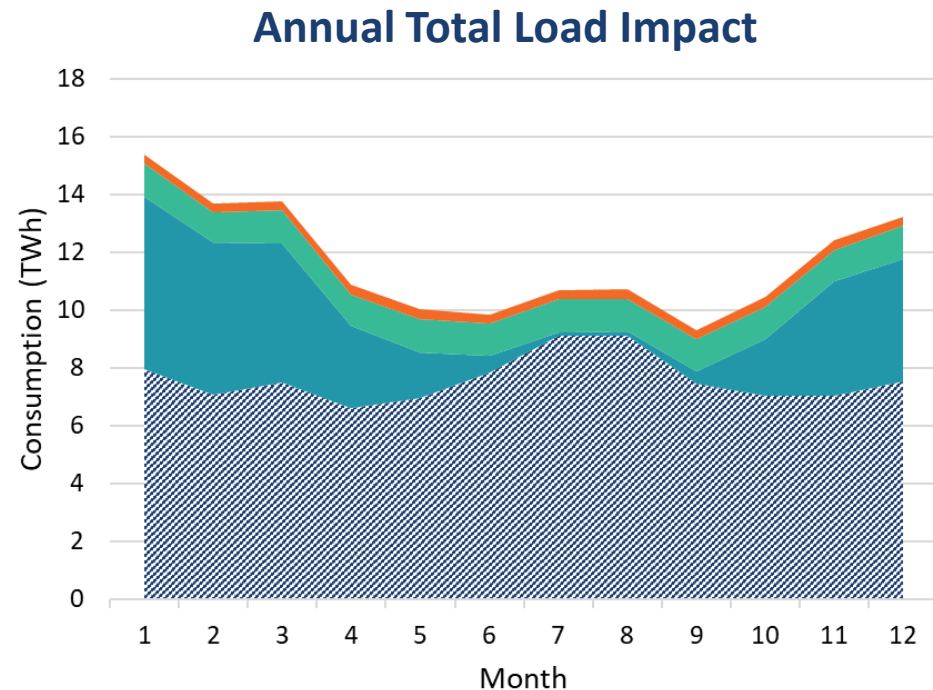
Due to high efficiency of ASHP, electrification involves less net end-use energy demand than gas but shifts max power demand to winter months.

Results shown are based on HDDs in 2023 weather year; gas load is representative of PGL, North Shore, and Nicor residential and commercial gas use.

Just with degasification, the ComEd territory electric energy and peak would each become about 50% higher by 2050

Full (100%) Chicago gas electrification greatly increases electric loads:

- Load (annual electric energy) increases +54% from 91 TWh to 140 TWh; equivalent to the annual output of about 28 GW of solar power at a 20% capacity factor, or about 6X the 4,700 MW installed in IL as of summer 2025.
- Peak grows about 11 GW, or +43%, from about 22 GW to 33 GW, and it shifts from summer to winter once about half the city is degasified (around 2040 if uniformly accomplished and starting soon).

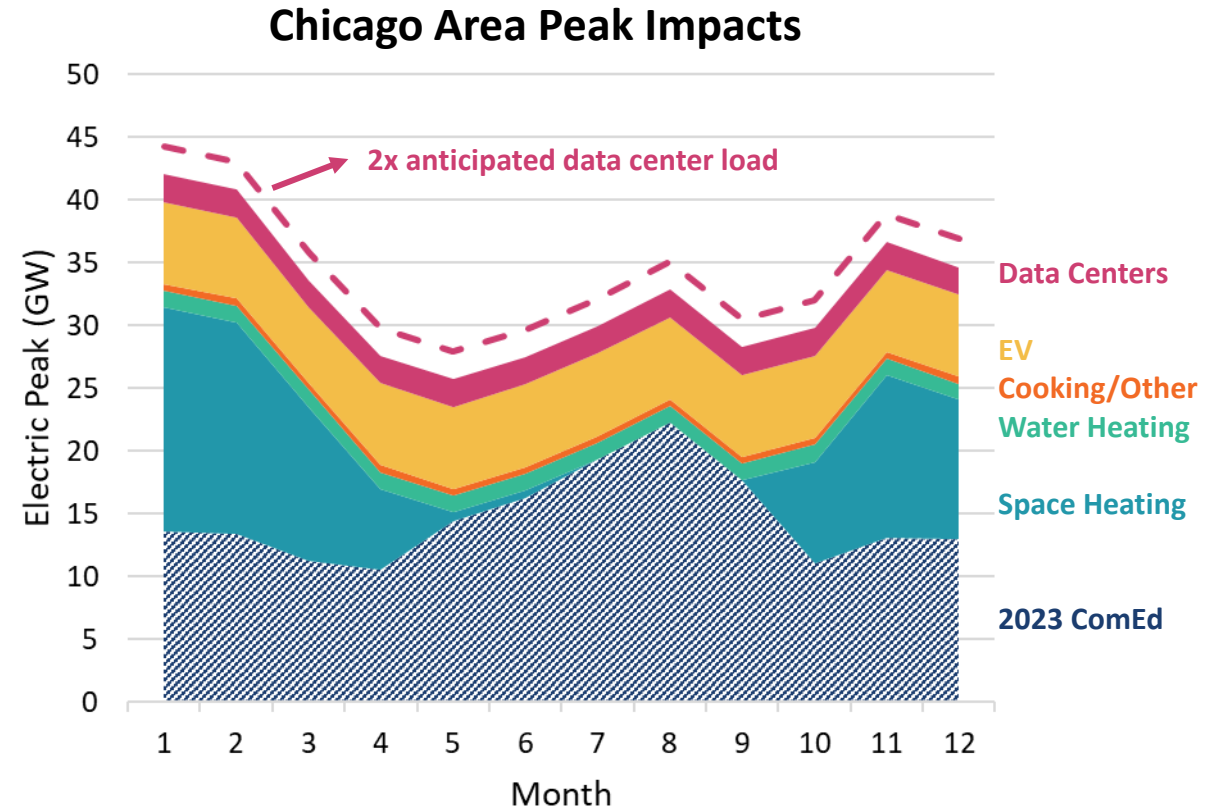


Note: ComEd 2023 load is used as the base before electrifying gas customers for PGL, North Shore, and Nicor, whose service territories do not exactly match or overlay ComEd's. Results assume a 2023 weather year and no customer growth in current load, e.g. no new AI or EVs.

Load growth from additional end-uses would further stress the grid

EVs and data centers will contribute another 50% to Chicago area load.

- When likely data centers and EVs are considered, just those new loads could add roughly 46 TWh by 2050 (~50% of current ComEd load) and raise area peak to ~43 GW (incl. degasification), to about 21 GW above current summer peak.
- These results assume full electrification of Chicago metro existing LDV ICE fleet (~7 million vehicles), with each vehicle consuming 3,800 kWh/year.
 - We use NREL EVI-X to create a Chicago-specific weighted avg load shape from home, work, and public charging.
- The resulting total energy load is ~190 TWh (full electrification plus existing ComEd load in Chicago), *approximately double current ComEd retail sales* of ~91 TWh.
- Our new load is *a conservative estimate* because we only consider data center load through 2030 and Light Duty Vehicle stock conversions (no HDVs); we add a 2x data center sensitivity (dotted line) to show how future load growth will influence the peak.



Not shown – Adoption of electric HPs would add some air conditioning load to summer, but this would be somewhat offset by improved efficiency for existing A/C customers.

Indicative incremental system electrification costs

Ignoring cleaning up the 2025 embedded system, ComEd territory could see an incremental load from full electrification of about 30GW added to winter peak and 91TWh of increased annual energy, requiring around \$200 Billion of upstream infrastructure additions.

- **Generation** – Since the system will become winter peaking, wind is likely the dominant component (solar has only about 5% capacity factor in IL winter).
 - Supply the energy with 75% wind (34% capfac), 25% solar (17% capfac) → **+23GW wind, +15GW solar**
 - Assume wind @ \$1600/kW = **\$37B**, solar @ \$1200/kW = **\$18B**
- **Storage** – Need enough for a full winter-day renewable drought (with 85% efficiency).
 - $30\text{GW} * 24 \text{ hours} / .85 = \mathbf{250-300GWh}$ of battery inventory
 - \$250-400/kWh for Li-ion batteries = **\$60-100B**
- **Transmission** – Assume renewables need new lines to wind sourced from IA, MN/ND and solar from IL.
 - HV lines with 2-4GW transfer capability, about \$2-4mm/circuit mile
 - Need about **10,000 GW-miles/3 corridors => 3500 circuit miles** * \$3mm/mile = **\$10B**
- **Distribution** -- Larger, more coincident and more protracted winter loads likely require many upgrades.
 - Assume half of new supply needs new 50-100MVA substations @ \$5-20mm each => 200 substations = **\$1-4B**
 - 1500–2000 feeder upgrades with 15mi/feeder @ \$.5-2mm/mi => **\$10-50B**
 - 3mm customers/(5 custs per dist transformer) @ \$5000-10,000 each) = **\$3-6B**

Total = (18+37) gen +(60-100) storage +10 trans +(14-60) distribution = \$140B – 225B

Opportunities and Costs for Decarbonization (possible NPA) Measures

More than a dozen candidate carbon reduction technologies/NPAs were evaluated for load impacts and costs*

Evaluation process (for each major type of dwelling and type of commercial business):

- 1) Which techs or approaches are feasible for which customer types?
- 2) What is their range of cost and performance (gas usage and carbon reduction rates)?
- 3) How extensively can they be implemented for less than the social cost of carbon (\$200/mt)?
- 4) Which will be chosen if multiple techs are suitable?

Demand Reduction or Energy Efficiency

Weatherization in both residential and commercial buildings to different extents

Replace gas furnaces with **Gas Heat Pumps** on breakage

Replace boilers with **CarbinX** in commercial buildings

Electrification

Air Source Heat Pumps for heating and cooling

Thermal Energy Networks in suitable dense neighborhoods

Electric Water Heaters and Stoves for residential heating and cooling

Clean Fuels

Replacing natural gas with **Renewable Natural Gas**

Replacing natural gas with **Certified Natural Gas**

Replacing natural gas with **Hydrogen**

Emissions Capture

Sustaining gas usage but moving emissions using **Direct Air Capture (DAC)**

Carbon Capture & Sequestration (CCS)

* Where decarb techs reduce load, they have potential to be NPAs. That is evaluated here, but pipe avoidance or degasification for their own sake are not the focus, which instead is on economical decarbonization.

One size does not fit all – Possible NPA measures must be evaluated separately for each Chicago building type

PGL Residential Building Types Modeled

Building Type	Therms (000s)	% of Therms	Dwelling Units	Therms/Dwelling Unit
Standard SF	265,129	31%	204,093	1,299
Chicago Bungalow – Basic Shell	50,103	6%	60,000	835
Chicago Bungalow – Deep Shell	19,004	2%	20,000	950
2-4 Units – Basic Shell	161,410	19%	190,422	848
2-4 Units Deep Shell	61,224	7%	63,474	965
5-20 Units	162,888	19%	422,685	385
Large Apartment Buildings	142,527	17%	558,991	255
Unknown	1,485	0%	5,442	273
Total	863,769	100%	1,525,106	566

PGL Commercial Building Types Modeled

Building Type	Therms (000s)	% of Therms	Sqft (000s)	Therms/sqft
Office	84,829	14%	258,936	0.33
Health	139,365	24%	212,698	0.66
School	94,896	16%	195,390	0.49
Lodging	52,231	9%	68,174	0.77
College	41,892	7%	183,762	0.23
Food Service	31,921	5%	15,419	2.07
Retail	23,775	4%	42,524	0.56
Food Sales	12,888	2%	14,898	0.87
Warehouse	5,125	1%	61,154	0.08
Misc.	100,937	17%	195,821	0.52
Total	587,859	100%	1,248,776	0.47

The complex and heterogeneous nature of PGL's building types and demographics requires evaluating NPA potential against sub-categories of customers rather than as whole classes or as statistical load aggregates. The same type of customer living in different types of dwellings can face very different feasibility and economics of adopting alternative technologies.

Results: Residential Weatherization is largely economic

Weatherization for almost all of PGL residential is economic at less than \$200 per ton, except for deep shell treatment of older dwellings like some Chicago Bungalows.

Nonetheless, all residential households (HH) are modeled as performing weatherization before implementing any other NPAs.

- Assuming 8% of homes have already been weatherized as of 2025, an additional 14.2% reduction in residential sector load would be expected by 2050 from weatherization of all remaining homes.

Requires PGL to treat ~65k homes annually for 20-year period – likely well above current processing pace.

Residential Weatherization Carbon Abatement Costs

	Standard SF	Chicago Bungalows		2-4 Units		5-20 Units	Large Apt Buildings
Type	---	Basic	Deep Shell	Basic	Deep Shell	---	---
HH Gross cost of Weatherization	\$5,340	\$2,900	\$15,000	\$2,200	\$6,670	\$2,000	\$740
HH Net Cost of Weatherization	\$2,800	\$1,620	\$12,920	\$530	\$4,480	\$1,030	\$405
% HH Therm Reduction	18%	14%	21%	19%	22%	25%	13%
Net Carbon Abatement Cost (\$ mt/CO ₂)	\$110	\$130	\$610	\$30	\$200	\$100	\$120

Note: Abatement costs assume *clean grid*; absent that costs/ton would be *lower*, because weatherization avoids some electric usage.

Above, green shaded cells indicate net costs below the SCC.

Net costs used as last filter do not include any offset from the social benefit of carbon reductions. Instead, they are compared on a present value net basis (without subsidies or special rate incentives) per lifecycle ton of CO₂ reduction to \$200/ton, taken to be a measure of the social cost of carbon. (The US EPA estimate of the SCC in 2020 was set at \$190/ton.)

Results: Residential Gas Heat Pumps are largely economic

Residential Gas Heat Pumps are largely economic for less than \$200/mt CO₂ due to significant therm savings.

- Standard SF GHP modeled as \$15,000 vs. \$9,000 for replacement furnace.
- Incremental gross cost of residential GHP vs. replacement gas furnace is largely offset by 40% reduction in therm usage for SF and 2-4 Unit buildings.
- Abatement costs are significantly higher for larger multi-unit buildings due to lower starting therm usage.

Residential Gas HP Carbon Abatement Costs

	Standard SF	Chicago Bungalows		2-4 Units		5-20 Units	Large Apt Buildings
Type	---	Basic	Deep Shell	Basic	Deep Shell	---	---
HH Gross cost	\$15,000	\$12,000	\$12,000	\$10,000	\$10,000	\$8,000	\$8,000
HH Net Cost	\$2,710	\$4,770	\$4,700	\$3,010	\$2,840	\$2,780	\$2,910
% HH Therm Reduction	40%	40%	40%	40%	40%	40%	40%
Net Carbon Abatement Cost (\$ mt/CO ₂)	\$70	\$190	\$180	\$130	\$110	\$340	\$430

Note: Abatement costs assume *clean grid*; absent that (as is realistic for the next several years) costs/ton would be about 2x higher.

Results: Commercial scale CCS (CarbinX) is mostly economical, while Gas HP is expensive

CarbinX is an emerging technology to improve efficiency and capture a few % of residual CO₂ emissions from commercial gas boilers (in the majority of large urban buildings in Chicago). It is economical for the majority of building categories, whereas Gas HPs for commercial furnaces are not economical for < \$200/mt CO₂.

- CarbinX system applicable only for buildings with boilers. It currently costs \$27,000 for a 1.5MM BTU/hr unit integrated with existing boiler. CarbinX has been deployed in Chicago, Minnesota, New Jersey, Vermont, and Alberta.

Commercial CCS (CarbinX)
Carbon Abatement Costs

	Office	Health	School	Lodging	College	Food Service	Retail	Food Sales	Warehouse	Misc.
Net Carbon Abatement Cost (\$/mt CO ₂)	\$130	\$110	\$40	\$50	\$110	\$220	\$150	NA	\$130	\$20

- Under ideal conditions, CarbinX can reduce up to 20% energy and CO₂; here it is assumed to save 12% of therm and additional 2% of emissions from carbon capture. Its CCS byproducts are commercially valuable but excluded in these calculations.
 - There are other commercial-scale CCS systems, such as SandBox Carbon.
 - “NA” for CCS Food Sales indicates no boiler usage in category. Figures assume clean grid.
- Commercial gas heat pumps (HP) can achieve a 40% reduction in therm usage, but they are not yet standardized or widely used. Assumed here to cost \$4,250/heating ton and replace existing furnaces at \$2,000/ton.

Commercial Gas HP
Carbon Abatement Costs

	Office	Health	School	Lodging	College	Food Service	Retail	Food Sales	Warehouse	Misc.
Net Carbon Abatement Cost (\$/mt CO ₂)	\$590	\$700	\$370	\$410	\$830	\$350	\$250	\$360	\$910	\$300

Results: Space Heating HP Electrification is often expensive

Residential and Commercial space heating electrification are only economical (< \$200/mt CO₂) in a few select home/building categories.

- Residential carbon abatement costs vary based on equipment used to electrify homes (ex: ASHP vs. PWHP) and existing therm usage.
- Retrofit needs for commercial buildings vary greatly; “Low-Cost” electrification reflects retrofits in buildings with existing rooftop units (RTUs, common in non-skyscraper buildings).
- Costs of carbon reductions measured after all homes/buildings weatherized prior to electrifying.

Electrification of other gas appliances was also evaluated, with water heating most promising, cooking less so.

Residential Space Heating Electrification Carbon Abatement Costs

		Standard SF	Chicago Bungalows		2-4 Units		5-20 Units	Large Apt Buildings
	Type	---	Basic	Deep Shell	Basic	Deep Shell	---	---
Net Carbon Abatement Cost (\$/mt CO ₂)	High	\$460	\$730	\$700	\$240	\$220	\$580	\$650
Net Carbon Abatement Cost (\$/mt CO ₂)	Medium	\$280	\$310	---	\$150	---	\$230	\$650
Net Carbon Abatement Cost (\$/mt CO ₂)	Low	\$170	\$230	---	\$240	---	\$570	\$650
% of Category with <\$200/mt CO ₂	%	21%	0%	0%	60%	0%	0%	0%

Commercial Space Heating Electrification Carbon Abatement Costs

		Office	Health	School	Lodging	College	Food Service	Retail	Food Sales	Warehouse	Misc.
Net Carbon Abatement Cost (\$/mt CO ₂)	High	\$550	\$935	\$480	\$590	\$1,070	\$720	\$320	\$855	\$1,165	\$745
Net Carbon Abatement Cost (\$/mt CO ₂)	Low	\$160	\$190	\$350	\$260	\$535	\$390	\$100	\$345	\$450	\$190
% of Category with <\$200/mt CO ₂	%	80%	20%	0%	0%	0%	0%	55%	0%	0%	20%

Note: Figures assume clean grid.

Clean Fuels are expensive (above SCC) but may be long run solutions for decarbonizing the industrial sector

Clean fuels like RNG and hydrogen are under consideration by many gas companies, but preliminary evidence indicates that for large quantities they can be expensive, are not yet widely available, and will likely be heavily sought by other sectors beyond gas distribution (i.e., they may be more necessary for decarbonization of heavy transportation or the high-heat industrial sector).

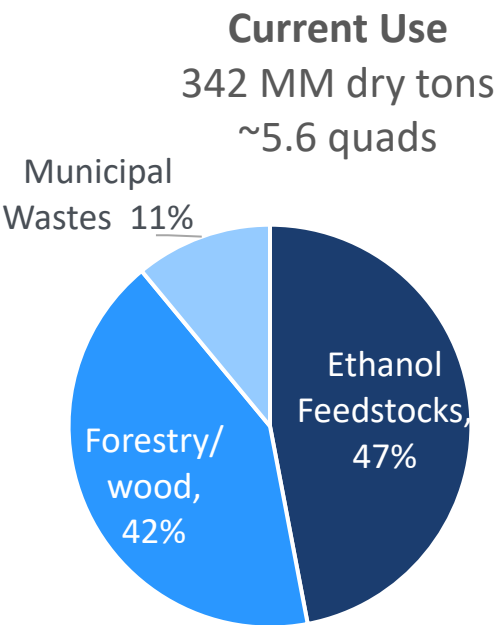
RNG and Biomass:

- **Current biomass market:** dominated by the use of corn-based ethanol, forestry products for onsite CHP, and municipal waste for power generation; only about 5.6 quads nationwide; RNG mostly from municipal and agricultural waste at about 2–3% of US natural gas demand, of which very little goes to gas companies (LDCs).
- **Mid-term (2030s) market:** RNG supply likely will be limited to sources in close proximity to demand sinks. Growth expected from agricultural waste and urban waste that could double supply, but regional constraints and infrastructure gaps will limit scaling.
- **Long-term (2040s) market:** A national market could emerge with largely agricultural feedstocks, possibly reaching 20 quads/yr or about 45% of 2023 gas consumption. Costs likely to be **\$15–\$30/MMBtu or up to \$300/ton** for carbon reduction. Heavy demand from transportation, particularly those sectors subject to federal and state fuel blending standards.

Hydrogen: With loss of federal support, complex clean power requirements for its manufacturing, and expensive end-use conversions, H₂ looks to be (and to remain) out of the money at **\$3–5/kg or \$20–40/MMBtu** except for niche applications.

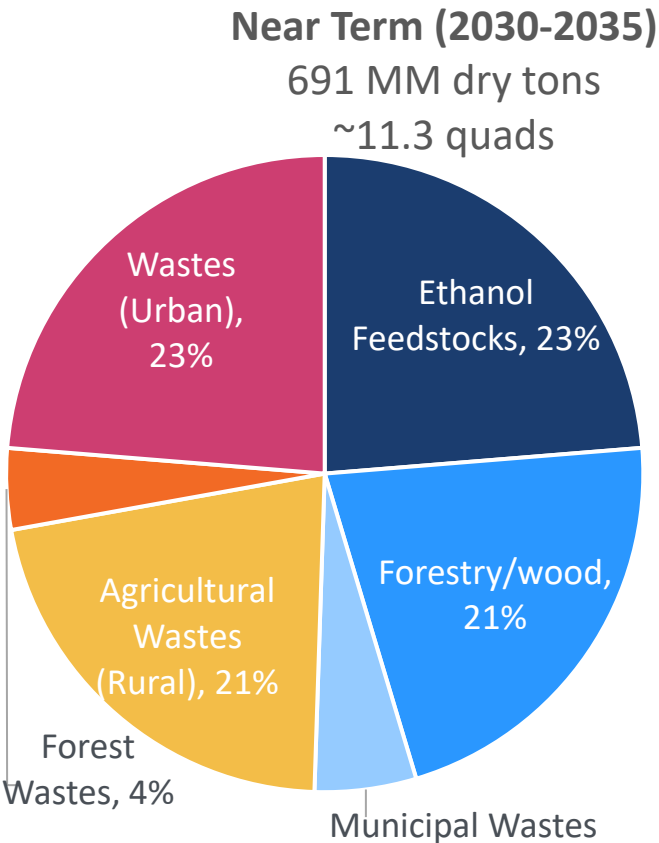
There is limited RNG potential until major new feedstock development.

National biomass/RNG supply projections expect 3x+ growth but even with that, projects will be costly and face strong demand competition from transportation and industrial users.

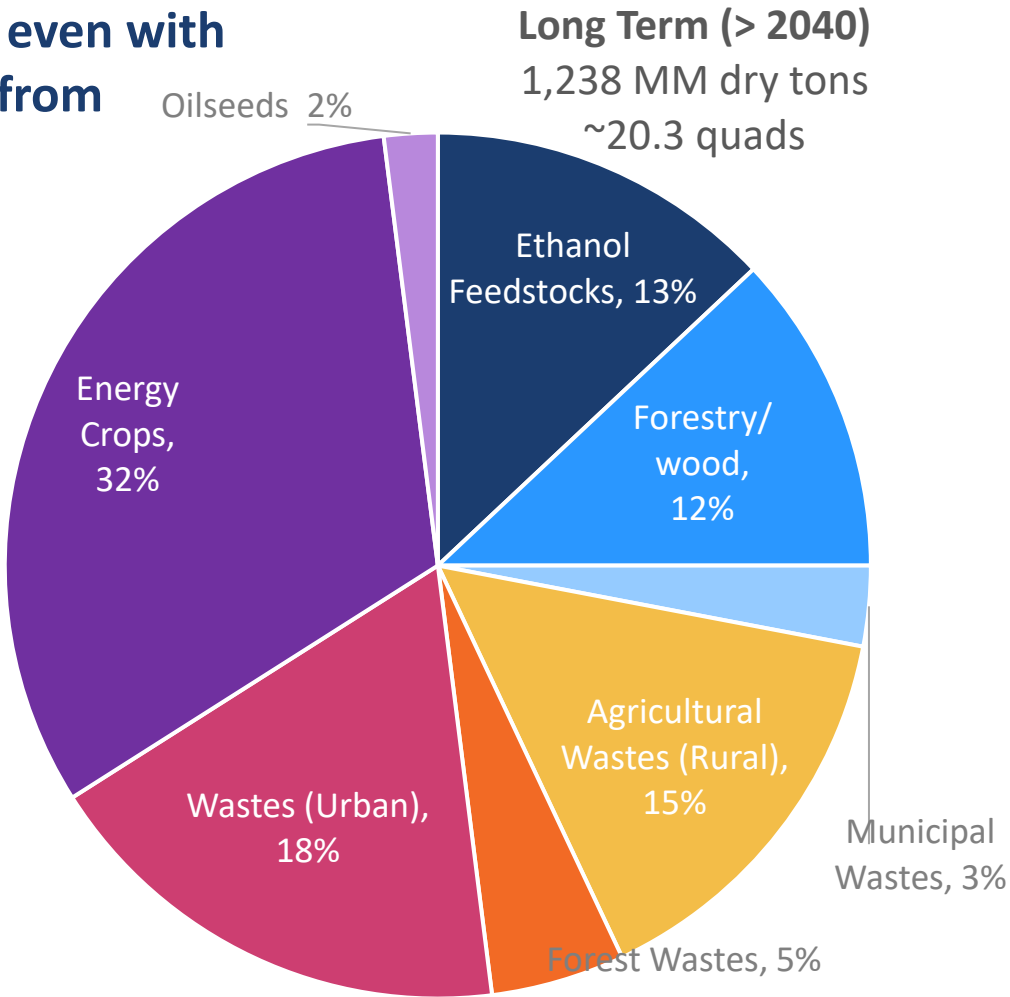


Virtually none of this available to gas LDCs at present

Source: Billion-Ton Report.



Incremental ~5.7 Quads or 18% of total 2023 US gas consumption



Incremental ~9 more Quads reaching 45% of total 2023 US gas consumption

Hydrogen -- a quick rise and fall in economic prospects

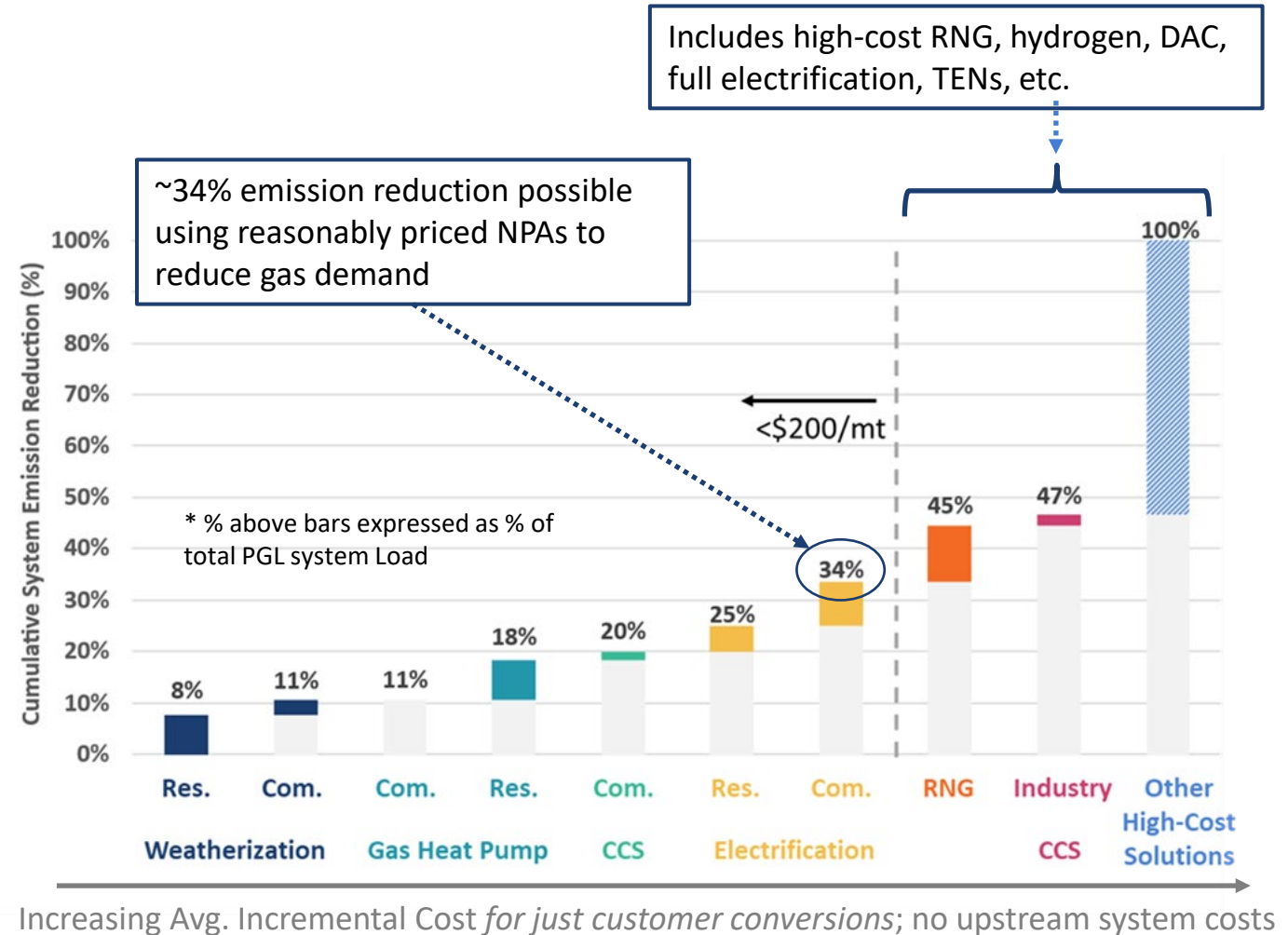
- **Initial Policy Support:** The Inflation Reduction Act in 2022 created very significant tax credits and incentives for the investment in or production of clean hydrogen, garnering significant attention from the energy industry to deploy hydrogen in hard-to-decarbonize industries.
 - U.S. set a goal to reduce the cost of clean hydrogen to \$1/kg within 10 years, equiv. to about \$8/MMBtu. IRA plus reductions in electrolysis and renewable power costs were expected to achieve that.
 - Department of Energy created \$8B hydrogen hub initiative to invest in regional supply and demand projects and kickstart the development of regional hydrogen markets.
- **Limitations:** Hydrogen adoption faces substantial technological challenges (*e.g.*, leakage, pipeline embrittlement, blending % limitations) and limited hydrogen infrastructure (*e.g.*, pipelines, storage, end-use equipment) which must be overcome before it can be used widely as a decarbonization solution.
- **Recent policy developments:** The US has greatly scaled back IRA tax incentives, requiring hydrogen projects to be substantially under construction by 2028 to qualify, and with incremental clean energy to match H₂ production to fully qualify for tax credits. Federal funding for hydrogen hubs has been cut – at present only two of seven are proceeding.
- **Current Market Prices:** Absent tax benefits, hydrogen is much more expensive than natural gas and RNG, with current prices often around \$3.50/kg (~\$24/Dth) in the US – equivalent to about \$250/mt as substitute for conventional gas (just for the fuel costs, ignoring system and end-use conversions).

Ranked average cost ordering of decarbonization alternatives informs economic tradeoffs against the Social Cost of Carbon.

Ranking NPAs by ease and approximate cost of adoption suggests that **about one-third of the carbon from PGL (and Chicago-area) gas usage could be eliminated for less than \$200/mt -- while getting the rest could be several times more expensive.**

- \$200/mt is the approximate Social Cost of Carbon (SCC) per the US EPA [in 2020\$].
- No emissions allowance market or carbon tax anywhere in the world has CO₂ prices this high.

This indicates full decarbonization is likely to be both impractical and implausible at this time. Instead, pursuing lower cost, partial decarb alternatives could accomplish substantial decarbonization sooner for far less per ton and per customer.



Financial Impacts of Decarbonization Strategies

A long-term Financial Model was developed to assess the gas customer and utility impacts of different decarbonization strategies and subsidization structures.

Financial model is annual revenue requirements, using recent rate-case parameters for costs of capital, tax rates, cost allocations across customer classes, capital structure, op ex shares of total costs:

- Pipe Replacement Program (PRP) modeled as a 10-year program costing \$3.4 Billion, increasing from \$240 M in 2027 to \$450 M in 2035, then dropping to \$100 M per year for maintenance capex afterwards.
- Tax vs. book depreciation and resulting ADIT tracked for all assets (hence rate base)
- Additional non-PRP spending of \$100 M/year capex assumed.
- O&M opex assumed very slightly proportional to volume of sales; otherwise, expenditures are on a nearly fixed trajectory.
- Perfect annual cost of service ratemaking i.e. net income always equals target ROE.

	2025	2026	2027	2030	2034	2035	2036	2040	2045	2050
BOY Net Book Value	4,874.8	4,763.3	4,649.3	5,150.3	6,069.6	6,282.1	6,510.8	5,975.8	5,194.6	4,517.5
Net Capital Additions	100.00	100.00	340.00	490.00	520.00	550.00	200.00	200.00	200.00	200.00
EOY Net Book value	4,763.3	4,649.3	4,766.8	5,384.1	6,282.1	6,510.8	6,384.6	5,829.6	5,023.3	4,521.8
Total ADIT	658.9	664.9	672.8	723.7	852.4	893.4	901.3	817.5	718.6	713.9
Average Rate Base	4,160.1	4,041.4	4,035.3	4,543.5	5,323.4	5,503.0	5,546.4	5,085.2	4,390.4	3,805.7
After-Tax Return on Equity Rate Base	198.2	192.5	192.2	216.5	253.6	262.2	264.2	242.3	209.2	181.3
Required Return on Rate Base	386.9	375.9	375.3	422.6	495.1	511.8	515.9	473.0	408.4	354.0
Total O&M	469.3	469.7	474.6	510.8	566.6	580.6	588.3	592.0	595.2	610.2
Depreciation Expense	211.5	214.0	222.5	256.2	307.5	321.2	326.2	346.2	371.2	195.8
Rev. Req. from PGL Cust.	1,067.7	1,059.6	1,072.4	1,189.6	1,369.3	1,413.7	1,430.4	1,411.2	1,374.9	1,159.9
Rev. Req. from ComEd	-	-	-	-	-	-	-	-	-	-
Rev. Req. from Com Cust	-	-	-	-	-	-	-	-	-	-
Total Rev. Req	1,067.7	1,059.6	1,072.4	1,189.6	1,369.3	1,413.7	1,430.4	1,411.2	1,374.9	1,159.9
Total Net Income	198.2	192.5	192.2	216.5	253.6	262.2	264.2	242.3	209.2	181.3

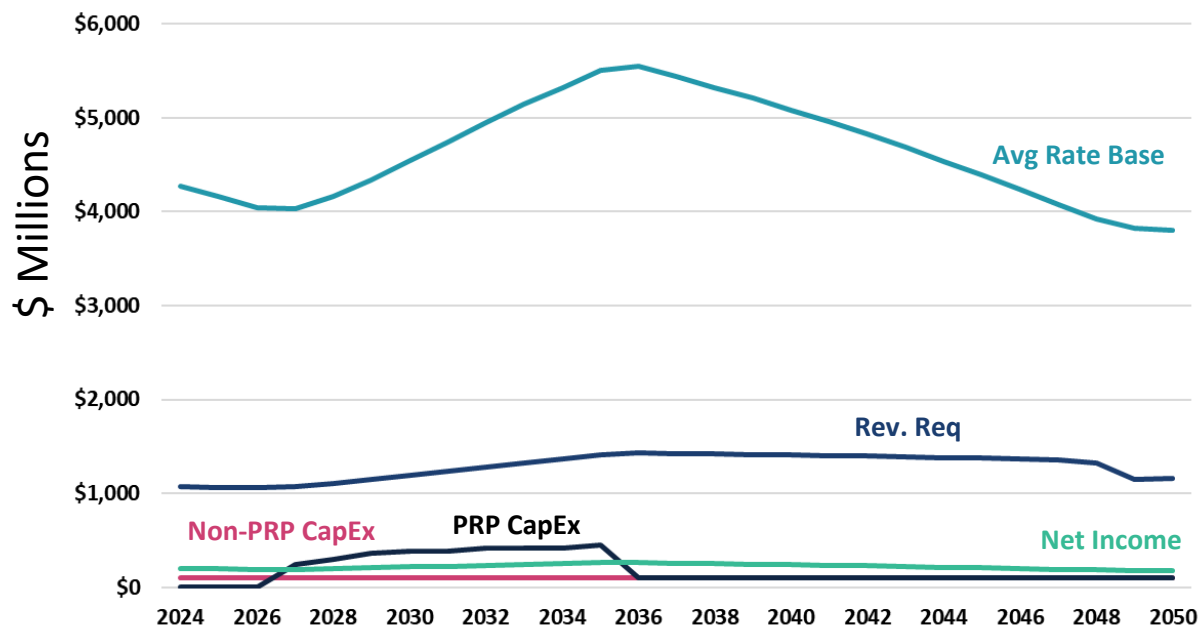
Illustrative Cash Flow Findings

- Rate base grows rapidly until 2035 (when it peaks due to end of PRP DI/CI replacements), then declines (due to depreciation exceeding reinvestments).
- Overall Rev. Req. increases 32% by 2035 but by only 9% by 2050.
- Residential bills increase by 16% by 2045 (\$865), less than likely inflation.

A long-term cost-of-service financial model was built to depict changes from BAU under decarbonization approaches

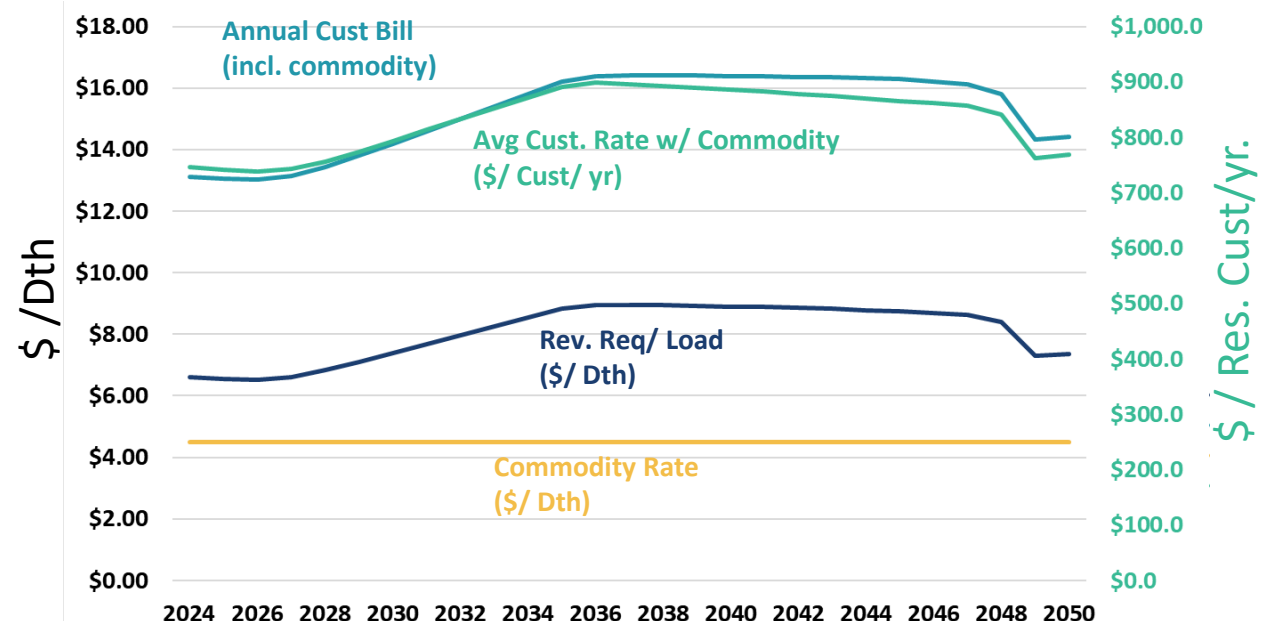
Under BAU, there are no material long term bill impacts after an interim increase for completing the Pipe Replacement Program (PRP).

BAU PGL Financial Metrics



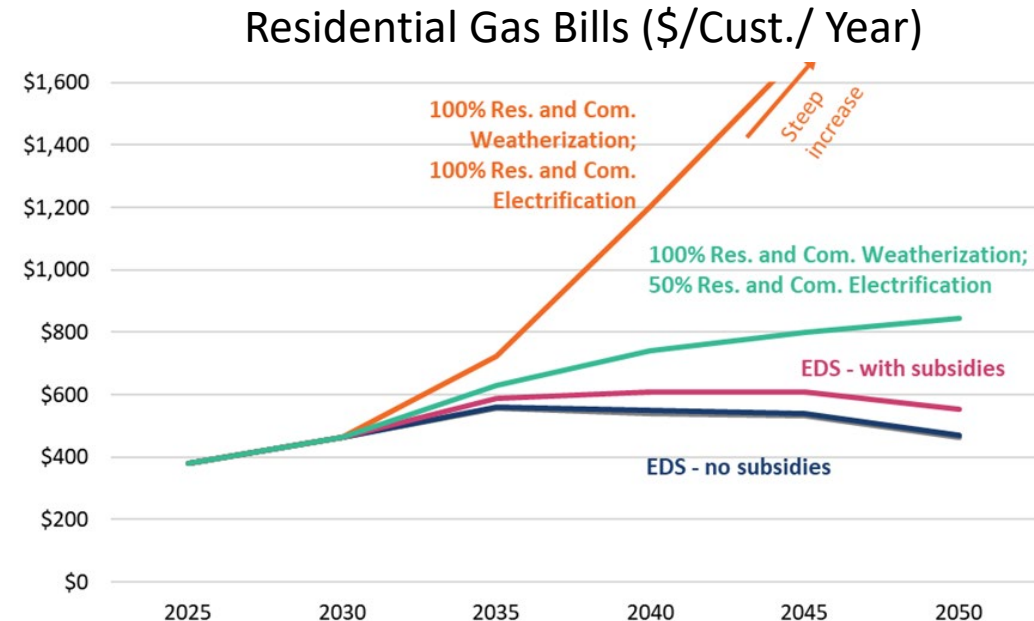
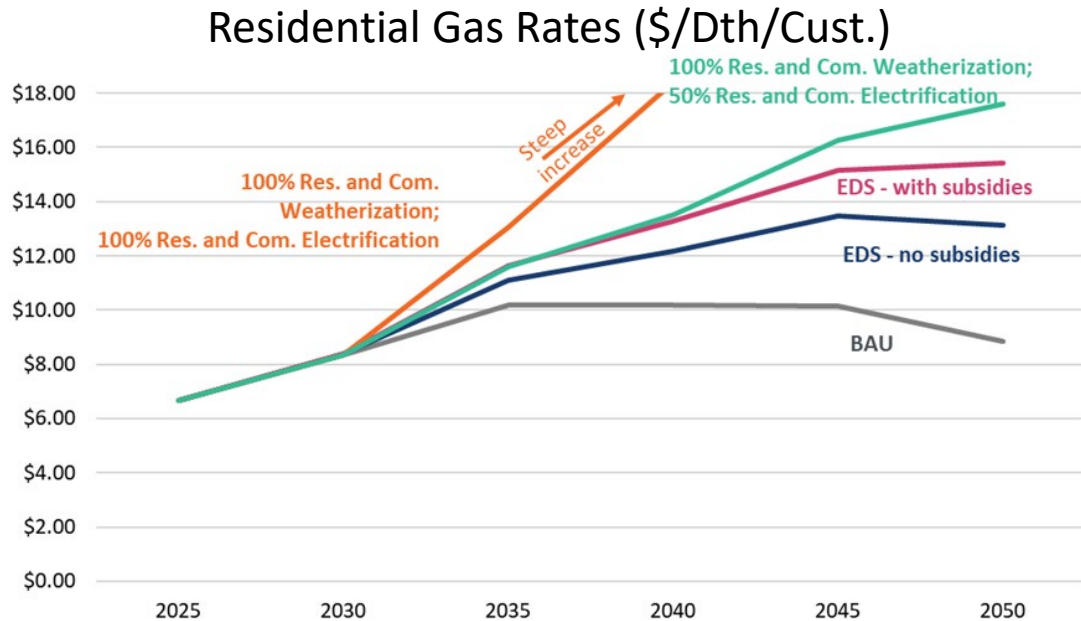
- Pipe Replacement CapEx for DI/CI upgrades occur 2027-2035
- Net income is target RoE * equity rate base in each year
- No load forecast adjustments made for the rise and fall of average costs
- Model calibrated to 2023 PGL regulatory filings and financial statements

BAU Customer Financial Metrics



- BAU customer count and total sales are nearly flat over whole horizon
- Rates use current allocations of 73% to resi and 27% to Comm
- Rate design for resi uses 72% of rev req (excl. commodity) to variable charge, 28% to fixed (per customer) charge

Under EDS, customers' rates would increase by around 15–40% depending on subsidization levels (only 0.5–1.4%/year).

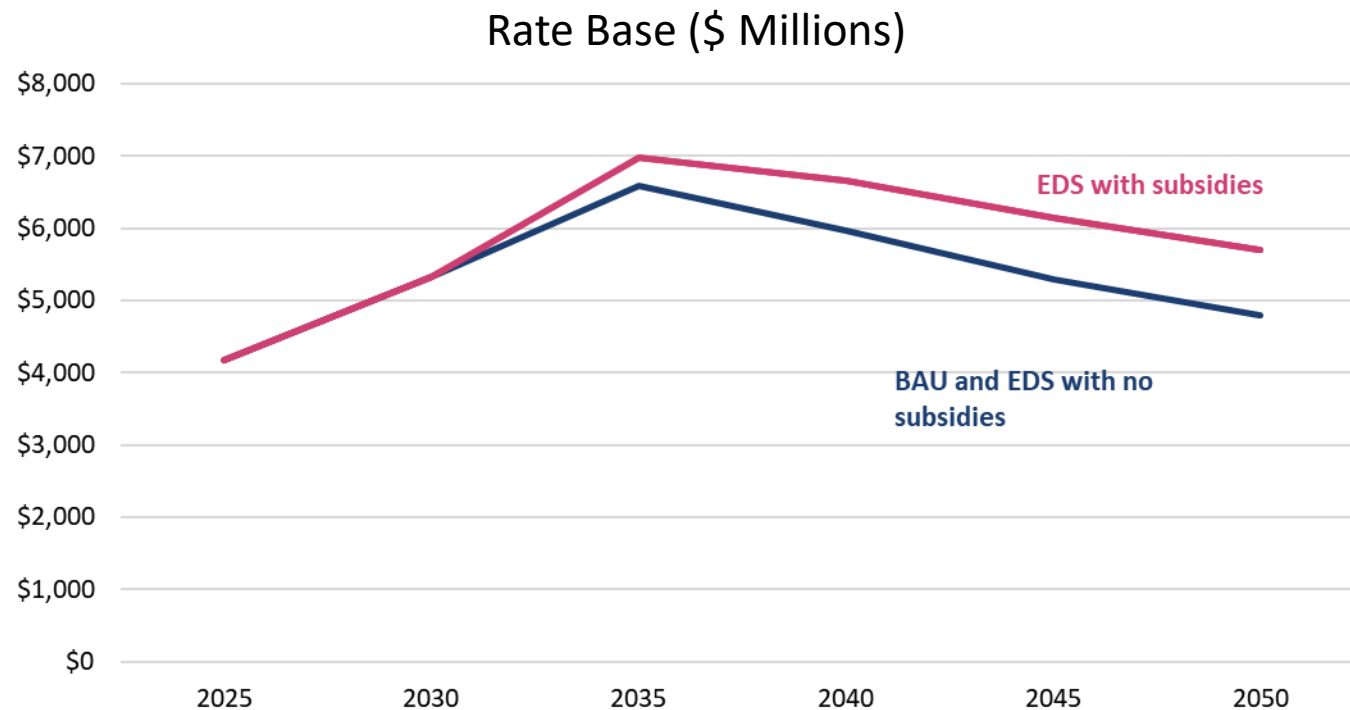


However, EDS gas bills would stay fairly flat and nearly identical to BAU because customer usage would be going down to offset the rising unit costs, and the number of customers paying fixed customer charges is relatively constant.

- By contrast, a scenario with **50% electrification** involves persistent and accelerating bill growth.
- **Full electrification** involves hyperbolic growth in gas bills to the dwindling customer base, which would create untenable bills for customers and significant stranded assets on the system.
- **Subsidization** of low income weatherization and heat pumps, and utility financing of a portion of commercial HPs and CarbinX costs, only slightly raise rates and bills, but provide substantial financial offset to lost loads. brattle.com | 38

In the absence of decarbonization mandates, enabling EDS might need financial support, particularly for low-income customers

EDS could conceivably occur just from customer behavior if there were mandates for decarbonization or a \$200 carbon tax on end-use emissions. Lacking that, it is more realistic that subsidies will be needed, esp. for low-income residential customers.



Increase in rate base through 2035 driven by pipeline replacement capital expenditures.

If the company funds some residential decarbonization and capitalizes those expenditures in rate base, then the rate base will grow a bit.

- This assumes 90% of weatherization costs for low-income customers are socialized in rates.
- And 33% of gas heat pump and CarbinX costs for commercial customers are utility financed.

Implementation Issues

Regulatory and policy actions can support gas decarbonization

The current legislative and regulatory landscape was designed for gas utilities to operate under conventional service design and pricing policies, as well as scope of activities. However, new or changed frameworks will be required if decarbonization is the primary objective (while still maintaining a safe, reliable, and affordable system).

[R] = Regulatory, [P] = Policy



Infrastructure and Utility Obligations

- Update line-extension policies [R]
- Modify obligation to serve [P]
- Align pipe replacement program requirements with decarb goals [P]
- Establish provisions for gas utilities to timely recover investments in the gas system at just and reasonable rates [R]



Market Transition

- Amend least-cost supply planning requirements to include alternative fuels [R]
- Develop frameworks to allow cost sharing between utilities or alternative utility models (e.g., heating-as-a-service utility) [R]
- Workforce development programs to support end-use conversion requirements [R]



Planning and Coordination

- Establish integrated gas-electric planning procedures and guidelines for information sharing [R]
- Enact decarbonization frameworks with clear evaluation criteria and project selection criteria [R]



Customer Adoption

- Increase funding for EE and DR programs [P]
- Fund necessary subsidies and technical support to support customer transition to natural gas alternatives [P]

Many states have initiated FoG proceedings, but implementation specifics are still being debated

To date, 13 states have undertaken FoG proceedings and generally coalesced around a similar set of potential pathways to achieve gas decarbonization (alt fuels <-> aggressive electrification) – though they have identified a myriad of challenges associated with these strategies:

- **Technical** – Gas hydraulics, electric system capacity, building wiring and duct compatibility, etc.
- **Economic** – Transition costs, stranded assets, energy burden, affordability
- **Legal** – Modification of existing laws and regulations or adoption of new ones
- **Social** – Customer choice, equity, energy justice

No state has fully specified plans and associated facilitation mechanisms to achieve gas decarbonization (yet), but some states (MA, NY, CA, have strong directional statements about the extent to which electrification is their primary or preferred or expected pathway):

- States are focusing on stemming near-term investments in the gas system (non-pipeline alternatives) through the adoption of decarbonization programs (NY, MA, CA, CO), clean heat standards (CO, MD, MA), gas bans (NY, CA, OR, WA).
- States are requiring long term plans or integrated energy planning (CA, CO, MA, MN, NY, WA) to establish gas utilities' decarbonization actions over the next 5 to 25 years and enhance coordination with electric utilities.
- *Very few have enacted new decarbonization paradigms or specified funding or incentives* for achieving the projected revisions to their energy systems. Exploratory examples include:
 - Washington's combined gas-electric rate base for Puget Sound Energy, or Quebec's cost-sharing between the gas and electric utility for hybrid heating conversions.
 - NY is considering carbon pricing to incentivize customer behavior, but so far not in place.

Insights on cost of abatement from other FoG studies

For comparison to our findings, we evaluated FoG pathway studies for states aspiring to reduce emissions.

- Studies vary in conclusions – while some find full decarbonization feasible for the state or service territory, others find that only partial decarbonization is affordable.
 - e.g., IL’s Clean Energy Future study emphasizes partial electrification as the path forward, while NY’s Scoping Plan finds that full electrification is worthwhile with average NPV costs = \$120/ mt CO₂e (below the value of environmental and health benefits).
- Most studies report *total or average, not marginal, carbon costs*, obscuring how activity costs may vary across sectors or technologies and over time.
- Studies are difficult to compare side-by-side. Some but not all separate appliance economics from building shell requirements. Some report net lifecycle costs while others use gross. Different discount rates are applied. Some evaluate customer costs with prevailing or expected subsidies.
- Few reports examine what level or type of financial mechanisms and subsidies are needed to implement their decarbonization scenarios.
 - e.g., IL Decarb. Study assumes use of statewide and IRA tax credits.
 - PSE Electrification Report evaluates a securitization charge, which would recoup electrification costs directly from customers.

Our study examines decarbonization **solely for the building sector in PGL’s utility-wide service territory**. Studies that do report sectoral cost differences often find that buildings are more expensive than average to decarbonize.

Costs of CO₂ abatement in other states' FoG or pathway studies often > SCC.

Study	Author	Regional Scope	Sector Scope	Reported or Implied Costs of Carbon Reduction
CO's Clean Affordable Climate Pathways (2025)	SSG	Statewide	All sectors	NPV net \$107-\$427/ ton in high elec. scenario for building sector
BGE Integrated Decarbonization Strategy (2022)	E3	Utility	All sectors	Limited Gas Scenario: Net avg. \$125/ mt systemwide Hybrid Scenario: Net avg. \$91/ mt systemwide
MD Building Decarbonization Study (2021)	E3	Statewide	Building	High Elec. Scenario: Gross avg. \$870/ mt Elec. w/ Fuel Backup Scenario: Gross avg. \$290/ mt High Decarb. Methane Scenario: Gross avg. \$773/ mt
NY Scoping Plan (2025)	E3	Statewide	All sectors	Net Zero A Scenario: avg. ~\$400/ mt systemwide cost; abatement costs exceed GHG benefits but not total benefits
RI Investigation into the Future of the Regulated Gas Distribution Business (2024)	E3	Statewide	All Sectors	Resi. space htg: \$151 to \$467/ mt, Res. water htg: -\$161 to \$552/ mt Comm. space htg: \$413 to \$803/ mt, Comm. water: -\$87 to \$760/ mt
Analysis of Potential Pathways to a Clean Energy Future in Illinois (2025)	Concentric and AGA	Statewide	All sectors	Carbon-Free Scenario: Gross avg. \$1,855/ton Rate-Impact-Constrained Scenarios: Gross avg. \$483-\$607/ton
IL Decarbonization Study (2026)	E3	Statewide	All sectors	5 paths to full decarb, with net costs > climate benefits for high electrification, but costs < benefits when health effects included. SCC \$384/mt by 2050. 80% decarb 30-40% less costly.

Note: Where possible, results are values reported in studies, but some do not explicitly report costs of carbon, so those values are estimated based on abatement costs and emissions reductions data in the studies.

Takeaways from Pathway Studies

- **Pathway studies often support the finding that full electrification is not feasible for less than the Social Cost of Carbon (~\$200/mt CO₂):**
 - Some directly model the value of avoided climate damage plus air quality benefits and find that *as a whole* (or on average) electrification results in net savings (societal benefits, e.g., ex. E3), but components of the plan may not be cost-effective.
 - Brattle’s analysis of net carbon abatement costs does not include climate-related or health benefits, but gross costs are reduced by fuel savings and avoided equipment costs. If net costs are higher than SCC, they are not included in the EDS scenario.
- **Hybrid scenarios that prioritize lower-cost decarbonization measures show substantial emissions reductions at a fraction of the cost/ton of 100% decarbonization:**
 - Ex: Concentric Energy Advisors’ study found that rate-impact-constrained scenarios reduce 58% of CO₂ emissions for 28–33% of the cost of the carbon-free scenario.
 - E3 2026 IL study shows 80% reduction 30–40% cheaper than full decarb and almost as net beneficial.
- **Most studies adopt a stated end-goal (usually region full decarbonization) and only depict scenarios that all reach the end-goal. This allows comparisons across scenarios but not within scenarios of marginal costs.**
 - Our approach to the end-goal is agnostic, relying on technology performance ranked on a common basis of lifecycle net \$/mt of CO₂ avoided basis, benchmarked against an indicative Social Cost of Carbon (\$200/mt CO₂).
 - The resulting decarbonization technology supply curves directly inform both the types and circumstances for technologies to be included in the EDS along with the scope of adoption that is economically feasible within the SCC limit.
- ***This step-wise approach to decarb policy sizing and pacing is essential given current affordability tensions and concerns about the feasible pace and cost of clean electric supply keeping up with rapidly growing demands.***

About Brattle

The Brattle Team



Frank Graves
BRATTLE PRINCIPAL

BOSTON

Frank.Graves@brattle.com



Josh Figueroa
BRATTLE PRINCIPAL

NEW YORK

Josh.Figueroa@brattle.com



Ragini Sreenath
SENIOR ENERGY ASSOCIATE

BOSTON

Ragini.Sreenath@brattle.com



Steve Thumb
EXTERNAL ADVISOR



John Gonzalez
SENIOR ENERGY ANALYST



Julie Yoon
ENERGY ANALYST



Drew Kassman
ENERGY ANALYST



James Herrigel
ENERGY ANALYST

Our Work

The Brattle Group answers complex economic, finance, and regulatory questions for corporations, law firms, and governments around the world. We are distinguished by the clarity of our insights and the credibility of our experts, which include leading international academics and industry specialists. Brattle has 500 talented professionals across four continents. For more information, please visit **brattle.com**.

Our Services

Research and Consulting
Litigation and Support
Expert Testimony

Our People

Renowned Experts
Global Teams
Intellectual Rigor

Our Insights

Thoughtful Analysis
Exceptional Quality
Clear Communication

Clarity in the face of complexity

