The Cost of Heat

Managing Pennsylvania's Thermal Transition

August 2026

A report by the
Building Decarbonization Coalition

BDC

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Acknowledgements

Thank you to the following people, who provided input on different sections of this report at various stages of its composition: Mia Caparaz (BDC), Matt Casale (BDC), Zachary Fabish (Sierra Club), Ashita Gona (RMI), Malak Nassereddine (BDC), Amy Rider (BDC), Dorie Seavey (Future of Heat Initiative), and Jessica Silber-Byrne (BDC).

Report design by Ben Oldenburg

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Thank you to the Heinz Endowments for their support of this report.

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Stakeholder Group Members and Interviewees

From July to November 2025, BDC met with stakeholders three times to discuss the challenges and opportunities associated with building decarbonization and the thermal transition in Pennsylvania. During this same period, BDC interviewed 16 stakeholders representing 12 Pennsylvania-based organizations to glean their expertise and insights related to the Commonwealth's energy policy, workforce, housing, and other relevant topics. These stakeholders also reviewed the report in its draft form and provided many useful comments. We are grateful for their time and dedication. Their insights informed the whole of this report and are also summarized in the Appendix: "Stakeholder Analysis."

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Energy Foundation, Nicholas Kowalski

Generation 180, Shannon Crooker

Green Building United, Rich Freeh

Heinz Foundation, Matt Barron

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Office of Sustainability for City of Philadelphia, Nidhi Krishen

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Pennsylvania House Energy Committee, Stephon Petro

Pennsylvania Utility Law Project (PULP), Elizabeth Marx

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The Clean Energy Center at Penn College, Jason Embick

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George Bagdanov, Kristin, and Kevin Carbonnier. *The Cost of Heat: Managing Pennsylvania's Thermal Transition*. Building Decarbonization Coalition, August 2026. buildingdecarb.org/the-cost-of-heat-pa

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BUILDING DECARBONIZATION COALITION

The Building Decarbonization Coalition (BDC) unites critical stakeholders on a path to transform the nation's buildings through clean energy, using policy, research, market development and public engagement. The BDC and its members are charting the course to eliminate fossil fuels in buildings to improve people's health, cut climate and air pollution, prioritize high-road jobs, and ensure that our communities are more resilient to the impacts of climate change. www.buildingdecarb.org

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Chapter 1

Overview and Recommendations

Executive Summary

Delivering heat to homes, businesses, and industry is an essential service. However, in Pennsylvania, it is becoming increasingly expensive: the average monthly residential gas bill has increased 67 percent over the past ten years.[1] A major driver of this increase is infrastructure policy. Since Act 11 was enacted in 2012, gas utilities have spent $11 billion on accelerated pipeline replacements, pushing a growing share of customer bills toward infrastructure costs and investor returns.[2] Pennsylvania is now on a path of accelerated gas system spending that is raising customer bills even as household demand for gas use declines.

> **"Since Act 11 was enacted in 2012, gas utilities have spent $11 billion on accelerated pipeline replacements."**

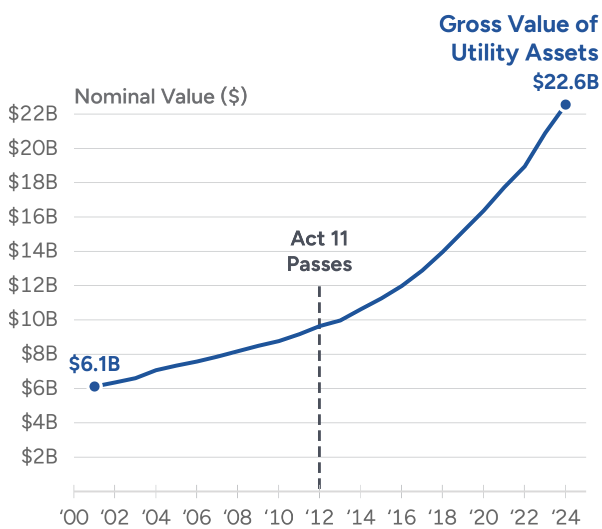
This report calls for a managed gas transition: a coordinated, regulator-led strategy to limit unnecessary gas investment, retire portions of the gas system where cost-effective alternatives exist, and protect customers and workers during the shift to cleaner heating and cooling. This managed gas transition is one part of a broader thermal transition: the long-term shift toward cleaner, more affordable, and better-coordinated systems for delivering heat. The analysis that follows traces how Act 11 accelerated gas system spending, how those costs affect customer bills, and why neighborhood-scale clean thermal alternatives offer a more affordable and strategic path forward. Rather than treating each pipeline replacement as inevitable, Pennsylvania can use long-term gas planning to identify where targeted electrification, efficiency, and neighborhood-scale clean thermal solutions can avoid costly reinvestment while maintaining safe and reliable service.

Decisions made now will shape customer costs, infrastructure needs, and workforce pathways for decades. Pennsylvania can continue investing billions in aging gas infrastructure, or it can begin shifting capital toward clean heating and cooling systems that reduce long-term financial risk, lower bills, and strengthen the thermal workforce. By building on its long history of powering American industry, Pennsylvania can demonstrate how a managed thermal transition can modernize essential energy systems while keeping workers and customers at the center.

1 BDC analysis of Pennsylvania PUC Rate Comparison reports, 2015-2025. See Chapter III for details.
2 BDC analysis of Annual Asset Optimization Plans (AAOPs) and Long-term Infrastructure Investment Plans (LTIIPs) from the Big Six gas utilities, 2013-2025. See Chapter III for details.

> **"This report calls for a managed gas transition: a coordinated, regulator-led strategy to limit unnecessary gas investment, retire portions of the gas system where cost-effective alternatives exist, and protect customers and workers during the shift to cleaner heating and cooling."**

Figure ES-1: From 2001 to 2024, the gross value of gas infrastructure owned by the Big Six gas utilities has increased 4.5x, or 2x after inflation.



Data Source: S&P Global and Utility Regulatory Filings, nominal dollars

The Challenge: Accelerated Spending and Declining Demand

In recent years, Pennsylvania's gas system has become significantly more expensive while customer growth in the Commonwealth has stayed modest, residential gas use per customer has fallen, and Pennsylvania's state and local climate commitments have advanced. Since 2000, the annual average growth rate for residential customers was just 0.62 percent, while per-customer residential gas use declined 28 percent in that same period.[3] Yet the investment trajectory has not followed the demand trajectory.

Beginning in 2013, utilities sharply increased capital spending, moving from a relatively stable period of business-as-usual growth (an average of 4.3 percent per year) to an accelerated period (an average of 7.8 percent per year). As a result, the Commonwealth's major gas utilities more than doubled their collective asset base in just over a decade, from $10 billion in 2013 to $22.6 billion in 2024. Close to 90 percent of these assets comprise the gas distribution system: the pipes, service lines, and meters that connect the larger transmission pipes to homes and businesses.[4]

A central driver of this acceleration is Act 11 (2012), which allowed utilities to ramp up pipeline replacement spending by accelerating cost recovery through surcharges outside traditional rate cases. Since 2013, Pennsylvania's six largest gas utilities—the "Big Six"—have collectively spent $11 billion on gas assets through their accelerated pipeline replacement programs. Once investor returns and financing costs are included, this first twelve years of accelerated spending is projected to cost ratepayers $18 to $30 billion over the lifetime of the assets.[5] Because Act 11 spending is reported utility-by-utility across multiple filings and multiple years, the program's total scale is difficult to see in one place; this report assembles those filings into a cross-utility accounting for the first time.

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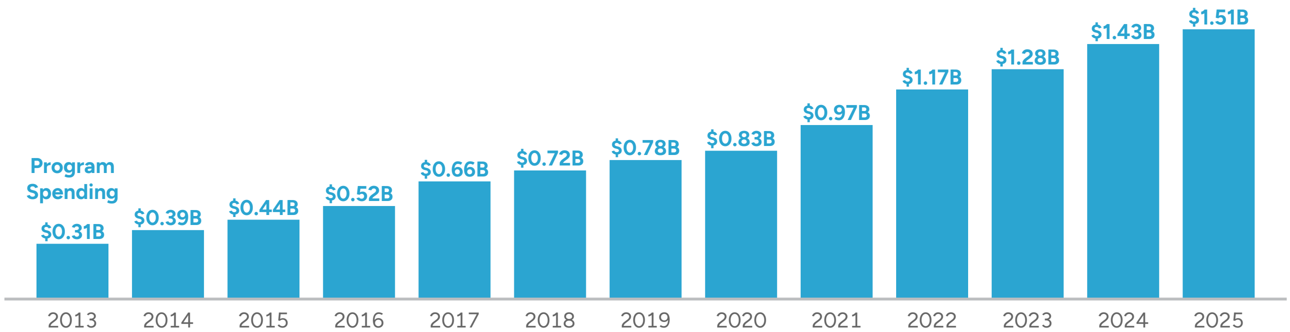
3 BDC analysis of EIA data, 2000-2024. See Figure D.11 in "Gas Customers and Demand" in Chapter III, Dashboard.

4 BDC analysis of Pennsylvania gas utility financial filings and consumption trends sources from S&P Global, EIA, and utility regulatory filings; see Chapter III and methodology discussion for details.

5 BDC analysis of Annual Asset Optimization Plans (AAOPs) and Long-term Infrastructure Investment Plans (LTIIPs) from the Big Six gas utilities, 2013-2025. See Chapter III for details and Table 3.4 for the utility-level breakdown.

Figure ES-2: **Since their inception in 2013, annual spending from LTIIPs (i.e. accelerated pipeline replacement) across the Big Six has grown steadily every year, totaling $11B in direct costs through 2025.**



Data Source: Annual Asset Optimization Plans and Long-Term Infrastructure Improvement Plans filings, 2013-2025

While there are legitimate safety concerns about aging gas infrastructure that should be addressed, Pennsylvania's current framework defaults to like-for-like gas pipeline replacement rather than requiring side-by-side evaluation of retirement and cost-effective non-pipeline alternatives (NPAs). This is especially consequential because 13.2 percent of Pennsylvania's distribution mains are classified as being made of "leak-prone" materials,[6] creating a major intervention point for determining whether aging pipes are replaced with new gas assets or with clean thermal alternatives. As more of the system ages and requires intervention, Pennsylvania needs a long-term gas plan that accurately assesses risk and evaluates cost-effective NPAs before locking customers into decades of mounting costs for an increasingly underutilized gas system.

This long-term gas planning is especially important in Pennsylvania, where customer growth and gas demand have not increased in step with accelerating investment. As a result, mounting costs are being spread across a relatively flat, and in some places declining, customer base, pushing a growing share of system spending onto each remaining customer. Since 2013, the amount of gas infrastructure allocated to each gas customer across all customer classes has more than doubled, reaching about $7,150 per customer in 2024, roughly $2,150 above the national median.[7]

Together, rising assets per customer and declining per-capita gas use indicate a growing mismatch between the scale of utility investment and underlying demand, increasing the risk that remaining customers will bear a larger share of system costs. Infrastructure-related delivery charges now make up roughly two-thirds of a typical residential gas bill in Pennsylvania, while the gas itself accounts for about one-third. These pressures do not fall evenly across the Commonwealth's gas utilities: differences in system age, service density, and customer need shape how replacement costs are incurred and who bears them, with Philadelphia Gas Works facing especially acute legacy infrastructure and affordability pressures.[8] But these outcomes are not simply the result of aging infrastructure; they are also shaped by the rules Pennsylvania uses to approve, recover, and oversee gas system spending.

Pennsylvania does have some customer protections within this accelerated spending framework, including a cap on the Distribution System Improvement Charge (DSIC), which allows utilities to recover eligible distribution-system repair, improvement, and replacement costs between base rate cases.[9] But the broader framework lacks the stronger cost controls and planning requirements used elsewhere. For example, commissions

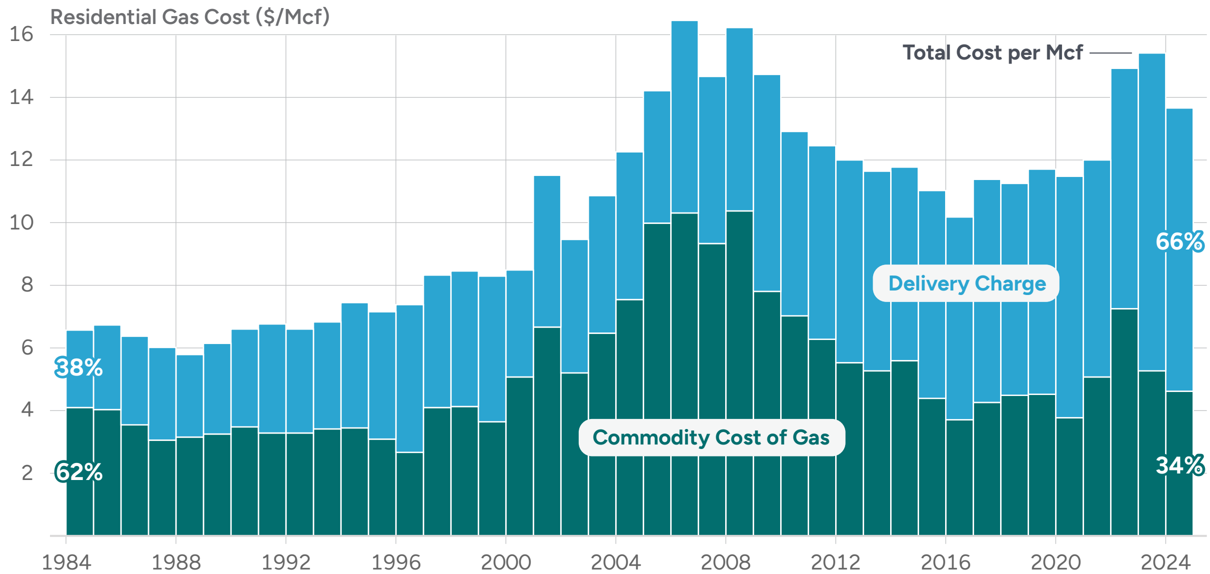
6 BDC analysis of Act 11, Pennsylvania gas utility LTIIP and AAOP filings, and federal pipeline data (PHMSA); see Section III for report discussion of leak-prone pipe, safety-driven replacement, and non-pipeline alternatives.

7 BDC analysis of gas utility asset values and customer counts for Pennsylvania's Big Six utilities using utility financials sourced from S&P Capital IQ Pro and utility annual reports; national median comparison from American Gas Association, 2021–2023 Performance Benchmarks for Natural Gas Utilities (2025), p. 26. See Chapter III.

8 PGW has the oldest gas system among the Big Six, with 50 percent of mains 65 years or older. See Chapter III.

9 66 Pa. Cons. Stat. § 1353. The DSIC is generally capped at 5 percent, but Act 11 does not have an overall end date and therefore no estimated "total spend," as some accelerated replacement programs have.

Figure ES-3: **Residential gas costs have increased steadily over time, with most growth coming from delivery charges, which now make up two-thirds of gas bills.**



Data Source: EIA

in Massachusetts, Maryland, and Washington, D.C., have recently imposed greater spending constraints on accelerated pipeline programs, required evaluation of non-pipeline alternatives, or tied replacement programs more directly to long-term emissions and system-planning goals. By contrast, Act 11 does not require the evaluation of non-pipeline alternatives, nor does it have a statutory end date for accelerated replacement spending, effectively leaving gas utilities with open-ended authority to continue investing in new pipelines.

The need for stronger oversight is especially urgent because replacement itself is becoming more expensive. As utilities have accelerated pipeline installations, their per-mile pipeline replacement spending has risen rather than stabilized, reaching $2.8 million per mile in 2025, more than double the 2014 level of $1.2 million.[10] Continued spending on increasingly costly gas infrastructure raises long-term cost exposure for households and compounds overall energy burdens, especially as one in four Pennsylvania households already struggles to pay utility bills.

The scale of replacement activity already underway makes this a pivotal moment to sequence gas system decommissioning with neighborhood-scale clean thermal solutions. Instead of continuing on an unsustainable cost trajectory, Pennsylvania can shift investment toward the parts of the thermal sector it will continue to need well into the future: the electric grid and clean thermal technologies that are transforming how heat is produced, delivered, and paid for.

> **“Infrastructure-related delivery charges now make up roughly two-thirds of a typical residential gas bill in Pennsylvania, while the gas itself accounts for about one-third.”**

10 Based on the Big Six utilities’ Annual Asset Optimization Plans, 2014-2025. See Chapter III for details.

Scaling Up the Thermal Sector

Treating heat as a system-wide infrastructure challenge, rather than a building-by-building or appliance-by-appliance decision, can help streamline Pennsylvania's thermal transition. This report proposes a strategy called neighborhood-scale decarbonization, which focuses on coordinating the deployment of heat pumps, electric equipment, efficiency upgrades, and in some cases thermal energy networks, across entire blocks or communities so that segments of the gas system can be retired strategically rather than replaced. This coordination is critical because electrification alone does not guarantee gas system savings. Incremental, uncoordinated electrification can reduce individual building emissions and energy use, but it will not fully address one of the central drivers of rising energy costs: the continued need to rebuild and maintain two parallel delivery systems. A better approach is to plan clean thermal deployment geographically, using neighborhood-scale projects to consolidate heating and cooling needs around one resilient, clean energy platform—the electric system—while reducing total infrastructure costs and aligning affordability, climate, and workforce goals.

The economic case for this approach is already visible in the cost of gas pipeline replacements. In many neighborhoods, the cost of replacing a gas main, which ranged from roughly $17,000 to $92,000 per customer in 2025 depending on the utility, is high enough to warrant comparison with clean thermal alternatives before utilities proceed with like-for-like replacement.[11] Prioritizing areas with aging gas infrastructure and high energy burdens can deliver the greatest bill relief and public health benefits while aligning equity and workforce objectives and avoiding costly reinvestment in legacy systems.

The modeling conducted for this report shows that neighborhood-scale clean thermal strategies, including electrification and Thermal Energy Networks (TENs), can reduce long-term system costs, lower peak electricity demand, and avoid unnecessary gas reinvestment. TENs can support electrification by using shared, ambient-temperature thermal loops and electric heat pumps to deliver heating and cooling more efficiently, particularly in places where coordinated deployment can reduce grid impacts and avoid gas system replacement. Neighborhood-scale strategies are well-suited to Pennsylvania's climate, geology, and existing thermal workforce, and offer a scalable pathway to stabilize customer bills while meeting climate and reliability goals.

The Workforce: From Gas Workers to a Thermal Workforce

Pennsylvania's thermal transition must include its existing thermal workforce—roughly 140,000 drillers, pipefitters, electricians, HVAC technicians, and insulators—who deliver heating and cooling across fossil and clean energy systems. Framing the transition around the thermal sector, rather than a clean-versus-fossil divide, recognizes that these jobs exist along a continuum. Over a managed, decades-long transition, workers who spend part of their time in oil and gas today can increasingly apply similar skills to geothermal, thermal networks, and building electrification as clean heat deployment expands.

Neighborhood-scale projects create a pathway to retain and redeploy the thermal workforce at scale. Because they are infrastructure-scale efforts, they can support union labor, apprenticeships, and high-road career pathways while providing the consistency and time horizon needed for long-term workforce planning. With the right planning framework, Pennsylvania can turn the gas transition from a reactive infrastructure challenge into a proactive workforce strategy, one that preserves skilled jobs, expands clean thermal career pathways, and directs investment toward the systems customers will depend on in the future.

11 Authors' analysis of utility-specific gas main replacement costs on a per-customer basis; see utility-level comparison in Chapter III.

Key Findings

1 Cost Drivers and Bill Impacts

- Act 11 has driven a major increase in gas infrastructure spending, with the Big Six spending a little over $11 billion on accelerated pipeline replacements since 2012.
- Pennsylvania customers are paying more for infrastructure than the gas they actually use: roughly two-thirds of a typical bill now goes to delivery charges, with only one-third going to gas itself.
- Gas bills are rising quickly. In 2025, the average monthly residential gas bill was $234 during heating season and $111 on a year-round basis. Over the past ten years, the average year-round monthly residential gas bill increased 67 percent, with utility-specific increases ranging from 48 percent for National Fuel to 94 percent for Columbia Gas. Over the same period, the average residential gas price per therm increased by 16 percent, adding to pressure on household energy costs.
- Pipeline replacement is also becoming more expensive. Average per-mile replacement costs more than doubled over the past decade, rising from $1.2 million per mile to $2.8 million per mile.
- In 2025, new mains installed by the Big Six averaged $40,000 in direct capital costs per connected customer, with some utilities far exceeding that level.

2 Misalignment Between Infrastructure Investment and Demand

- Gas system investment is growing much faster than underlying demand. The value of gas assets owned by Pennsylvania's six largest gas utilities reached approximately $22.6 billion in 2024—3.7 times higher than in 2001 and equivalent to an average annual growth rate of 5.9 percent.
- Over the past decade, residential gas customers in Pennsylvania increased by only 6.8 percent, while gas use per capita declined by 20 percent, indicating that customer growth and gas demand are out of sync with the pace of gas utility investment.
- The amount of gas infrastructure allocated to each customer has more than doubled since 2013, reaching $7,150 per customer across all customer classes in 2024, about $2,150 above the national median. This creates a top-heavy gas system: more infrastructure cost is being spread across each customer even as demand growth slows.

3 Regulatory and Planning Gaps

- Act 11 enabled broad accelerated pipeline replacement programs that have created $18 to $30 billion in additional lifetime costs for ratepayers from a little over a decade of spending.
- Although Act 11 includes some customer protections, it lacks broader guardrails adopted in other states, including overall program spending limits, requirements to evaluate non-pipeline alternatives, and clear off-ramps for continued replacement spending.
- Most Pennsylvania rate cases are resolved through "black box" settlements, which reduce transparency and make it more difficult for the public to evaluate whether utility spending is prudent and cost-effective.

4 Affordability and Equity Impacts

- One in four Pennsylvania households struggles to pay utility bills, making continued increases in gas delivery costs a major affordability concern.
- Because delivery charges are tied to long-lived infrastructure costs, customers can face rising bills even when they do not increase their gas use, creating particular risks for low-income households and communities with aging infrastructure.
- Pennsylvania has established strong consumer protections that helped to prevent utility shut-offs for low-income households, but as energy bills continue to rise these protections may not be enough, leaving many households vulnerable to increased energy insecurity.

5 Neighborhood-Scale Solutions and Workforce Capacity

- High pipeline replacement costs make neighborhood-scale alternatives increasingly important to evaluate before like-for-like gas replacement proceeds. Across Pennsylvania utilities, replacing gas mains cost between $17,000 and $92,000 per customer in 2025.
- Neighborhood-scale electrification, including air-source heat pumps, electric equipment, and efficiency upgrades, can eliminate the need for pipeline replacement in lower-density or residential neighborhoods, particularly where gas demand is already declining and grid capacity is available.
- Thermal energy networks are a highly efficient, infrastructure-scale solution, especially in denser or mixed-use areas. Modeling in this report shows that thermal energy networks can reduce peak electric demand by roughly 40 percent compared to air-source heat pumps, lowering grid upgrade costs while delivering shared heating and cooling.
- Neighborhood-scale projects can support union labor, apprenticeships, and transferable skills across gas, geothermal, electrification, and thermal network work, providing longer-duration, infrastructure-scale employment and enabling a managed transition for Pennsylvania's 140,000-person thermal workforce.

To respond to these challenges, this report advances four priorities for a managed thermal transition:

1. Reform gas planning, spending, and oversight.
2. Deploy neighborhood-scale clean heat solutions.
3. Protect customers and target bill relief.
4. Support the growth of the existing thermal workforce and increase local implementation capacity.

Pennsylvania's thermal transition is already underway, and the decisions ahead will determine how quickly it proceeds, how costs are managed, and who is protected along the way. Continuing to invest billions in gas infrastructure designed to be paid for over decades will lock in significant customer costs and delay the shift toward a more resilient and affordable thermal system. Strengthening the Commonwealth's thermal sector will allow Pennsylvania to support its workers and communities while positioning the state as a leader in the thermal energy future.

Recommendations

1 Reform gas planning, spending, and oversight

Align gas infrastructure investment with long-term demand, affordability, and climate goals.

- **Reform Act 11 (Legislature, PUC):** Limit accelerated cost recovery to clearly defined safety-critical infrastructure and require utilities to evaluate non-pipeline alternatives (NPAs), including repair, retirement, electrification, and thermal energy networks, before like-for-like gas pipeline replacement.
- **Add stronger cost controls and planning requirements (Legislature, PUC):** Lower the DSIC cap over time and add a sunset date for Act 11 authority; require long-term gas system planning that accounts for declining demand, stranded asset risk, and least-cost transition pathways.
- **Strengthen transparency and accountability (PUC):** Standardize reporting on pipeline replacement spending in Long-Term Infrastructure Improvement Plans (LTIIPs) and Annual Asset Optimization Plans (AAOPs) and require inclusion of alternatives evaluated, avoided investments, and bill impacts. Limit the use of black box settlements and require public disclosure of the cost, rate, and investment assumptions underlying settlement outcomes.
- **Reform ratemaking practices (PUC):** Align return on equity with the market cost of equity through transparent, evidence-based financial modeling that reflects current interest rates and the risk profile of regulated utilities.

2 Scale neighborhood-scale clean thermal solutions

Shift from gas-centric planning to coordinated investment in clean thermal service.

- **Authorize thermal energy networks and fuel-neutral thermal service (Legislature):** Clarify that utilities and municipalities may plan, own, and operate thermal energy networks, and allow utilities to provide heating and cooling services through non-gas thermal infrastructure by reforming the "obligation to serve."
- **Launch targeted neighborhood-scale pilots (Legislature, PUC, Utilities):** Require or incentivize coordinated electrification and thermal energy network demonstration projects in areas with aging gas infrastructure, high energy burdens, or public health concerns.
- **Integrate gas and electric system planning (Legislature, PUC):** Require coordinated planning to avoid duplicative investment and ensure grid upgrades align with thermal transition needs.
- **Modernize utility business models (Legislature, PUC):** Create regulatory pathways that allow gas utilities to recover costs and earn reasonable returns by delivering clean heating and cooling services rather than only gas infrastructure.
- **Reinvest avoided gas costs in clean thermal infrastructure (Legislature, PUC):** Allow deferred or avoided gas system spending to be redirected to neighborhood-scale clean heat deployment.

3 Protect customers and target bill relief

Ensure the transition lowers costs and does not leave customers behind.

- **Strengthen bill impact analysis (PUC):** Require utilities to compare the full asset-life bill impacts of gas investments and non-gas alternatives before major infrastructure decisions are approved.
- **Prioritize energy burden reduction (PUC, Legislature):** Target clean thermal investments and transition resources to households and communities facing the greatest affordability pressures.
- **Align transition policy with customer assistance programs (PUC):** Ensure LIHEAP, Customer Assistance Programs, arrearage support, and related protections evolve alongside changes in household heating systems.
- **Expand consumer protections and bill-relief priorities (Legislature, PUC):** Strengthen protections against unsafe disconnections and prioritize avoided gas system costs for bill relief, arrearage reduction, and affordable clean heat deployment in high-burden communities.

4 Build a durable thermal workforce and support local implementation

Support a transition that strengthens Pennsylvania's workforce and enables community-scale implementation.

- **Adopt a unified thermal workforce framework (Utilities, Local Governments, Organized Labor, Independent Contractors):** Treat gas, electrification, geothermal, efficiency, and thermal network workers as part of a single evolving thermal workforce with transferable skills.
- **Expand training and credentialing pathways (Legislature, State Agencies):** Invest in workforce development for heat pumps, geothermal drilling, advanced building systems, and thermal energy networks, building on existing trades and training infrastructure.
- **Tie public support to high-road labor standards (Legislature, PUC):** Require prevailing wages, apprenticeship utilization, and labor-management partnerships in publicly supported and ratepayer-backed thermal projects.
- **Support local planning and utility partnerships (Legislature, Local Governments, PUC, Utilities):** Fund local planning and technical assistance and encourage partnerships to identify priority neighborhoods and coordinate project delivery.
- **Require meaningful community and labor engagement (PUC, Utilities, Local Governments):** Ensure workers and communities are engaged early in planning, siting, and project design so neighborhood-scale deployment is both durable and equitable.

Thermal Transition Policy Roadmap

A roadmap for the next 12-24 months to stabilize heating bills and evolve Pennsylvania's thermal sector.

Priority area	Primary policy venue	Near-term action
Gas planning, spending, and oversight	Act 11 reform, PUC planning requirements, and gas rate cases	Amend Act 11 to narrow accelerated recovery to safety-critical infrastructure, require evaluation of repair and non-pipeline alternatives before replacement, strengthen LTIIP and AAOP reporting, and use upcoming rate cases to require fuller bill-impact, benefit-cost, DSIC, and ROE review.
Neighborhood-scale clean thermal solutions	Act 129 Phase V, PUC planning requirements, and utility pilot approvals	Use Act 129 Phase V to strengthen heat pump incentives, building-readiness support such as weatherization, consumer protections, and implementation standards; require more coordinated gas and electric planning; and approve targeted neighborhood-scale electrification and TEN pilots in areas with aging gas infrastructure, high energy burdens, or public health concerns.
Proof of concept for managed transition	PGW strategic planning, city-utility coordination, and PUC oversight	Advance PGW as a Pennsylvania proof case by identifying candidate retirement and neighborhood transition zones and moving at least one thermal energy network or neighborhood-scale alternative forward in a way that avoids planned gas main replacement and produces replicable standards for future projects.
Customer protection and delivery capacity	PUC dockets, legislative action, Act 129 implementation, and state-local workforce coordination	Establish equitable cost-allocation principles, strengthen full asset-life bill-impact review, align customer assistance programs with clean heat transitions, expand training and credentialing for heat pumps, geothermal drilling, and TENs, and fund local planning, labor standards, and early community engagement so customer protection and implementation capacity grow in parallel.

Introduction

Pennsylvania's gas bills are rising, and a major driver is infrastructure policy. Since Act 11 was enacted in 2012, gas utilities have been able to accelerate pipeline replacement and cost recovery, reshaping "business as usual" system spending and shifting a growing share of customer bills toward capital costs and investor returns.

This report presents a unified view of Pennsylvania's gas system and its cost trajectory by connecting laws and regulatory decisions to utility investment patterns and customer bills through an analysis of utility financials, PUC filings, rate cases, and public datasets. It shows why a managed gas transition is increasingly necessary within a broader thermal transition—one that strengthens planning and oversight to manage cost and risk, while creating pathways for Pennsylvania's thermal workforce to deliver cleaner and more affordable heating and cooling. In short, this report asks: How can Pennsylvania stabilize heating bills and reduce long-term financial risk by reforming gas infrastructure policy and planning a managed transition to clean thermal solutions?

Energy transitions are incremental and uneven, with old and new technologies operating side by side for long periods. This period of "mid-transition"[12] creates conditions where the overlap of technologies, labor, norms, and institutions can create both tension and innovation. Rather than treating the shift to clean energy as a sudden break with the past, this report approaches the mid-transition as a chance to guide the thermal transition intentionally. As such, states with deep roots in oil, coal, gas, and industry can view this period as an opportunity to shape a thermal transition that strengthens communities, supports workers, and grows the broader economy.

This report applies that lens to Pennsylvania's thermal sector: the integrated network of infrastructure, fuels, technologies, institutions, and skilled workers that produce, deliver, and manage heating and cooling across buildings and industrial facilities. In practice, it includes the energy used to heat buildings and water in the residential, commercial, and industrial sectors, as well as heat for industrial processes. It accounts for 30 percent of energy-related carbon dioxide emissions in Pennsylvania, and when the electric sector is included, this number rises to 72 percent of all energy-related emissions.[13] The sector is large, distributed across millions of customers and many decision-makers, and governed by long-lived equipment and infrastructure that can last for decades. The multitude of touch points, time frames, and decision makers, compared to the relatively narrow windows of intervention, presents a distinct challenge in transforming this sector and makes planning and policy choices especially consequential.

> **"Pennsylvania's gas bills are rising, and a major driver is infrastructure policy."**

Planning the Thermal Transition

In a world with increasingly extreme weather, heating and cooling are both essential. While technologies such as heat pumps, which provide heating and cooling through the same piece of equipment, are critical components of a low-carbon future, the cornerstone of the thermal transition is not any single technology. Rather, it is system-scale planning that coordinates technologies, infrastructure, and workforce investments to meet evolving thermal needs.

Affordability is central to this transition. Nearly a quarter of Pennsylvania households already struggle to pay energy bills.[14] In 2025, the average

12 Emily Grubert and Sara Hastings-Simon, "Designing the Mid-transition: A Review of Medium-term Challenges for Coordinated Decarbonization in the United States," *WIREs Climate Change* 13, no. 3 (2022), https://doi.org/10.1002/wcc.768.

13 U.S. Energy Information Administration, State Energy Data System (SEDS), "Pennsylvania Carbon Dioxide Emissions from Energy Consumption (2023)," accessed January 27, 2026, https://www.eia.gov/state/seds/seds-data-complete.php?sid=PA#Carbon%20dioxide%20(CO2)%20emissions%20from%20energy%20consumption.

14 U.S. Census Bureau, "Household Pulse Survey," accessed January 21, 2026, https://www.census.gov/data-tools/demo/hhp/#/?measures=ENERGYBILL&s_state=00042.

monthly residential gas bill during heating season in Pennsylvania was $234, while the year-round average was $111.[15] And roughly two-thirds of a household's gas bill now pays for what the utility builds rather than the gas itself,[16] meaning that as capital investments accelerate, customers are increasingly locked into paying for assets whose costs will remain on bills for decades.

This makes gas infrastructure policy a central question for thermal planning. A little over a decade ago, Pennsylvania, like several other jurisdictions, adopted laws that enabled utilities to accelerate pipeline replacement and recover those costs more quickly from customers. In Pennsylvania, that law is Act 11. While accelerated replacement programs in states like Massachusetts, Maryland, Washington, D.C., and Illinois have come under scrutiny in recent years, Pennsylvania's broad infrastructure replacement plans have received far less attention, even as they have driven dramatic growth in gas utility capital spending and customer bills.

From 2013 to 2025, Pennsylvania's "Big Six" gas utilities (Peoples Natural Gas, Philadelphia Gas Works, National Fuel Gas Distribution, UGI Utilities, Columbia Gas of Pennsylvania, and PECO Energy) spent $11 billion on the accelerated replacement of gas pipelines—in addition to their usual background rate of maintenance and replacement.[17] While initially intended to address safety concerns related to aging infrastructure, Act 11 has served to incentivize increased investment in gas assets even as customer growth and gas demand have stagnated. Further, available PUC earnings data indicate that gas utilities continue to earn robust returns on equity, underscoring how current ratemaking practices shield investor returns even as customer bills rise. As this report demonstrates, growth in the gas asset base, combined with accelerated cost recovery and returns on equity, has placed upward pressure on customer bills and created significant near- and long-term financial risks for both ratepayers and utilities.

At the same time, the range of viable alternatives for delivering heating and cooling has expanded significantly. Electrification and energy efficiency—including neighborhood-scale approaches such as Thermal Energy Networks (TENs)—can provide heating and cooling at lower lifecycle costs while reducing air pollution and emissions.[18] Today, nearly every end use in a building can be served by electricity, calling into question the economic rationale for continued large-scale investment in new gas infrastructure. A long-term, managed gas transition that shifts investments from fossil fuels to clean energy at a pace that allows workers, utilities, and institutions to redirect their skills and resources will prepare the Commonwealth to benefit from the energy- and cost-saving advantages of clean technologies well into the future.

Rather than framing this shift as a binary choice between fossil fuels and clean energy, this report offers a thermal transition framework that centers affordability while identifying pathways that increasingly rely on clean and renewable sources. For utilities, it highlights the limits of business models built on perpetual gas system expansion and the need to explore alternative forms of thermal infrastructure. For workers, it highlights job continuity by redirecting existing skills to emerging infrastructure and community-scale clean heat projects. And for communities—especially those facing high energy burdens or disproportionate pollution exposure—it links energy affordability directly to health and housing stability.

By situating clean energy and fossil fuels within a unified thermal sector, this report identifies the levers that can accelerate clean heat deployment while decelerating unnecessary investment in the gas system.

15 Pennsylvania Public Utility Commission, *Rate Comparison Report* (2025), https://www.puc.pa.gov/media/3429/2025_rate_comparison_report.pdf.

16 According to BDC analysis of EIA data in Chapter III.

17 See BDC analysis in Chapter III.

18 See BDC analysis of lifecycle costs in Chapter IV.

Report Structure

- **Part I. Summary and Introduction** presents recommendations for legislators, regulators, utilities, workforce leaders, and advocates to support a just and cost-effective thermal transition.
- **Part II. Policy and Energy Landscape** provides an overview of Pennsylvania's energy and policy landscape, including state and local climate commitments, regulatory authorities, and planning processes that shape investments in gas infrastructure and clean heat.
- **Part III. The State of Pennsylvania's Gas System** examines the structure and trajectory of Pennsylvania's gas system, including the infrastructure, customers, and demand profiles of the Big Six gas utilities, as well as new analysis of accelerated pipeline replacement spending allowed under Act 11.
- **Part IV. Neighborhood-Scale Building Decarbonization** evaluates neighborhood-scale alternatives to continued gas system investment, modeling how electrification and thermal energy networks can reduce costs and emissions across different climate zones and neighborhood typologies.
- **Part V. Building a Thermal Workforce** assesses the implications of a thermal transition for utilities and the thermal workforce.
- **Part VI. Conclusion** synthesizes the report's findings and shows why Pennsylvania should pursue a managed thermal transition to reduce long-term costs, scale clean thermal alternatives, and protect households and workers.
- **Part VII. Appendices** include insights from stakeholder interviews, detailed methodological documentation, and an overview of the roles that unions play in neighborhood-scale building decarbonization.

Terminology and Framework

This report uses the following terms to clarify how Pennsylvania's energy system is evolving:

Thermal sector: The integrated network of infrastructure, fuels, technologies, institutions, and skilled workers that produce, deliver, and manage heating and cooling across buildings and industry.

Thermal transition: The long-term evolution of the thermal sector toward cleaner, more affordable, and more efficient systems for delivering heat and cooling.

Thermal workforce: The skilled workers who build, maintain, and operate heating and cooling systems across fossil and clean energy technologies, including drillers, pipefitters, electricians, HVAC technicians, and insulators.

Managed gas transition: A central component of the thermal transition. A coordinated, regulator-led strategy to gradually right-size and retire portions of the gas distribution system as demand declines, while scaling up clean thermal alternatives and protecting workers and customers from unnecessary costs.

Neighborhood-scale building decarbonization: A strategy that coordinates electrification, efficiency, and thermal energy networks at the block or community level, allowing aging gas infrastructure to be retired rather than replaced.

Chapter 2

Policy and Energy Landscape

This chapter situates Pennsylvania's thermal transition within a broader energy landscape shaped by fossil fuel dependence, high household energy burdens, and uneven exposure to pollution and climate risk. It shows that although the Commonwealth has strong climate planning and customer protection frameworks, it still lacks binding policies and thermal-sector-specific tools to manage fossil fuel infrastructure costs and guide the shift toward cleaner, more affordable heating and cooling.

Pennsylvania's energy history is deeply intertwined with the rise of fossil fuels, which powered the Commonwealth's industrial growth for more than two centuries. Coal fueled early iron production in the 1700s and became the backbone of Pennsylvania's steel industry in the 19th and early 20th centuries, helping to establish the state as an industrial powerhouse. As manufacturing patterns shifted and domestic demand for coal declined, the role of coal evolved rather than disappeared. By the mid-20th century, coal was increasingly redirected toward electric power generation, where it dominated Pennsylvania's electricity mix for decades and shaped the state's energy infrastructure and labor markets.[19]

Though coal's prominence was unmatched in Pennsylvania, natural gas and oil have also long been central to Pennsylvania's energy economy. The state was home to the first commercial oil well in the United States in the mid-19th century, and oil and gas extraction has continued in various regions ever since.[20] While gas never matched coal's dominance in electricity generation, its role in the power sector expanded dramatically in the late 2000s with the proliferation of hydraulic fracturing ("fracking").[21] As coal became more costly to mine and increasingly

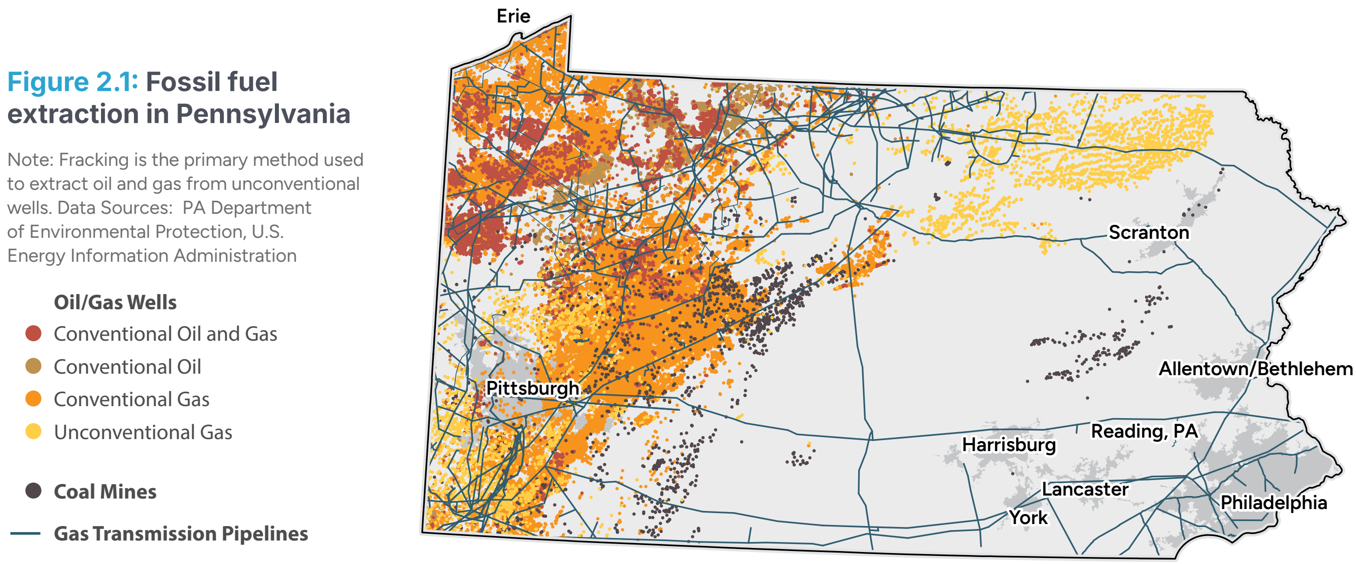
19 Commonwealth of Pennsylvania, "PAs Mining Legacy and AML," accessed December 5, 2025, https://www.pa.gov/agencies/dep/programs-and-services/mining/abandoned-mine-reclamation/aml-program-information/pas-mining-legacy-and-aml.

20 John A. Harper, "The Pit and the Petroleum," Pennsylvania Geology 29, no. 1 (1998): 24–27.

21 U.S. Energy Information Administration, "Electric Power Sector Has Driven Rising Pennsylvania Natural Gas Consumption since 2013," January 29, 2025, https://www.eia.gov/todayinenergy/detail.php?id=64424.

Figure 2.1: Fossil fuel extraction in Pennsylvania

Note: Fracking is the primary method used to extract oil and gas from unconventional wells. Data Sources: PA Department of Environmental Protection, U.S. Energy Information Administration



constrained by environmental regulations, fracking unlocked large volumes of relatively low-cost natural gas from the Marcellus Shale, which underlies roughly two-thirds of the Commonwealth.[22]

This shift drove a rapid transition in Pennsylvania's electricity sector from coal to gas and positioned the state as one of the nation's largest shale gas producers. However, abundant in-state gas production has not translated into lasting bill relief for Pennsylvanians, despite the commonly cited "Pennsylvania Gas Discount" that followed the shale boom.[23] As Chapter III shows, commodity gas now makes up only about one-third of the average gas bill, while roughly two-thirds reflects delivery charges tied to infrastructure costs. In other words, even when gas prices fall, the growing cost of maintaining the system limits how much customers benefit. At the same time, Pennsylvania maintains more than 49,000 miles of distribution main and 40,000 miles of service lines, making it the sixth-largest gas distribution system in the United States.[24] This vast pipeline network locks customers into the ongoing costs of maintaining an expansive fossil fuel system even as energy demand patterns and climate commitments continue to shift.

As the Commonwealth continues to evolve to meet changing thermal needs, it will need a combination of forward-looking policies, worker-centered programs, and strong customer-affordability protections. Pennsylvania does not have a legally binding economy-wide emissions reduction law, but it does have a substantial planning foundation. The 2024 Pennsylvania Climate Action Plan outlines the Commonwealth's current pathway for reducing emissions across major sectors,[25] while Executive Order 2019-01 established statewide greenhouse gas reduction targets and directed Commonwealth agencies to advance energy conservation.[26] Pennsylvania has also sought to empower local governments through the Local Climate Action Program, and cities such as Philadelphia have translated these broader goals into local climate frameworks through efforts like the Climate Action Playbook.[27] Building on this foundation will require a more specific set of policies focused on the thermal sector, where long-lived infrastructure decisions will shape energy costs, emissions, and workforce outcomes for decades.

22 Pennsylvania Department of Environmental Protection, "Marcellus Shale Development Fact Sheet," 2015, https://www.potomacdwspp.org/wp-content/uploads/2015/03/0100-FS-DEP4217.pdf.

23 Christina Simeone, *Pennsylvania's Gas Decade: Insights into Consumer Pricing Impacts from Shale Gas (2007-2016)*, (University of Pennsylvania), October 27, 2017.

24 Pipeline and Hazardous Materials Safety Administration, "Pipeline Mileage and Facilities," Pipeline and Hazardous Materials Safety Administration, U.S. Dept. of Transportation, accessed February 11, 2026, https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-mileage-and-facilities.

25 Pennsylvania Department of Environmental Protection, *Pennsylvania Climate Action Plan Update* (2025), https://greenport.pa.gov/elibrary/PDFProvider.ashx?PromptToSave=False&Size=17157562&ViewerMode=2&action=PDFStream&docID=9584245&docName=PENNSYLVANIA+CLIMATE+ACTION+PLAN+2024&nativeExt=pdf&overlay=0&revision=0&utm.

26 Tom Wolf, *E.O. 2019-01 Commonwealth Leadership in Addressing Climate Change and Promoting Energy Conservation and Sustainable Governance*, Executive Order 2019-01 (2019).

27 The City of Philadelphia Office of Sustainability, *Philadelphia Climate Action Playbook* (2021), https://www.phila.gov/media/20210113125627/Philadelphia-Climate-Action-Playbook.pdf.

Current Energy Use and Consumption Patterns

Key Takeaways

- Buildings and industry together account for roughly 70 percent of Pennsylvania's total energy demand, underscoring the central role of the thermal sector in the Commonwealth's energy system.
- Pennsylvania remains heavily reliant on fossil fuels for both home heating and industrial heat, with combustion contributing substantially to statewide emissions and local air pollution.
- Energy affordability, pollution exposure, and health burdens are closely linked, with the heaviest impacts falling disproportionately on low-income households, renters, and frontline communities.

Pennsylvania's energy landscape reflects its dual identity as both a major energy producer and a major energy consumer. After Texas, it is the second-largest net supplier of energy to the rest of the U.S.[28] In 2024, Pennsylvania ranked as the nation's second-largest natural gas producer, third-largest coal producer, third-largest electricity generator, and fourth-largest emitter of carbon dioxide.[29]

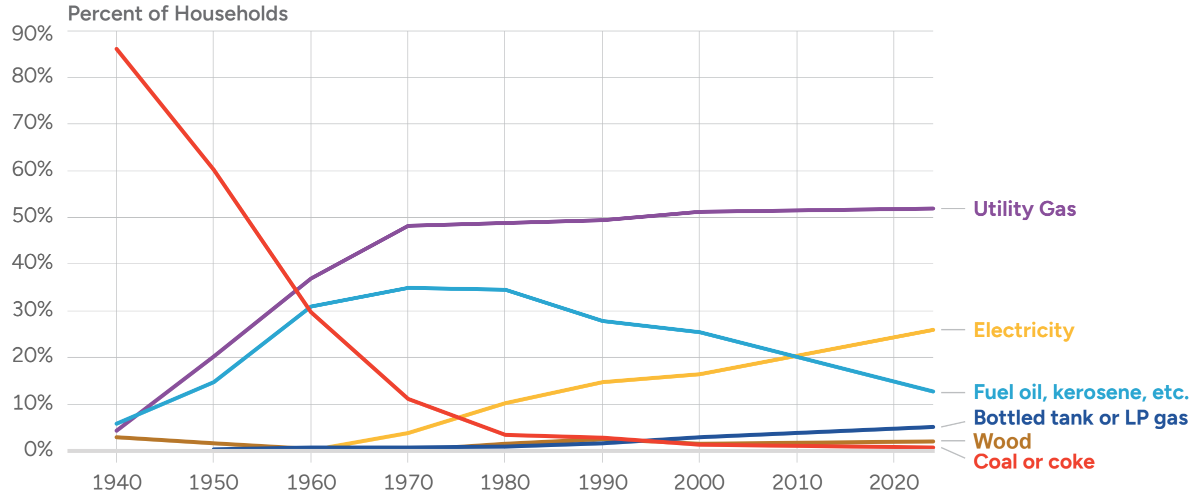
At the same time, Pennsylvanians consume approximately 3,600 trillion Btu of energy annually across all sectors, making the Commonwealth the fifth-highest-energy-consuming state in the United States[30] (ranking 25th on a per capita basis).[31] Residential and commercial buildings together account for roughly 30 percent of total energy consumption, while the industrial sector accounts for approximately 40 percent.[32] Combined, these sectors—where energy is primarily used for space heating, water heating, and as heat for industrial processes—comprise roughly 70 percent of total energy demand, underscoring the central role of the thermal sector in the Commonwealth's energy system.

Pennsylvania's building stock remains heavily reliant on fossil fuels for heating. Of the state's 5.4 million households, just over half rely on natural gas as their primary heating fuel (51 percent).[33] More than a quarter of households use electricity for heating (26 percent), while a significant share depend on delivered fuels, including fuel oil or kerosene (13.5 percent) and propane (5 percent).[34] A smaller but notable number of households continue to rely on wood (2 percent) and coal (1 percent) for home heating.[35] This relatively high dependence on delivered fuels reflects another defining feature of Pennsylvania's energy landscape: approximately one-quarter of the Commonwealth's population lives in rural areas,[36] where gas infrastructure has been slower to reach.

The industrial sector, which accounts for roughly one-third of Pennsylvania's greenhouse gas emissions, also relies heavily on fossil fuel combustion. Nearly two-thirds of direct industrial emissions stem from the on-site combustion of fossil fuels, with the remainder driven by fossil fuel extraction activities and industrial process emissions.[37] These emissions are often concentrated in and around frontline and fenceline communities, contributing to persistent air quality and public health burdens. For example, a recent investigation of the Clairton steelmaking facility in Pennsylvania found that benzene concentrations were significantly underreported, with fenceline

28 U.S. Energy Information Administration, "Pennsylvania Analysis," accessed January 20, 2026, https://www.eia.gov/states/pa/analysis.
29 U.S. Energy Information Administration, "Pennsylvania Overview," Pennsylvania Overview, accessed January 20, 2026, https://www.eia.gov/states/pa/rankings.
30 U.S. Energy Information Administration, "Table C10. Total Energy Consumption Estimates, Real Gross Domestic Product (GDP), Energy Consumption Estimates per Real Dollar of GDP, Ranked by State, 2023," accessed February 11, 2026, https://www.eia.gov/state/seds/sep_sum/html/pdf/rank_use_gdp.pdf.
31 U.S. Energy Information Administration, "Table C14. Total Energy Consumption Estimates per Capita by End-Use Sector, Ranked by State, 2023," accessed April 6, 2026, https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/rank_use_capita.html&sid=US.
32 U.S. Energy Information Administration, "Pennsylvania Overview."
33 U.S. Census Bureau, "House Heating Fuel. American Community Survey, ACS 1-Year Estimates Detailed Tables, Table B25040," n.d., accessed January 21, 2026, https://data.census.gov/table/ACSDT1Y2023.B25040.
34 U.S. Census Bureau, "House Heating Fuel. American Community Survey, ACS 1-Year Estimates Detailed Tables, Table B25040."
35 U.S. Census Bureau, "House Heating Fuel. American Community Survey, ACS 1-Year Estimates Detailed Tables, Table B25040."
36 U.S. Energy Information Administration, "Pennsylvania Analysis."
37 Joe Goodenbery et al., *A Roadmap for Industrial Decarbonization in Pennsylvania* (Ohio River Valley Institute, 2024), https://ohiorivervalleyinstitute.org/wp-content/uploads/2024/02/ORVI-Industrial_Decar_Pathway_Report_Final.pdf.

Figure 2.2: Electric heating is growing in Pennsylvania, while piped gas is flat and legacy fuels such as fuel oil and coal are phasing out.



Data Source: U.S. Census Bureau, U.S. Department of Commerce., "House Heating Fuel." American Community Survey, ACS 1-Year Estimates Detailed Tables, Table B25040.

monitors measuring levels nearly five times higher than the EPA standard.[38]

Emissions Profile and Public Health Impacts

In 2023, Pennsylvania's energy consumption produced 200 million metric tons of carbon dioxide emissions, making it the fourth-highest-emitting state in the country.[39] Electric power generation represents the largest source of these emissions at 33 percent, followed by transportation at 28 percent, industrial activity at 24 percent, and residential and commercial buildings at 15 percent.[40] When taken together, the thermal sector directly addresses 39 percent of emissions from energy consumption in residential and commercial buildings and from industrial buildings and processes while indirectly addressing another 33 percent from the electric power sector.

Beyond climate impacts, the fossil fuel system that supports heating and power in Pennsylvania also creates direct public health consequences. In addition to combustion in buildings and power plants, fracking has been linked to significant health risks, especially for children,[41] while methane leaks from the oil and gas sector contribute significantly to climate pollution.[42] Pennsylvania ranks among the top ten states nationally for average exposure to fine particulate matter (PM2.5),[43] a pollutant linked to asthma, reduced lung function, cardiovascular disease, and premature death.[44] These exposures are especially concerning in a state where about one in ten adults and one in ten children currently live with asthma.[45] While industrial facilities and power plants contribute significantly to this pollution burden, residential and commercial buildings add

38 Lisa Song and Annie Flanagan, "Air Pollution From Industrial Facilities Is Far Worse Than Estimated," *ProPublica*, October 30, 2025, https://www.propublica.org/article/epa-air-pollution-pittsburgh-clairton-coke-works.

39 U.S. Energy Information Administration, "Table CO2.7. Total CO2 Emissions Estimates from Energy Consumption, per Capita CO2 Emissions, and Carbon Intensities, Ranked by State, 2023," EIA, accessed January 28, 2026, https://www.eia.gov/state/seds/sep_sum/html/pdf/rank_co2_capita.pdf.

40 U.S. Energy Information Administration, "Table CO2.9. Total CO2 Emissions Estimates from Energy Consumption by Sector, Ranked by State, 2023," EIA, accessed January 28, 2026, https://www.eia.gov/state/seds/sep_sum/html/pdf/rank_co2_sector.pdf.

41 Pennsylvania Department of Health, "Fracking and Pediatric Health," 2022, https://www.pa.gov/content/dam/copapwp-pagov/en/health/documents/topics/documents/environmental-health/Fracking%20and%20Pediatric%20Health.pdf.

42 Commonwealth of Pennsylvania, "Reducing Emissions of Methane and Other Pollution from Oil and Natural Gas Operations," accessed April 1, 2026, https://www.pa.gov/agencies/dep/programs-and-services/air/methane-reduction-strategy.

43 America's Health Ranking, "Air Pollution in Pennsylvania," accessed December 10, 2025, https://www.americashealthrankings.org/explore/measures/air/PA.

44 OAR US EPA, "Health and Environmental Effects of Particulate Matter (PM)," Overviews and Factsheets, April 26, 2016, https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm.

45 Pennsylvania Department of Health, "Asthma Prevalence Fact Sheet 2025," October 7, 2025, https://www.pa.gov/content/dam/copapwp-pagov/en/health/documents/topics/documents/programs/2025%20Prevalence%20fact%20sheet.pdf.

to local air quality degradation through distributed combustion and leakage that affects indoor and outdoor air quality.

These health impacts are not evenly distributed. Communities located near major industrial facilities, such as the Mon Valley in Allegheny County, experience compounded exposure. The Mon Valley is home to the Clairton Coke Works, the largest coke manufacturing facility in North America, which still operates equipment installed in the 1950s. The company has repeatedly failed to complete planned infrastructure upgrades, leaving nearby residents, who are disproportionately communities of color, exposed to elevated levels of particulate matter, sulfur dioxide, and other harmful pollutants.[46] This failure to improve regional air quality "exacerbates generational health disparities and social inequalities,"[47] creating a pattern in which the communities that have historically powered Pennsylvania's economy continue to bear its health and environmental costs.

For these frontline communities, the transition away from fossil fuel combustion in buildings represents not merely a climate strategy but an environmental justice imperative. Eliminating on-site burning of gas and oil in homes, schools, and businesses can meaningfully reduce local pollution exposure while contributing to broader emissions reductions, particularly when paired with targeted interventions in the neighborhoods facing the highest cumulative burdens from industrial, transportation, and building-related pollution sources.

These emissions and health impacts provide critical context for understanding why building-focused climate policy has become central to Pennsylvania's broader climate strategy.

The Intersection of Energy, Emissions, and Affordability

Pennsylvania's energy and emissions challenges cannot be separated from questions of cost and equity. Nearly one in four Pennsylvania households had trouble paying their energy bills in 2024,[48] while 5.6 percent of gas customers were on payment plans and 8.7 percent were in debt to their gas utility.[49] These burdens are especially visible in Philadelphia, where residents face some of the highest energy costs relative to income among U.S. cities, driven by poverty, aging housing stock, underinvestment in building repairs and energy upgrades, and a history of community disinvestment.[50] For these households especially, the rising fixed costs of maintaining aging gas infrastructure create ongoing financial stress. In addition to economic hardship, high energy burdens are associated with indebtedness, poor health outcomes, and housing instability, and they disproportionately affect renters, low-income households, and people of color.[51]

This intersection of affordability, emissions, and energy access shapes the policy context for Pennsylvania's thermal transition. Any strategy to reduce building-related emissions must simultaneously address the financial pressures facing households and the structural inequities that determine which communities bear the greatest burdens from both pollution and energy costs.

46 PennFuture, "Mon Valley Campaigns," accessed November 6, 2025, https://pennfuture.org/Mon-Valley.
47 PennFuture, "Mon Valley Campaigns."

48 U.S. Census Bureau, "Household Pulse Survey."
49 Pennsylvania Public Utility Commission, *Universal Service Programs & Collections Performance 2024* (2026), https://www.puc.pa.gov/media/3771/2024-universal-service-report-final.pdf.
50 City of Philadelphia, *Alleviating Energy Poverty in Philadelphia* (2024), 4, https://www.phila.gov/media/20240701150359/Energy-Poverty-Alleviation-Strategy-Final.pdf.
51 City of Philadelphia, *Alleviating Energy Poverty in Philadelphia*, 4.

Climate Policies

Key Takeaways

- Pennsylvania has built a substantial climate-planning foundation through executive action, statewide planning, energy-efficiency policy, and local climate initiatives.
- Buildings and industrial energy use are already recognized in state climate planning as major opportunities for emissions reduction, highlighting the importance of the thermal sector.
- Despite this planning foundation, Pennsylvania still lacks binding, thermal-sector-specific policies to manage fossil fuel infrastructure costs and guide a long-term transition away from combustion.

Pennsylvania has established a set of statewide climate goals that reflect growing recognition of the economic, environmental, and public health risks associated with continued reliance on fossil fuels, while stopping short of binding emissions mandates. In 2019, the Commonwealth joined the U.S. Climate Alliance,[52] building on Executive Order 2019-01, which directed the Commonwealth to strive for a 26 percent reduction in net greenhouse gas emissions by 2025 and an 80 percent reduction by 2050 from 2005 levels, while also assigning energy and sustainability goals to state agencies.[53] These goals are implemented primarily through executive action and agency-led planning rather than statute and are reflected in Pennsylvania's Climate Action Plan, which outlines a cross-sector pathway for reducing emissions and adapting to climate impacts.[54]

This planning foundation is significant, but its non-statutory character also matters: unlike climate mandates enacted in some neighboring states, Pennsylvania's targets do not create the same binding framework for infrastructure and regulatory decision-making. At the local level, Philadelphia has adopted similarly ambitious climate frameworks, but its Climate Action Playbook is also a strategic planning document rather than a binding citywide decarbonization mandate.[55] Together, these state and local efforts show that Pennsylvania has built a substantial climate-planning architecture, but they also underscore a central gap: the Commonwealth still lacks a statutory, thermal-sector-specific framework for managing fossil infrastructure costs as energy needs and climate goals evolve.

Despite this lack of binding statutory targets, the Commonwealth has continued to identify significant opportunities to reduce emissions while strengthening its energy economy. Governor Josh Shapiro recently emphasized the urgency of evolving Pennsylvania's energy sector, stating that "Pennsylvania is falling behind in the race to create clean and reliable energy—and we must take action to be more competitive, ensure our consumers pay less for their electricity bills, and create more jobs and opportunities for our businesses to grow and our workers to get ahead."[56] In 2025, he introduced the Lightning Plan, a six-bill package intended to create jobs, lower costs for consumers, and accelerate in-state clean energy development. [57] Though these bills did not pass in 2025, the broader focus on job creation, affordability, and increased clean energy deployment is likely to remain central to Pennsylvania's energy policy debate.

52 Andrew Williams, "Gov. Wolf Joins U.S. Climate Alliance, Releases Pennsylvania Climate Action Plan Supportive of Swift and Concrete Action on Greenhouse Gas Emissions," Environmental Defense Fund, April 29, 2019, https://www.edf.org/media/gov-wolf-joins-us-climate-alliance-releases-pennsylvania-climate-action-plan-supportive-swift.
53 Tom Wolf, *E.O. 2019-01 Commonwealth Leadership in Addressing Climate Change and Promoting Energy Conservation and Sustainable Governance*.
54 Pennsylvania Department of Environmental Protection, "Pennsylvania Climate Action Plan," accessed April 1, 2026, https://www.pa.gov/agencies/dep/residents/climate-change/pa-climate-action-plan.
55 The City of Philadelphia Office of Sustainability, *Philadelphia Climate Action Playbook*.
56 "Governor Josh Shapiro's Energy Plan Builds on Pennsylvania's Legacy of Energy Leadership by Protecting and Creating Energy Jobs and Lowering Electricity Costs for Consumers," March 13, 2024, https://www.pa.gov/governor/newsroom/2024-press-releases/governor-josh-shapiro-s-energy-plan-builds-on-pennsylvania-s-leg.
57 "Gov Shapiro's 'Lightning Plan' Moves Forward Two Key Components Pass House," accessed February 3, 2026, https://www.pa.gov/governor/newsroom/2025-press-releases/gov-shapiro-s--lightning-plan--moves-forward-two-key-components-.

Pennsylvania's Building Decarbonization–Related Initiatives

Key climate, energy efficiency, and building policy milestones

2008

- **Climate Change Act of 2008:** A foundational statewide climate law that requires Pennsylvania to measure and report emissions annually and prepare an action plan to reduce emissions every three years.[1]
- **Act 129 of 2008:** Required large electric utilities to create energy-efficiency and conservation programs.[2]

2009

- **First Pennsylvania Climate Change Action Plan:** Outlined statewide mitigation and adaptation strategies and established a framework for periodic updates.[3]

2012

- **Act 11:** Amended the Public Utility Code to authorize Distribution System Improvement Charges (DSICs) and Long-Term Infrastructure Improvement Plans (LTIIPs), allowing utilities to accelerate replacement of eligible distribution infrastructure and recover those costs between base rate cases.[4]

2013

- **Pennsylvania Climate Impacts Assessment updated:** Documented increasing risks from extreme heat, heavy precipitation, and flooding; subsequent updates were released in 2015, 2020, 2021, and 2024.[5]

2016

- **Pennsylvania greenhouse gas emissions inventory report completed:** Annual inventory reports have been released since 2016.[6]

2019

- **Executive Order 2019-01 issued by Governor Wolf:** Established a statewide GHG reduction target of 80 percent by 2050 and set efficiency and renewable energy performance goals for state agencies.[7]
- **Pennsylvania joined the U.S. Climate Alliance:** Committed to multistate collaboration to achieve economy-wide greenhouse gas reductions consistent with the Paris Agreement.[8]

2021

- **Alternative Energy Portfolio Standards (AEPS) requirements continued to be implemented:** Required electric distribution companies and suppliers to provide 18 percent of electricity from alternative energy resources.[9]

2024

- **Pennsylvania Climate Action Plan updated:** DEP outlined 22 cross-sector strategies to reduce emissions, seven of which focus on buildings.[10]

2025

- **Lightning Plan introduced by Governor Shapiro:** An energy initiative designed to lower utility costs, create jobs, and accelerate in-state energy development.[11]
- **RISE PA launched:** Provided funding to create jobs and reduce air pollution from the industrial and manufacturing sectors.[12]
- **Statewide building energy codes updated:** The Residential Energy Code adopted the 2021 International Energy Conservation Code (IECC), and the Commercial Energy Code adopted the 2021 IECC and ASHRAE 90.1-2019.[13]

1 Pennsylvania Climate Change Act of 2008, No. 70 (2008), https://www.palegis.us/statutes/unconsolidated/law-information/view-statute?txtType=PDF&SessYr=2008&ActNum=0070.&SessInd=0.

2 Pennsylvania Public Utility Commission, "Act 129," PA PUC, accessed November 24, 2025, https://www.puc.pa.gov/filing-resources/issues-laws-regulations/act-129/.

3 Pennsylvania Department of Environmental Protection, *Pennsylvania Climate Change Action Plan* (2009), https://greenport.pa.gov/elibrary//GetDocument?docId=4504&DocName=0%20PENNSYLVANIA%20CLIMATE%20CHANGE%20ACTION%20PLAN.PDF%20.

4 Pennsylvania Public Utility Commission, "System Improvement Charges Act 11 of 2012," PA PUC, accessed April 1, 2026, https://www.puc.pa.gov/filing-resources/issues-laws-regulations/system-improvement-charges-act-11-of-2012/.

5 Pennsylvania Department of Environmental Protection, *Pennsylvania Climate Impacts Assessment Update* (2013), https://greenport.pa.gov/elibrary//GetDocument?docId=6806&DocName=PA%20DEP%20CLIMATE%20IMPACT%20ASSESSMENT%20UPDATE.PDF%20.

6 Pennsylvania Department of Environmental Protection, *Pennsylvania Greenhouse Gas Inventory 2016* (2016), files.dep.state.pa.us/Air/AirQuality/AQPortalFiles/Advisory Committees/CCAC/Docs/Inventory-2016_1-18-17_(final).pdf.

7 Tom Wolf, *E.O. 2019-01 Commonwealth Leadership in Addressing Climate Change and Promoting Energy Conservation and Sustainable Governance*.

8 Andrew Williams, "Gov. Wolf Joins U.S. Climate Alliance, Releases Pennsylvania Climate Action Plan Supportive of Swift and Concrete Action on Greenhouse Gas Emissions."

9 Pennsylvania Public Utility Commission, "Alternative Energy Portfolio Standards (AEPS) Act of 2004," accessed January 22, 2026, https://www.puc.pa.gov/filing-resources/issues-laws-regulations/aeps-act/.

10 Pennsylvania Department of Environmental Protection, *Pennsylvania Climate Action Plan Update*.

11 "Gov Shapiro's 'Lightning Plan' Moves Forward Two Key Components Pass House."

12 Pennsylvania Department of Environmental Protection, "RISE PA," accessed January 22, 2026, https://www.pa.gov/agencies/dep/programs-and-services/energy-programs-office/rise-pa.

13 U.S Office of Energy Efficiency and Renewable Energy, "Pennsylvania | Building Energy Codes Program," accessed December 17, 2025, https://www.energycodes.gov/status/states/pennsylvania.

Buildings and the Thermal Sector in Climate Policy

Pennsylvania's most recent Climate Action Plan, released in 2024, identifies 22 priority strategies for reducing greenhouse gas emissions across sectors. Notably, seven of these strategies focus directly on buildings and industrial energy use, underscoring the central role of the thermal sector in the Commonwealth's emissions profile. These strategies include improving building energy codes, expanding efficiency in existing buildings, deploying electric and non-combustion alternatives to fossil fuels for space and water heating, integrating distributed energy resources, and advancing industrial electrification and process decarbonization.[58]

The prominence of building-related strategies reflects the reality that a large share of Pennsylvania's emissions originate from on-site fossil fuel combustion in homes, businesses, and industrial facilities. However, many of these strategies remain dependent on voluntary adoption, limited funding, or pilot-scale implementation. Without binding performance standards, long-term funding mechanisms, or coordinated approaches to managing fossil fuel infrastructure, progress in the building sector risks being incremental rather than transformative.

State and Local Action

At the state level, Pennsylvania has a long history of climate planning and energy efficiency policy, including the Climate Change Act of 2008, Act 129 utility energy-efficiency programs, statewide energy code updates, and participation in multi-state climate initiatives such as the U.S. Climate Alliance. More recently, programs such as RISE PA, the Commonwealth's $396 million industrial decarbonization initiative,[59] have sought to link emissions reductions with industrial competitiveness and job creation.

At the same time, local governments have increasingly taken the lead in setting more ambitious climate and building decarbonization goals. Through DEP's Local Climate Action Program (LCAP), more than 80 municipalities, counties, and regional organizations have received technical assistance to develop local climate strategies, with dozens completing formal climate action plans.[60]

Cities such as Philadelphia and Pittsburgh have adopted building-focused policies that go beyond state requirements, including performance standards for large buildings, net zero-ready construction ordinances,[61] and commitments to 100 percent renewable electricity for municipal operations.[62] These local efforts demonstrate both the feasibility of building decarbonization policies and the uneven geography of climate ambition across the Commonwealth.

Energy Affordability and Customer Protections

Affordability is a defining feature of Pennsylvania's energy policy landscape. Nearly 25 percent of Pennsylvanians were considered energy insecure in 2023, reporting that they had to give up paying for food, medicine, or other basic needs in order to pay their utility bills.[63] Recognizing the essential nature of energy services, particularly heating, Pennsylvania has established a suite of statewide consumer protections and assistance programs designed to prevent service disconnections and support households facing financial hardship.

Pennsylvania law limits when utilities may disconnect residential customers for nonpayment, particularly during periods of heightened vulnerability. These protections include winter

58 Pennsylvania Department of Environmental Protection, *Pennsylvania Climate Action Plan Update*.

59 Pennsylvania Department of Environmental Protection, "RISE PA," accessed February 6, 2026, https://www.pa.gov/agencies/dep/programs-and-services/energy-programs-office/rise-pa.

60 Pennsylvania Department of Environmental Protection, "Local Climate Action Program," accessed December 9, 2025, https://www.pa.gov/agencies/dep/residents/climate-change/local-climate-action-program.

61 The City of Pittsburgh, "Executive Order Committing Pittsburgh to Be Carbon Neutral by 2050," April 27, 2021, https://www.pittsburghpa.gov/City-Government/Mayor/Executive-Orders/Mayor-Peduto-Issues-Executive-Order-Committing-Pittsburgh-to-Be-Carbon-Neutral-by-2050.

62 City of Philadelphia, *2025 Climate Action Update* (2025), https://www.phila.gov/media/20250613162209/Philadelphia-climate-action-update-2025.pdf.

63 "Support Legislation to Increase Energy and Water Access for Pennsylvanians," *Community Legal Services*, April 17, 2024, https://clsphila.org/utilities/help-pennsylvanians-stay-connected-to-vital-utilities/.

shut-off moratoria for income-qualified households, medical certification protections for customers whose health would be jeopardized by loss of service, requirements for payment arrangements based on ability to pay, advance notice provisions, and restrictions on terminations on weekends and holidays.[64] Collectively, these policies reflect a long-standing commitment to ensuring continued access to essential energy services, even when households are unable to keep up with rising costs.

In addition to disconnection protections, Pennsylvania requires public utilities to administer a set of universal service programs aimed at reducing energy burdens for low-income households. These include Low-Income Usage Reduction Programs (LIURPs), which provide energy audits, efficiency upgrades, and education; Customer Assistance Programs (CAPs), which can include percentage-of-income or percentage-of-bill payment plans, rate discounts, and arrearage forgiveness; Customer Assistance and Referral Evaluation Services (CARES), which connect households experiencing short-term crises with social services and support; and hardship funds that provide direct financial assistance for arrearages.[65] Together, these programs serve hundreds of thousands of households each year and represent a critical component of the Commonwealth's energy safety net.

At the same time, even Pennsylvania's universal service framework has limits. CAPs can reduce bills and arrears for enrolled low-income households, but the broader affordability system remains focused on helping customers manage hardship after costs have already become unaffordable rather than addressing the underlying drivers of rising bills, including long-lived fossil fuel infrastructure and fixed system charges. As these rising costs are spread across a relatively stagnant or declining customer base, many households that rely on gas for heating remain exposed to unaffordable bills even when their energy consumption declines or efficiency improves. As Pennsylvania pursues emissions reductions in buildings, the continued reliance on universal service and bill-assistance programs as a primary line of defense underscores the need for policies that reduce costs structurally rather than relying only on downstream affordability protections.

Pennsylvania's climate policies reflect a strong foundation of planning, analysis, and localized action, but also reveal significant gaps in implementation authority, scale, and coordination, particularly in the buildings and thermal sectors. The absence of binding emissions limits, long-term gas system planning, or a statewide building-specific strategy for phasing out emissions and managing fossil fuel infrastructure costs creates uncertainty for households, workers, and utilities alike.

"Pennsylvania's climate policies reflect a strong foundation of planning, analysis, and localized action, but also reveal significant gaps in implementation authority, scale, and coordination, particularly in the buildings and thermal sectors."

64 See Appendix A, "Utility Disconnection Protections" for corresponding codes and citations.

65 Pennsylvania Public Utility Commission, *Universal Service Programs & Collections Performance 2024.*

Chapter 3

The State of Pennsylvania's Gas System

This chapter examines how Act 11 reshaped gas utility investment in Pennsylvania and why the resulting costs are increasingly misaligned with system utilization. It traces how accelerated replacement expanded the gas asset base, how those costs translate to higher customer bills, and the risks of not reigning in infrastructure spending. It concludes by comparing Pennsylvania's accelerated cost recovery framework with peer states and explaining why stronger planning and oversight are needed to right-size the Commonwealth's gas system.

Over the past decade, Pennsylvania's gas system has grown steadily more expensive even as gas demand has declined, customer growth has slowed, and the Commonwealth's climate commitments have advanced. At the same time, gas utilities have dramatically accelerated their investment in infrastructure spending, with a noticeable shift in growth beginning in 2010. The result is a widening mismatch between the scale of gas infrastructure investment and the level of demand the system is likely to serve over time.

A central driver of this trajectory is Act 11 (2012), which allowed gas utilities to accelerate recovery of certain distribution-system investment costs through a Distribution System Improvement Charge (DSIC) outside traditional rate cases. At the time, this approach responded to real concerns about aging infrastructure and pipeline safety, including national efforts to speed replacement of higher-risk cast iron and bare steel pipe,[66] and it was intended to reduce regulatory lag in recovering prudent repair, improvement, and replacement costs.[67] However, in Pennsylvania, the framework evolved into a broader and more durable mechanism for increasing capital investment in the gas system. And while utilities must file Long-Term Infrastructure Improvement Plans (LTIIPs) and Annual Asset Optimization Plans

66 Pipeline and Hazardous Materials Safety Administration, U.S. Dept. of Transportation, "Pipeline Replacement Background," Pipeline and Hazardous Materials Safety Administration, U.S. Dept. of Transportation, accessed September 19, 2025, https://www.phmsa.dot.gov/data-and-statistics/pipeline-replacement/pipeline-replacement-background.

67 Pennsylvania Public Utility Commission, "System Improvement Charges Act 11 of 2012."

(AAOPs) for Commission review, these filings show steadily rising costs within a replacement framework that has expanded over time. Given the effect that this spending has had on ratepayer burdens, these filings should be subject to greater scrutiny.

Pennsylvania entered this period of accelerated pipeline replacement with an unusually large share of leak-prone pipe (LPP): 13.2 percent of distribution mains, compared with 3.5 percent nationally.[68] The prevalence of LPP makes a long-term gas plan and prioritization even more important. But LPP is a screening category, not a planning framework on its own. Under Pennsylvania's current approach, LPP designation often results in like-for-like gas pipeline replacement, even where demand is stagnant or declining. Instead, it should trigger a broader planning process that evaluates repair, relining, retirement, and non-pipeline alternatives. Without a long-term plan that includes these options and assesses clean thermal alternatives, the Commonwealth risks locking gas ratepayers into decades of paying for increasingly underutilized gas assets.

Key Terms

The following terms are helpful for understanding why gas system investments lead to increased customer bills and how certain policies accelerate those increases.

Leak-prone pipe (LPP). A screening category used in this report (and reflected in Act 11 LTIIP/AAOP filings) for distribution mains and services commonly prioritized for replacement due to material and/or vintage characteristics associated with higher leak incidence or corrosion susceptibility. In this report, examples include unprotected/bare steel and legacy iron (including cast/wrought iron, reconditioned cast iron that has not been relined, and ductile iron), as well as any utility-defined age-threshold categories. "Leak-prone" does not mean a segment is currently leaking, and actual risk varies with pressure, soil conditions, joint type, corrosion protection, installation quality, and leak history. Some of this pipe is age-dependent, meaning a pipe segment is treated as leak-prone only after it exceeds a specified age or vintage cutoff (as defined by the utility or program), rather than solely by material type.

Gas plant. This includes gas infrastructure such as: distribution mains, meters, and services; transmission mains; storage facilities; and other structures, property, and equipment. The designation of "gross gas plant in service" refers to the original cost of this utility-owned gas infrastructure before depreciation. "Net gas plant" (or "book value") refers to gross plant minus accumulated depreciation and represents the remaining undepreciated investment on which utilities continue to earn a return and recover costs from customers. Net gas plant serves as a key indicator of the gas system's growth over time as well as potential stranded asset risk. In this report, "gas infrastructure" refers to the physical pipes, mains, meters, and related equipment that deliver gas service, while "gas assets" refers to the original cost of that infrastructure.

68 BDC analysis of 2024 PHMSA data. See Figure D.5 in "Big Six Gas Infrastructure," Dashboard.

Distribution System Improvement Charge (DSIC). A surcharge authorized under Act 11 that allows a utility, with Commission approval, to recover the reasonable and prudent costs of certain repair, improvement, or replacement projects between base rate cases. In practice, the DSIC reduces regulatory lag by allowing qualifying distribution-system costs to be added to customer bills more quickly than they would be through a traditional rate case. The DSIC currently has a 5 percent cap on distribution rates, not a customer's total bill, with precedent for raising this cap based on a utility's needs.

Long-Term Infrastructure Improvement Plan (LTIIP). A multi-year plan filed by a utility under Act 11 that identifies eligible distribution-system repair, replacement, and improvement projects and provides the basis for accelerated cost recovery through the DSIC. In this report, LTIIPs are important because they show the scale, pace, and rationale of planned infrastructure investment.

Annual Asset Optimization Plan (AAOP). An annual filing associated with Act 11 implementation that reports utility replacement activity, costs, and project updates. In this report, AAOPs are used to track how accelerated replacement programs are being carried out in practice and how costs change over time.

Black box rate case settlement. A type of settlement in which, according to the Pennsylvania PUC, the parties agree on an overall revenue requirement or rate increase without specifically resolving or publicly identifying each underlying component, such as individual rate base, expense, or rate-of-return issues. In this report, the term is used to describe settlements that can make it more difficult for the public to see how particular cost and profit assumptions affect customer bills.

Rate Case. A quasi-judicial administrative proceeding in which the Public Utility Commission determines allowed utility revenue ("revenue requirement"), customer prices (the "rates"), and the rate of return that investor-owned utilities are permitted to earn on their capital spending.

During a typical rate case, utilities must justify their infrastructure investments and explain why they are necessary to meet customer needs. They must also provide information about what constitutes "prudent" and "reasonable" cost of service, and the rates that would allow the utility to fulfill its service obligations, recover its costs, and make a profit. Rate cases determine three critical numbers for gas utilities that in turn shape whether customer rates will go up or down and by how much: the rate base, rate of return (or "cost of capital"), and revenue requirement.

Rate base. The rate base is the value of the utility's gas plant used to provide gas services that is approved by regulators as constituting the investment on which a fair rate of return is to be based. The rate base is calculated by adding up the original cost of the assets and adjusting for depreciation and other factors. The rate base grows when utilities invest above the rate of depreciation.

Rate of return. Investor-owned utilities engage in approved capital spending to maintain and upgrade their infrastructure, and they earn an authorized rate of return on their investments known as the "weighted average cost of capital." That blended rate of return includes the profit rate that utilities are allowed to earn on their capital spending. This rate is then multiplied by the rate base to determine the amount of revenue needed to compensate utilities for the equity their shareholders invest, the cost of bond capital, whether it is short, medium, or long term, and income taxes.

Revenue requirement. The basis for setting a utility's rates is known as the "revenue requirement." The revenue requirement refers to the total funds that an investor-owned utility needs to collect from its customers in order to pay for the gas system expenses it expects to incur in a given year. These expenses include the utility's profit on its capital spending, operations and maintenance, depreciation, taxes, customer service, and administration.

Dashboard: Pennsylvania Gas System Overview

The six largest gas utilities (the "Big Six") in Pennsylvania comprise 97 percent of the Commonwealth's gas infrastructure. This dashboard tracks their gas infrastructure, spending, customer and demand growth, and energy affordability metrics.

The Big Six Gas Utilities

- Peoples Natural Gas Co. (IOU)
- Philadelphia Gas Works (Municipal utility)
- National Fuel Gas Distribution Corporation (IOU)
- UGI Utilities (IOU)
- Columbia Gas of Pennsylvania, Inc. (IOU)
- PECO Energy Company (IOU)

Figure D.1: Territories covered by the Big Six gas utilities in Pennsylvania Modified from: S&P Global

Sources: Esri, Tom Tom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community,

- Peoples Natural Gas Co.
- Philadelphia Gas Works
- National Fuel Gas Distribution Corporation
- UGI Utilities
- Columbia Gas of Pennsylvania, Inc.
- PECO Energy Company

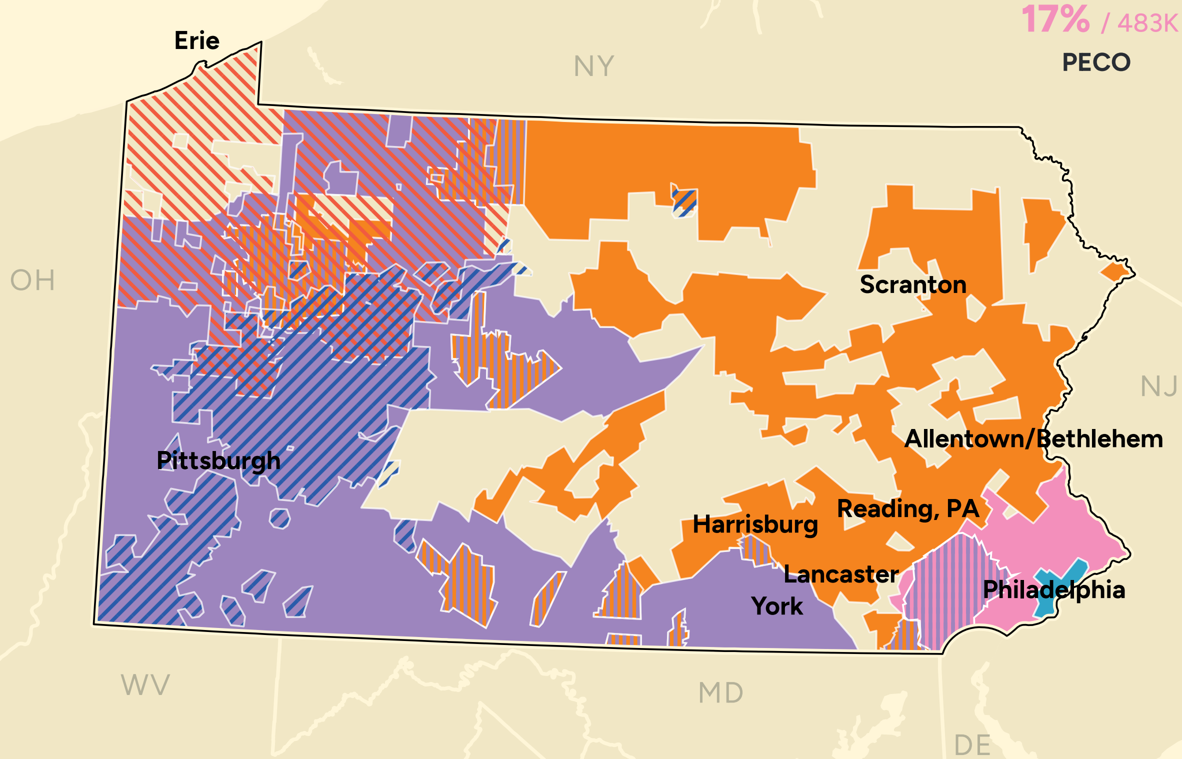
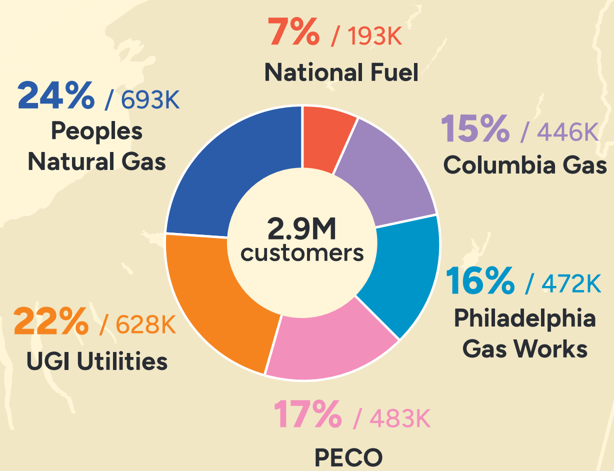


Figure D.2: The Big Six gas utilities serve from nearly 200,000 for National Fuel to nearly 700,000 for Peoples Natural gas, and together serve 98% of gas customers in Pennsylvania.



Gas Infrastructure

49k
Miles of distribution main pipeline (2024)

3.8%
Avg. annual growth, miles of distribution main pipeline (2017-2024)

40k
Miles of service pipeline (2024)

2.1%
Avg. annual growth, number of service pipelines (2017-2024)

1.2k
Miles of interstate transmission pipelines (2024)

71 years
Useful life of a gas main

15%
Gas mains 65+ years old in Big Six territory

50%
Gas mains in PGW territory 65+ years old

13.2%
Leak-prone pipe gas main mileage based on material alone in Pennsylvania

Figure D.3: **Since 2017, overall gas distribution infrastructure mileage has grown an average of 3% per year across the Big Six gas utilities.**

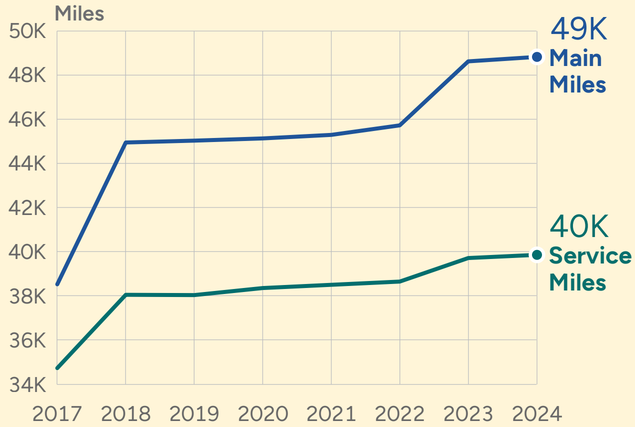


Figure D.4: **Main pipeline materials vary across iron, plastics, steel, and other materials. Across the Big Six, 13% of pipe mileage is made of known leak-prone materials, such as iron and unprotected bare steel, regardless of pipe age. Pennsylvania as a whole has about four times the national rate of leak-prone pipe.**

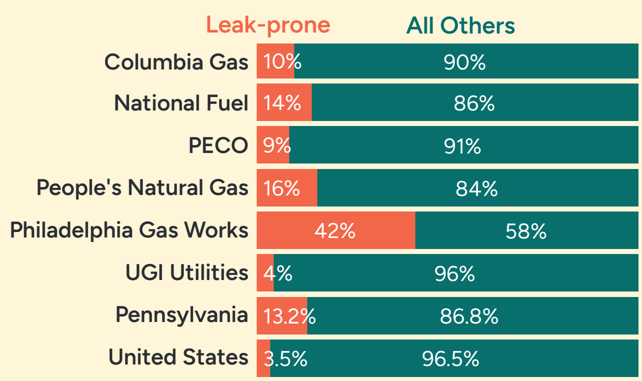
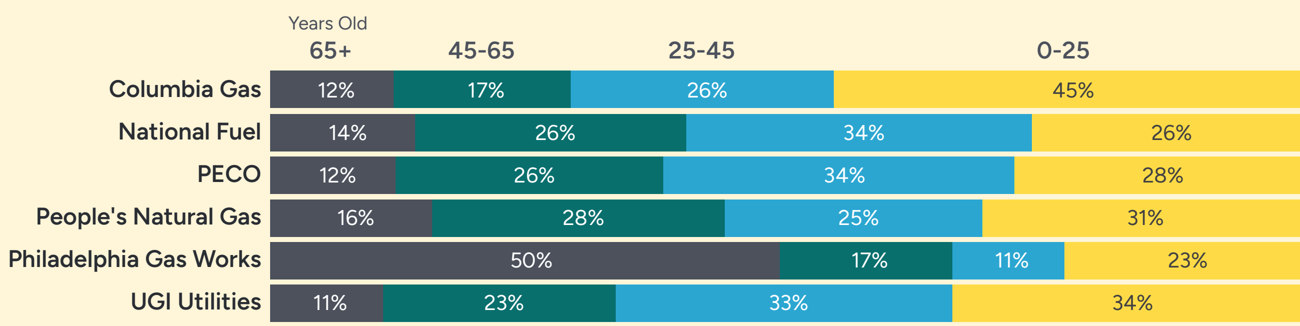


Figure D.5: **Main pipeline age varies by gas utility, with PGW maintaining the oldest system. Across the Big Six, 15% of pipes are over 65 years old, and those pipes have higher leak potential.**



See Appendix for list of sources for Gas System Overview Section

Gas System Spending

$22.6B
Gross value of gas utility assets, Big Six (2024)

166%
Growth in value of gas utility assets, Big Six (2013–2024)

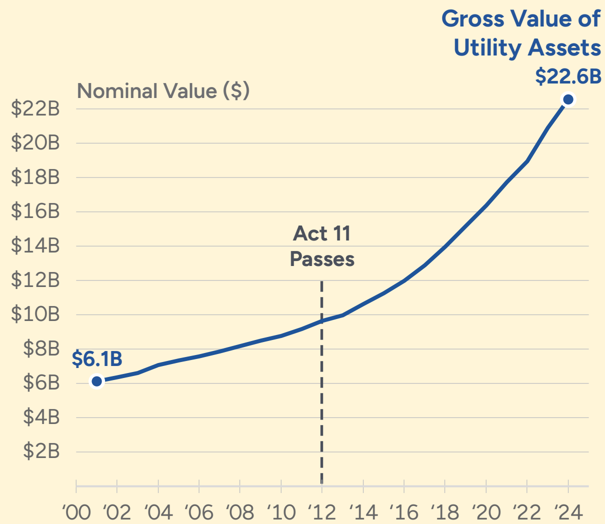
3.2x
Growth in value of gas utility assets per customer (2001-2024)

$7,150
Value of gas utility assets per customer (all classes) (2024)

$2.8M
Avg. spend per mile of main, Big Six

$40k
Average utility spending per connected customer per mile of main, 2025

Figure D.6: Since 2001, the gross value of gas infrastructure for the Big Six utilities has increased 4.5x (or 2x after inflation), increasing the asset base on which utilities earn a return and recover costs from customers.



Data Source: S&P Global and Utility Regulatory Filings, nominal dollars

Figure D.7: Since their inception in 2013, annual spending from LTIIPs, or accelerated pipeline replacement, across the Big Six has grown steadily every year, totaling $11B in direct costs through 2025.

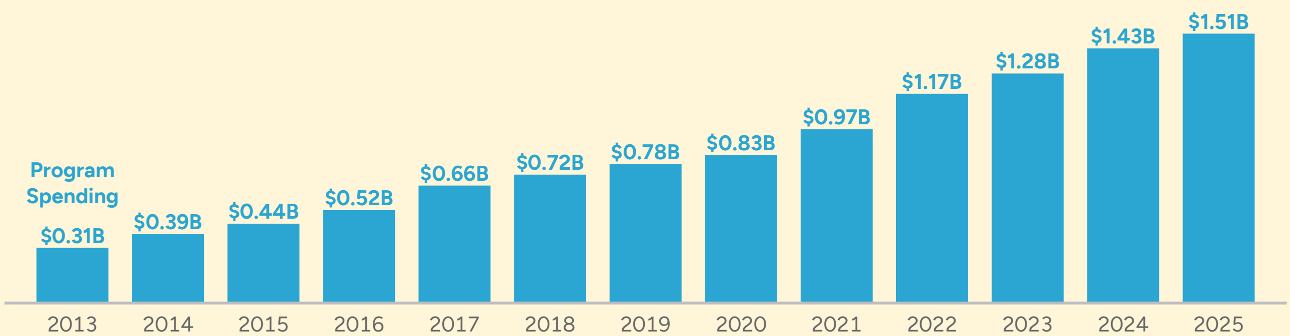


Table D.1: Gas main replacement economics by utility: spending per mile of main and per customer

Utility	Customers	Services per mile of main (2024)	Main mile replacement spending ($M), 2025 Actual	Main replacement spending per customer	Per-mile spending increase since 2014
UGI	700,000	50.3	$4.62	$91,768	209%
Philadelphia Gas Works*	500,000	154.8	$2.71	$17,493	23%
Peoples Natural Gas	700,000	52.5	$2.52	$47,970	289%
Columbia	446,000	57.4	$2.94	$51,298	132%
National Fuel**	215,000	39.9	$0.70	$17,426	70%
PECO	495,000	65.9	$3.02	$45,795	112%

*Earliest available data from 2015 **Earliest available data from 2017

Figure D.8: The amount that a utility spends to replace a mile of gas main pipeline has more than doubled in the decade since the introduction of Act 11.

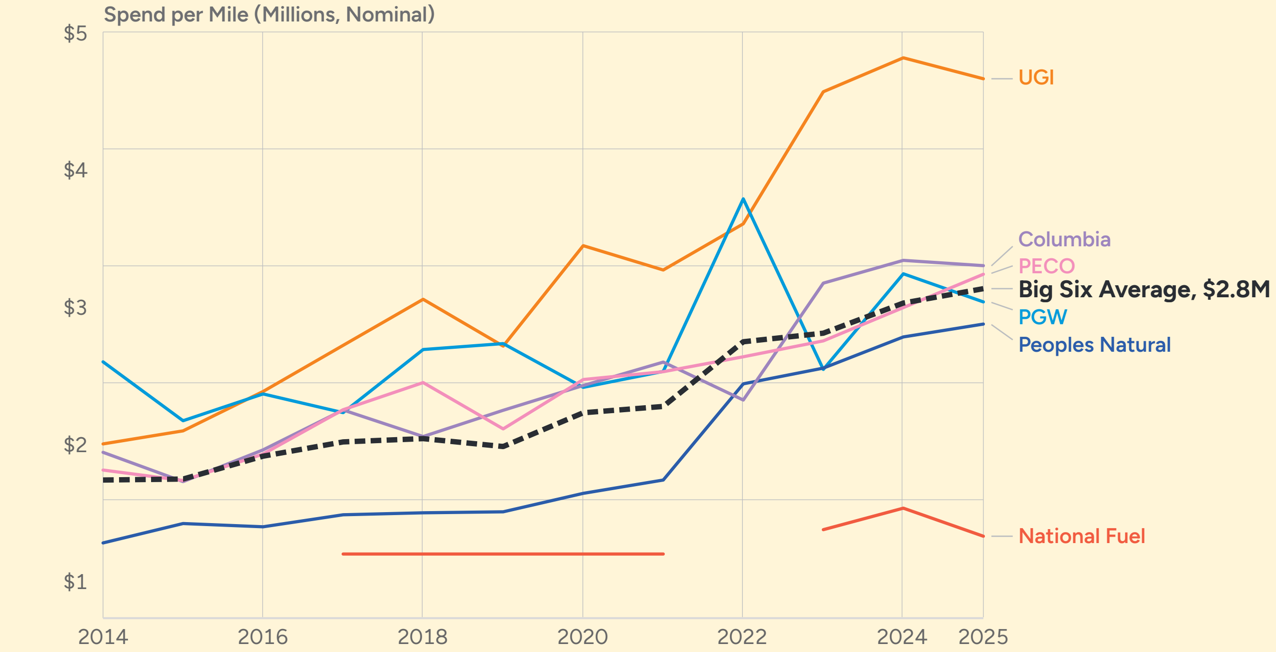
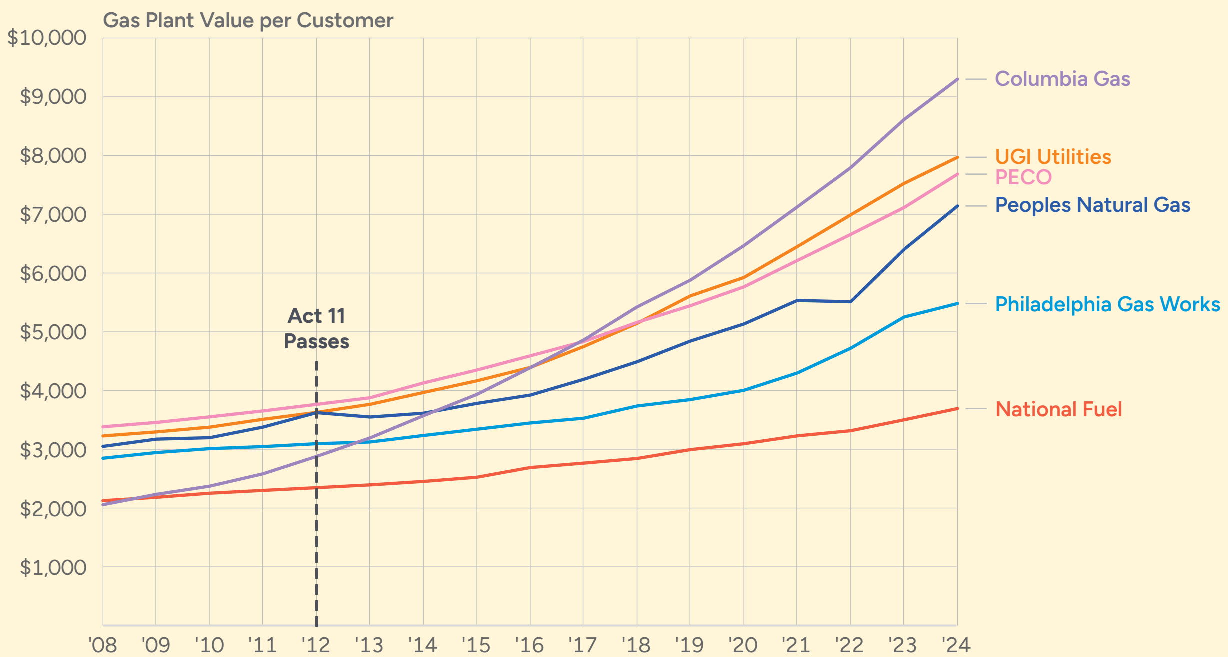


Figure D.9: Since Act 11 passed in 2012, gross value of gas infrastructure per customer has increased by 5% (National Fuel) to 18% (Columbia Gas) per year



Gas Customers and Demand

3.15M

Customers, all classes

91.9% **8.0%** **0.1%**

Residential, commercial, industrial customer share, respectively

0.59%

Annual average growth for all customer classes since 2000

0.62% **0.4%** **-1.7%**

Average annual growth for residential, commercial, and industrial customers, respectively, since 2000

-18%

Overall change in residential gas use (2000-2024)

-28%

Change in residential gas use per customer (2000-2024)

+61%

Change in residential gas price (2000-2024)

Figure D.10: The majority of gas customers in Pennsylvania are residential. Across all sectors, annual average customer growth since 2000 was 0.59%.

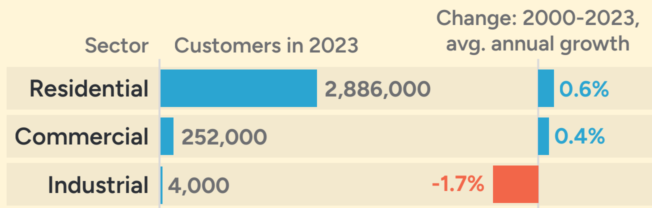


Figure D.11: Gas consumption in buildings in Pennsylvania is stagnant, with nearly all growth going to electric power generation.

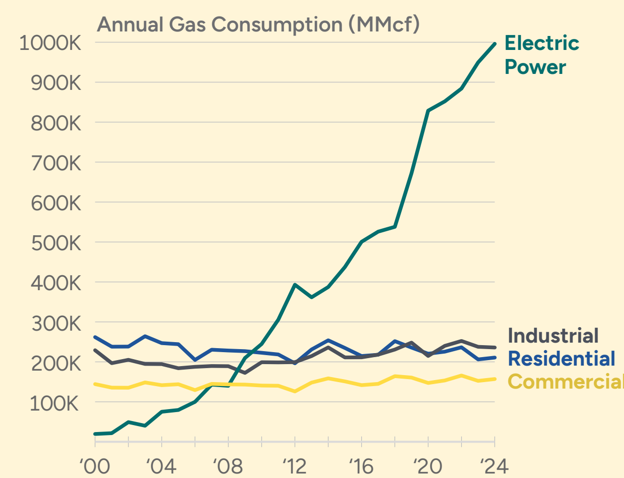
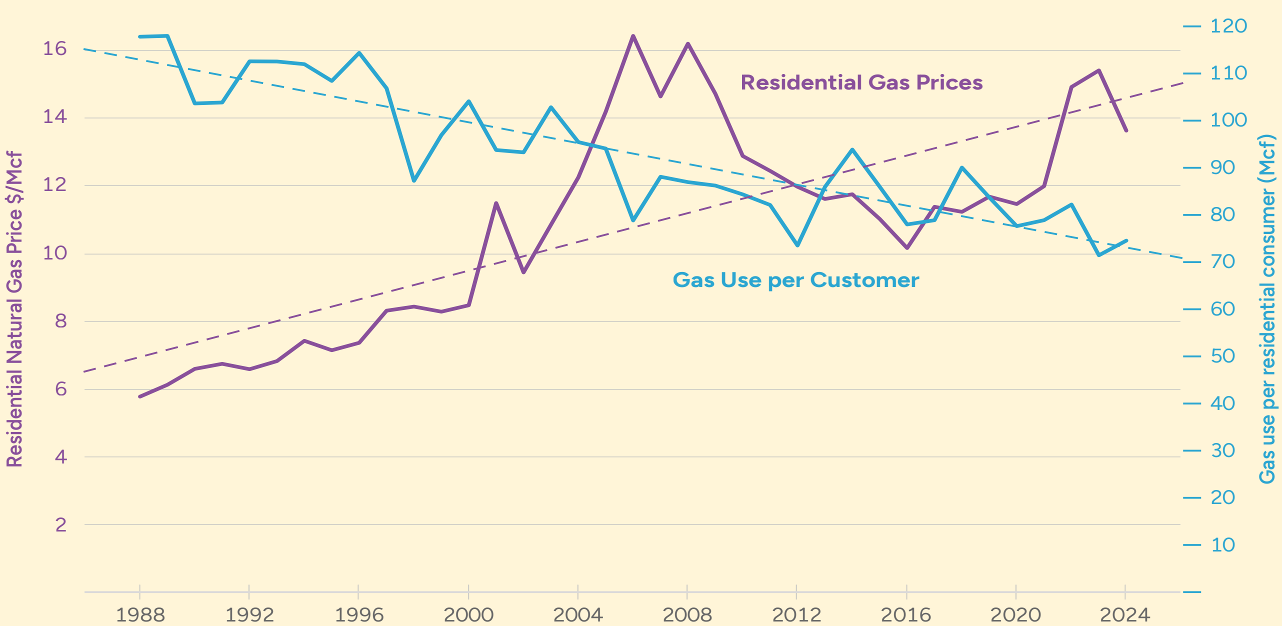


Figure D.12: Recent trends in delivered cost of gas to the residential sector and average gas use per residential customer show residential customers paying more even while consuming less gas.



Energy Affordability

Gas Bills

66%

Portion of gas bill that pays for infrastructure

34%

Portion of gas bill that pays for gas itself

$111

Average monthly residential gas bill, year-round (2025)

$234

Average monthly residential gas bill, heating season (2025)

67%

Increase in average monthly residential gas bill, year-round, since 2015.

Table D.2: Average monthly residential bill by utility

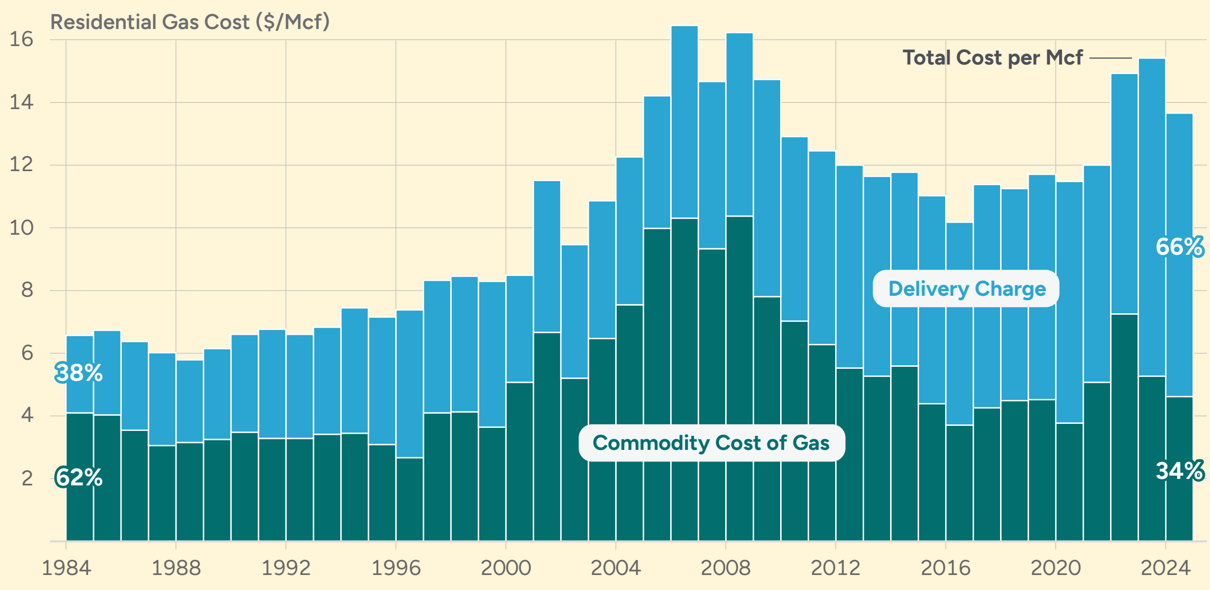
Utility	Avg. Monthly Res. Usage, Year Round (Mcf)	Avg. Monthly Res. Bill, Year Round ($)	Avg. Monthly Res. Bill, Heating Season (15 Mcf)
Columbia	7	$155	$309
National Fuel	8	$86	$148
PECO	7	$108	$203
Peoples Natural	7.1	$105	$203
PGW	5.5	$118	$290
UGI	7.3	$118	$229

Table D.3: Energy Insecurity Metrics for Residential Gas Customers*

Category	2024
Low-Income Customers, Confirmed	456,514 (16.2%)
Low-Income Customers, Estimated	705,234 (25%)
Customers with Payment Arrangements	159,093 (5.6%)
Payment-Troubled Customers	104,998 (3.7%)
Number of Customers in Debt	245,355 (8.7%)
Average Arrearage Amount ($)	$571.67
Service Terminations	99,684 (3.5%)

*See Methodology in Appendix B for definitions and further analysis

Figure D.13: Overall residential gas costs have increased steadily over time, with the majority of the growth coming from delivery charges, which now make up two-thirds of gas bills.



The Trajectory of Pennsylvania's Gas System

Key Takeaways

- The gross value of gas utility assets owned by Pennsylvania's Big Six utilities reached $22.6 billion in 2024, a 267 percent increase since 2001.
- Customer growth, across all classes, remained weak, averaging 0.59 percent annually since 2000.
- Gas use per residential customer has declined for decades, even as gas bills have increased.
- Growth in the gas asset base is the primary driver of higher gas bills.

Figure 3.1: **How Infrastructure Policy Raises the Cost of Heat in Pennsylvania**

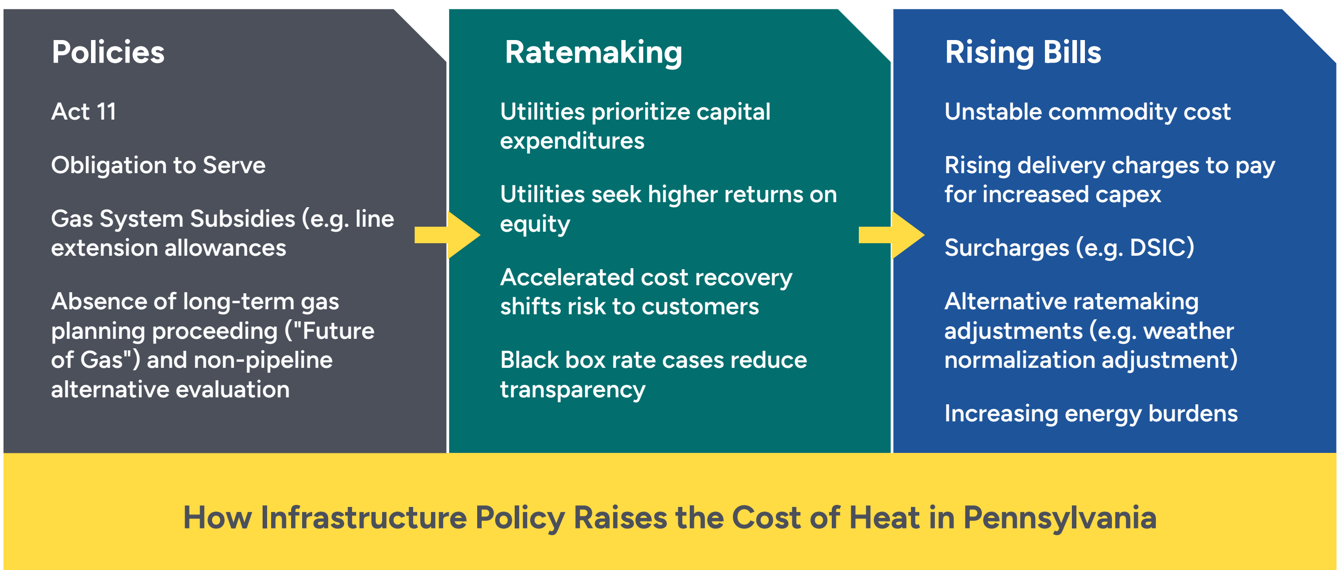
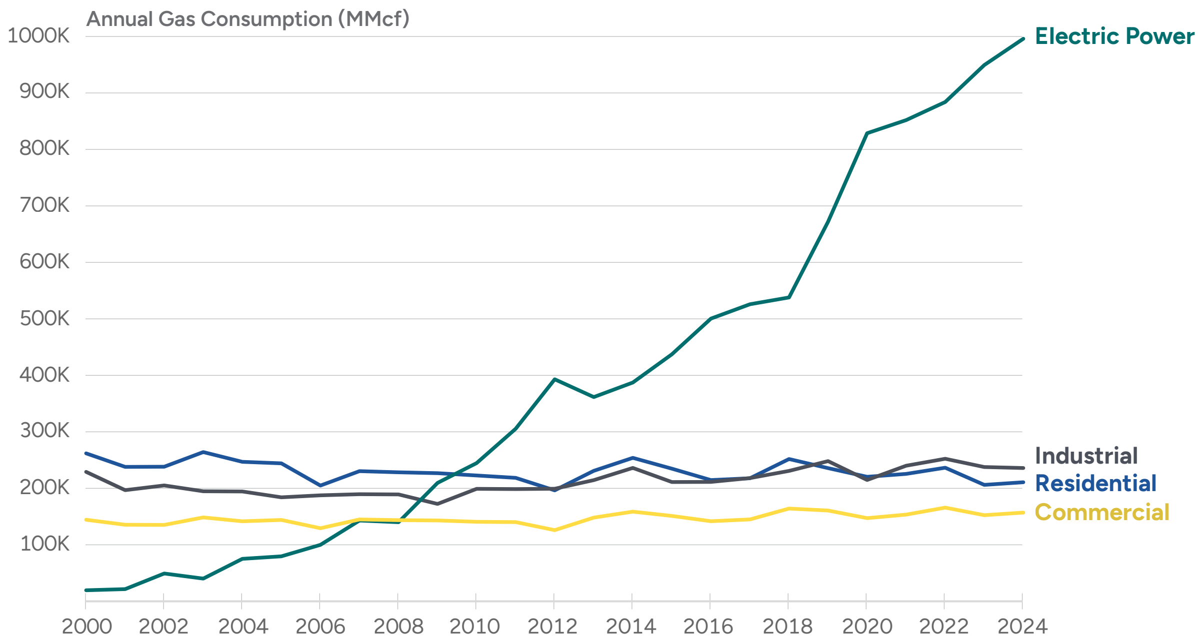


Figure 3.2: **Gas consumption in buildings in Pennsylvania is stagnant, with nearly all growth going to electric power generation.**



Data Source: EIA

Rising Infrastructure Investment Amid Declining Demand

Pennsylvania's gas system is increasingly defined by a basic mismatch: utilities are making historically high capital investments in gas distribution infrastructure even as customer growth slows and gas use declines or stagnates. While gas has seen growth on the power generation side, gas use in buildings has remained stagnant or declined, especially on a per-customer basis. For residential customers in particular, gas use has declined 28 percent per customer since 2000. Meanwhile, gas prices have increased 61 percent in that same time period. Despite these trends, gas utilities have been accelerating their investment in gas distribution infrastructure, including long-lived assets like pipes and service lines, since the passage of Act 11 in 2012.

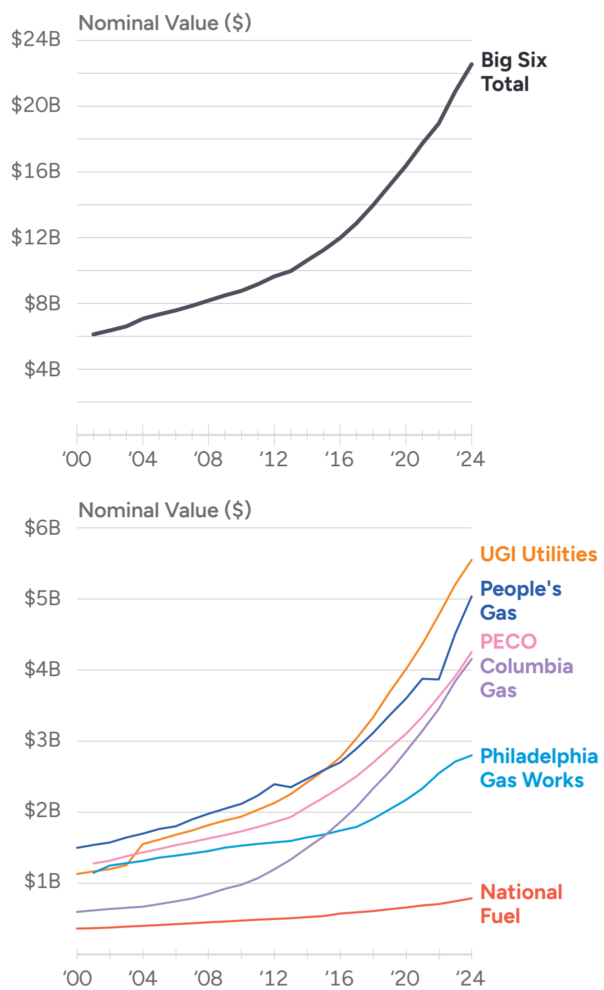
Act 11 enabled a surge of capital spending by allowing utilities to recover pipeline replacement costs more quickly between rate cases, reducing regulatory lag and giving utilities greater certainty that large capital projects would be recovered from customers. This encouraged utilities to ramp up spending on new pipelines, the primary assets on which they earn a rate of return. As of 2024, distribution infrastructure, primarily gas mains and

> **"Pennsylvania's gas system is increasingly defined by a basic mismatch: utilities are making historically high capital investments in gas distribution infrastructure even as customer growth slows and gas use declines or stagnates."**

services, comprised 89 percent of the Big Six's total gas plant. This increased spending dramatically expanded the utilities' overall asset base: collectively, the Big Six more than doubled the gross value of their gas assets from less than $10 billion in 2012 to over $22 billion in 2024.[69] Because gas assets are depreciated over a set time period, this increase represents an increase in utility spending, not appreciation.

This surge in gas assets reflects the significance of these sustained capital expenditures, but it does not demonstrate an equally increasing demand for

Figure 3.3: The value of the gas system in Pennsylvania has grown dramatically from 2000 to 2024, seen by gas utility (bottom) and in total (top).



Data Source: S&P Global Capital IQ and Annual LDC Reports

69 BDC Analysis of utility financials sourced from S&P Global, Capital IQ.

How Act 11 Accelerated Growth in Net Gas Plant

Utilities often frame Act 11 spending as routine replacement of aging pipe. But customer bills are driven by the rate base, which is based on net gas plant (the book value of assets after depreciation). Net gas plant grows when annual capital investment exceeds depreciation. For the utilities analyzed below, net gas plant grew markedly faster after Act 11—consistent with sustained spending above a baseline replacement pace and an expanding customer-funded asset base.

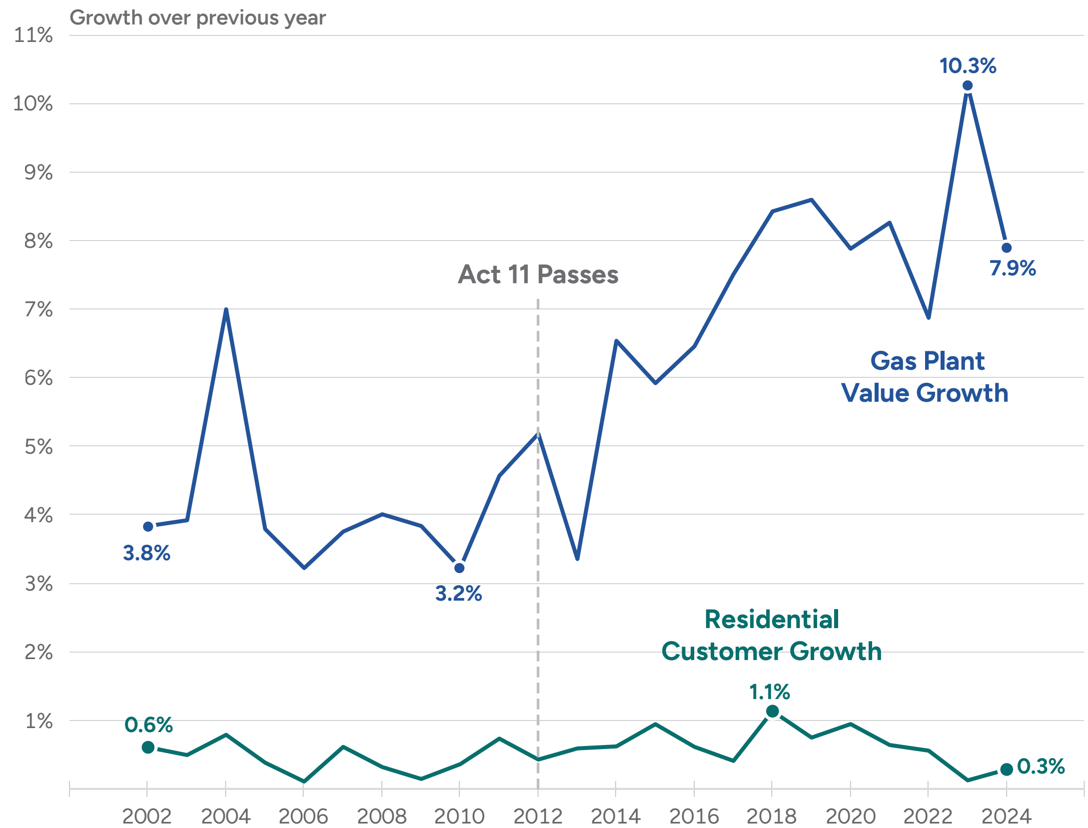
Across these three examples, the municipally owned utility, PGW, shows the slowest growth. Unlike investor-owned utilities, municipal utilities do not earn shareholder returns on capital expenditures, which can change their incentives around system growth.

Note: Net plant data were not consistently available in a comparable form for every utility (e.g., bundled financials for diversified and multi-state utilities), so this callout uses three illustrative examples. The pattern is consistent with the broader finding: accelerated capital programs increased the gas asset base faster than demand and customer growth.

Table 3.1: Average annual growth in net gas plant (book value), before and after Act 11

Utility	Pre–Act 11 (2001–2012)	Post–Act 11 (2013–2024)
PGW	2.2%	4.6%
Columbia Gas	7.6%	12.1%
Peoples Natural Gas	6.7%	15.4%

Figure 3.4: Despite modest customer growth, capital spending on the gas system has doubled the average annual growth rate since Act 11 passed in 2012.



Data Source: S&P Global Capital IQ and EIA

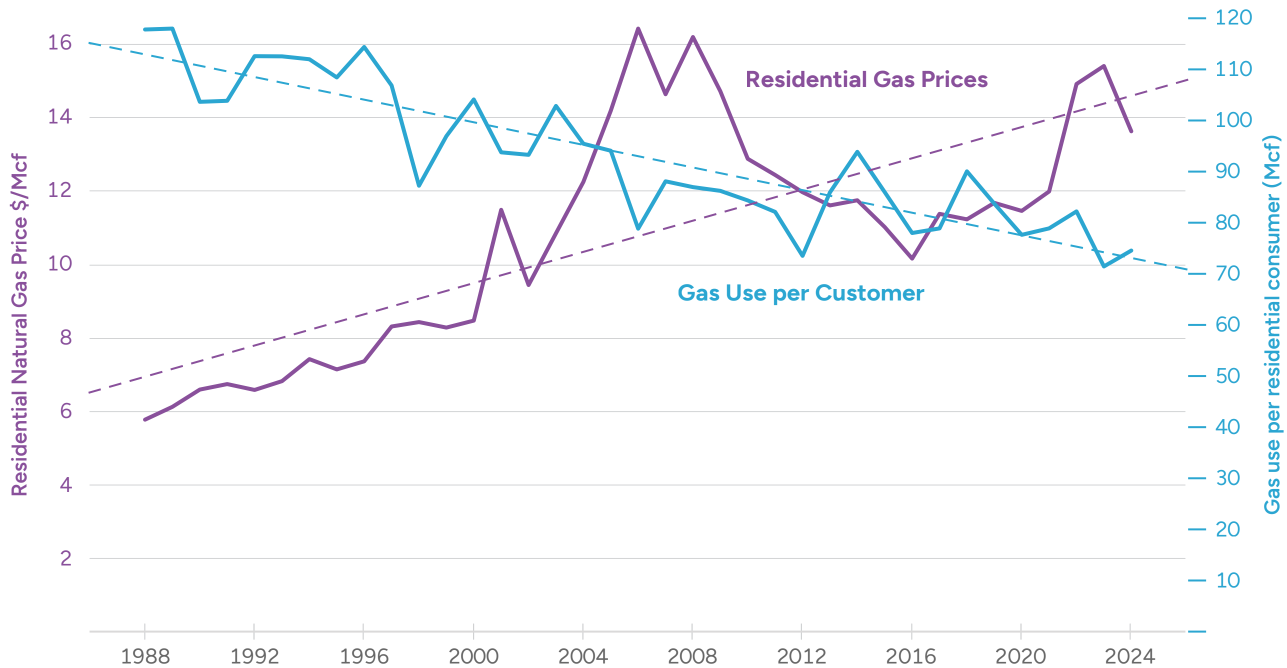
gas service. In fact, when the net gas plant value is examined, it becomes clear that investments are outpacing depreciation as well as demand, producing an increasingly expensive gas system per customer. While utilities often describe their capital investments as "replacement," implying steady-state growth in which an asset removed from service is replaced with a new asset, the recent spending pattern is more like "replacement-plus," as these capital investments have in fact outpaced depreciation and retirements, causing the net gas plant and the resulting rate base (on which bills are built) to grow, even as demand does not. In practice, that means pipeline replacement programs are doing more than swapping like-for-like assets; they are expanding the system's financial footprint and committing customers, who are using the system less and less, to decades of additional cost recovery.

An accelerated investment in gas infrastructure could be justified if it were matched by sustained customer growth. But customer growth across the Big Six has remained weak (and in some cases negative) over the past two decades, averaging just 0.59 percent annually since 2000. As a result, gas assets per customer (all classes) have more than doubled since 2013, reaching $7,150 per customer in 2024, more than $2,000 above the national median.[70] The cost of the gas system is therefore being spread across a customer base that is growing too slowly to absorb it. Some of this investment responds to real public-safety hazards associated with aging gas infrastructure, including leak-prone mains and services. That makes it especially important to distinguish targeted safety spending from broader investment that continues to enlarge the long-term cost burden of the system.

Gas consumption trends reinforce this mismatch between investment and demand. Gas use per customer has declined for decades due to efficiency

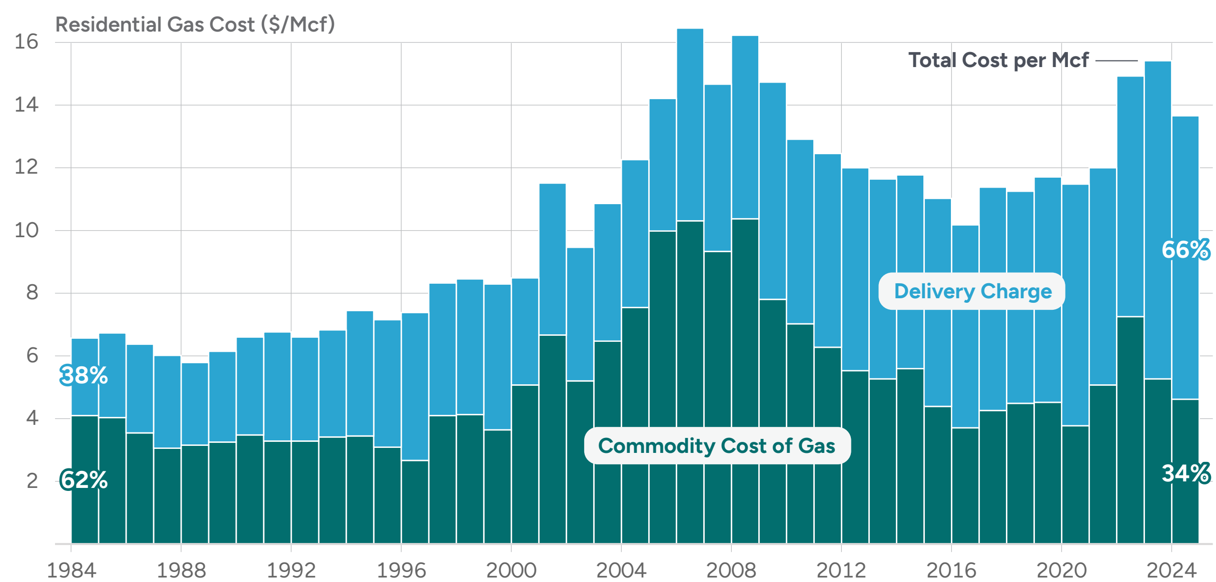
70 American Gas Association, *2021-2023 Performance Benchmarks for Natural Gas Utilities* (American Gas Association, 2025), 26, https://www.aga.org/wp-content/uploads/2024/10/AGA-USR-Benchmarking-Report-2023-Data.pdf.

Figure 3.5: **Recent trends in the delivered cost of gas to the residential sector and average gas use per residential customer show residential customers are paying more while consuming less gas.**



Data Source: EIA

Figure 3.6: **Overall residential gas costs have increased steadily over time, with the majority of the growth coming from delivery charges, which now make up two-thirds of gas bills.**



Data Source: EIA

improvements, warmer winters, and electrification, while gas bills have risen sharply over the same period. This dynamic signals that this once growing system has not only matured, but also entered into a period of decline.

The result is a top-heavy thermal delivery system: an expanding asset base with accelerating capital costs recovered from a relatively stagnant customer base. An increasing share of customer bills now goes toward paying for infrastructure rather than for the gas customers actually use. In 2024, roughly two-thirds of a residential gas bill went to delivery charges, while only one-third went to the gas commodity itself. As delivery charges make up a larger share of the bill, customers have less ability to manage costs through reduced consumption. The next section examines how this expanding asset base translates into customer bills through the utility business model that turns capital spending into long-term revenue requirements.

From Capital Spending to Customer Bills

Capital investments are central to the investor-owned utility business model. Utilities earn a regulated return on approved capital expenditures, so larger portfolios of gas assets increase shareholder earnings. By contrast, lower-cost strategies such as leak repair, maintenance, and demand reduction are generally treated as operating expenses and do not generate returns. Act 11 strengthens this capital-spending incentive by allowing utilities to recover eligible infrastructure costs more quickly between rate cases through bill surcharges. Due in large part to this accelerated cost recovery, analysts have recognized Pennsylvania as especially favorable from the perspective of investors: S&P Global has described the Commonwealth as a "constructive jurisdiction" because of its rate-case structure and accelerated capital recovery.[71] But the same features that reduce delay and uncertainty for utilities also shift costs to customers more quickly, requiring them to pay sooner for infrastructure that may remain in rates long after system use has changed.

71 Lillian Ferderico, *Regulatory Risk a Crucial Factor for US Energy Utility Holding Companies: Part 2* (S&P Capital IQ, 2024), 3.

Fixed vs. Variable Delivery Charges

A gas bill includes delivery charges, which recover infrastructure costs, and commodity charges, which pay for the fuel itself. Bills also include taxes and surcharges.

As shown in the chart above, the proportion of delivery to commodity charges has been shifting since the 1980s, such that today the majority of a customer's bill consists of delivery charges.

Within these delivery charges are two components: fixed and variable charges. **Fixed charges** are flat monthly fees that customers pay regardless of how much gas they use. **Variable charges** are based on usage and are calculated per therm consumed. Regulators determine how much of a utility's approved revenue is recovered through each component. A higher share of fixed charges provides greater revenue stability for utilities, even if gas consumption declines.

Fixed Delivery Charges, often called "customer charges," by Utility (2025, 2026):

PECO Energy	$15.70 [1]
UGI Utilities	$16.25 [2]
Peoples Natural Gas	$16.80 [3]
PGW	$17.25 [4]
Columbia Gas	$20.15 [5]
National Fuel	$14.00 [6]

1 PECO Energy Distribution Company, "PECO Energy Company Gas Service Tariff, Supplement No. 4 to Gas-Pa. P.U.C. No. 6," May 29, 2025, 57, https://www.peco.com/cdn/assets/v3/assets/blt1b5616c79bacadb4/bltf5810f02f744f9c7/684f8d0dcdd80b478782520f/Revised_current_Gas_tariff_No._6_eff_June_1_2025.pdf?branch=prod_alias.
2 UGI Utilities, "UGI Gas Division: Service Tariff No. 7 & Choice Supplier Tariff No. 7S," November 26, 2025, 85, https://ugi.outsystemsenterprise.com/UGITariff_FO/Tariffs?Division=Gas.
3 Peoples Natural Gas Company, "Peoples Natural Gas Retail Tariff No. 48-Supplement No. 19," December 29, 2025, 40, https://www.peoples-gas.com/my-account/understand-my-bill/gas-rates.
4 Philadelphia Gas Works, "PGW Gas Service Tariff Pa. P.U.C. No. 2 Supplement No. 182," March 20, 2026, 83, https://www.pgworks.com/uploads/pdfs/CURRENT_(Full)_PGW_Gas_Services_Tariff_Through_Supp_186_(1Q26_DSIC_Update)(125274601).pdf.
5 Columbia Gas of Pennsylvania, Inc., "Columbia Gas of Pennsylvania, Inc., Supplement No. 409 to Tariff Gas – Pa. P.U.C. No. 9," January 16, 2026, 16.
6 Pennsylvania Public Utility Commission, *Rate Comparison Report*, 35.

Beyond accelerated cost recovery embedded in bill surcharges, capital spending translates into customer bills through rate cases, where the Public Utility Commission determines how much revenue a utility is allowed to collect to provide service. As the value of an investor-owned utility's gas assets grows, so does its rate base, its shareholder returns, and its revenue requirement (the total amount of revenue it is permitted to collect from customers).[72] Because delivery charges are designed to recover that revenue requirement, growth in the rate base translates directly into higher customer bills, even as households use less gas. This dynamic is visible in statewide bill trends: in 2025, the average monthly residential gas bill in Pennsylvania was about $111 year-round, and about $234 during the heating season.[73] Over the past decade, the average year-round residential gas bill increased 67 percent statewide, with utility-specific increases ranging from 48 percent for National Fuel to 94 percent for Columbia Gas.[74]

Due to Pennsylvania's practice of "black box" rate case settlements (explained further later in this chapter), key indicators like approved rate base, revenue requirement, and return on equity are not available to the public in rate case filings, making it more difficult to track trends in utility spending. However, a review of rate cases does allow the tracking of requested rate increases and the resulting bill impacts as modeled by the utilities themselves. For example, UGI's recent rate cases illustrate how seemingly modest rate increases compound over time to increase bills. In its 2015 rate case, UGI requested a $58.6 million increase to its rate base and was approved for $27 million, raising the average residential bill from $51.77 to $56.11 per month.[75] In isolation, an increase of less than four dollars a month may appear modest. But successive rate cases layer these increases on top of one another. By UGI's 2025 rate case, the average monthly bill had doubled to $110.51.[76] In 2026, UGI filed another increase that would raise the average bill to $123.55 per month if approved—a 139 percent increase in little more than a decade.[77]

When capital spending on gas infrastructure grows faster than demand for gas-delivered heat, the cost burden per customer rises. That places upward pressure on rates and increases the likelihood that parts of the system will be underutilized before the end of their useful lives. The result is a growing affordability challenge for the customers who remain on the gas system the longest. This same top-heavy dynamic also increases stranded asset risk. When gas infrastructure remains in rates long after demand has declined and customers begin to exit the system for more affordable alternatives, regulators may eventually face the question of whether those remaining costs should continue to be recovered from customers, be absorbed in part by utility shareholders, or be managed through some other policy mechanism. The longer Pennsylvania continues to add multi-decade gas assets without a clear plan for future system size and utilization, the more difficult those allocation questions become.

72 See "Key Terms" at the beginning of this section for more detailed definitions.

73 *Pennsylvania Public Utility Commission Rate Comparison Report* (Bureau of Technical Utility Services, 2026), https://www.puc.pa.gov/media/3901/rate_comparison_report_2026.pdf.

74 *Pennsylvania Public Utility Commission Rate Comparison Report* (2026) and (2017); See Methodology, "Gas System Dashboard Section" in the appendix for notes on calculation.

75 See UGI Rate Case, D-R-2015-2518438.

76 Pennsylvania Public Utility Commission, "PUC Approves Rate Case Settlement with UGI Gas," PA PUC, September 11, 2025, https://www.puc.pa.gov/press-release/2025/puc-approves-rate-case-settlement-with-ugi-gas-9-11-25.

77 Pennsylvania Public Utility Commission, "PUC to Investigate UGI's Natural Gas Rate Increase Request," PA PUC, February 19, 2026, https://www.puc.pa.gov/press-release/2026/puc-to-investigate-ugi-s-natural-gas-rate-increase-request-02192026.

The Long-Term Cost of Accelerated Gas Investment

Key Takeaways

- From 2013, when the first Long-Term Infrastructure Investment Plans were approved, through 2025, Pennsylvania's Big Six gas utilities have added a little over $11 billion to the gas asset base through accelerated pipeline replacement programs.
- Because these investments are recovered over decades and include financing costs and investor returns, Pennsylvania's $11 billion in Act 11 spending will likely result in total customer costs of roughly $18 to $30 billion over the life of the infrastructure—even if accelerated replacement were to stop after 2025.
- Pipeline replacement costs have risen sharply on a per-mile basis: the average main replacement spend reached $2.8 million per mile, more than double 2014 levels of $1.2 million.
- These costs are not evenly distributed: utility density, timing, ownership structure, and replacement strategy all shape per-customer impacts.

From when the first Long-Term Infrastructure Investment Plans (LTIIPs) were approved in 2013 through the most recent reporting for 2025, Pennsylvania's Big Six gas utilities have spent approximately $11 billion on accelerated pipeline replacement. This investment accounts for most of the growth in their collective gas asset base over this period. Annual gas asset growth increased from an average of 4.3 percent during the business-as-usual period (before Act 11) to 7.8 percent during the accelerated investment period following Act 11, reaching 9.1 percent in 2023 and 2024.

Act 11 helped drive this increase by giving utilities a new pathway to secure Commission approval of pipeline investment plans and begin recovering eligible costs between rate cases. Frequent rate cases mean that some LTIIP costs are incorporated into base rates before much is collected through the DSIC surcharge. Still, approval of a three- to five-year LTIIP reduces regulatory uncertainty by establishing an approved investment framework and pathway to cost recovery.

How Act 11 Accelerated Infrastructure Spending

In practice, these plans allow utilities to pursue multi-year pipeline replacement programs without first demonstrating that continued investment in gas infrastructure is the lowest-cost way to meet Pennsylvania's future thermal needs. In addition, LTIIPs are only required to address the accelerated portion of pipeline replacement spending, not a utility's overall infrastructure replacement and expansion plan, resulting in a piecemeal and uncoordinated view of investments in the gas system as a whole.[78] And because these plans address only a three- to five-year planning horizon, they do not address the ways in which this long-term acceleration of pipeline spending will shape customer costs and infrastructure decisions for decades.

The accelerated spending enabled by Act 11 enters the customers' bills through two ways: first, via a bill surcharge called the Distribution System Improvement Charge (DSIC), which is updated as new infrastructure enters service; and second, through the rate base at the utility's next rate case. Although the DSIC is nominally capped at 5 percent of a utility's distribution rates, the Public Utility Commission may authorize a higher level;[79] Philadelphia Gas Works, for example, was permitted to collect up to 7.5 percent of distribution revenues.[80] When a utility later files a general rate case, DSIC-funded investments are rolled into base rates and the surcharge is reset, but the underlying costs remain embedded in delivery rates for years to

78 For an in-depth critique of LTIIPs specific to PGW see: Seavey, *Philadelphia's Gas Pipe Replacement Plan: How much will it cost and does it make sense* (2023).

79 Pennsylvania General Assembly, "2012 Act 11," The Official Website of the Pennsylvania General Assembly, accessed August 14, 2025, https://www.palegis.us/statutes/unconsolidated/law-information?SessYr=2012&SessInd=0&ActNum=011.

80 See *Petition of Philadelphia Gas Works for Waiver of Provisions of Act 11 to Increase the Distribution System Improvement Charge CAP and to Permit Levelization of DSIC Charges,* Docket No. P-2015-2501500, (Order entered June 9, 2016), pg. 2.

come. As the economist Dorie Seavey has observed of a similar accelerated cost recovery program in Massachusetts, this roll-in process can obscure the cumulative cost of accelerated replacement because newer investments appear in a dedicated surcharge while older ones are absorbed into the broader delivery charge.[81] The result is that customers continue paying for past replacement spending even after the standalone surcharge declines or resets.

For customers, this process obscures the true cost of accelerated pipeline replacement as the surcharge shown on the bill does not capture the full, accumulating burden of those investments. Given that gas mains in Pennsylvania have an average service life of roughly 71 years, each new pipeline installed today can commit customers to decades of future cost recovery before the long-term size of the gas system has been resolved.[82] Added to the fact that Pennsylvania's black box rate cases make it nearly impossible for the public to understand what goes into the rate base and contributes to resulting bill hikes, customers have little to no insight into the pace of accelerated spending and the impact it has on their gas bills.

The Real Customer Cost of Capital Spending

The $11 billion in accelerated capital expenditures by the Big Six represents only the upfront portion of what customers will ultimately pay. Over the decades-long life of a pipeline, utilities recover not only construction costs, but also financing costs, taxes, and—for investor-owned utilities (IOUs)—shareholder returns. As a result, the total revenue collected from customers over the life of a pipeline routinely exceeds its initial capital cost. Seavey describes the long-lived customer burden of past capital investments as the "undertow effect": capital investments remain embedded in utility rate bases for decades, causing customer bills to continue to rise even if new infrastructure spending slows or stops.[83]

Studies of accelerated gas investment in other states suggest that each dollar of capital expenditure can translate into roughly two to three dollars of total customer cost over the life of the asset.[84] Table 3.2 shows illustrative ratios from several jurisdictions.

Table 3.2: CapEx to Total Ratepayer Burden

Jurisdiction	CapEx: Total Ratepayer Burden (Ratio)	Example
Massachusetts	1 : 2.6	~$34.4B total ratepayer burden based on ~$15.9B in capital spending[85]
Maryland	1 : 2.8	~$2.33B total ratepayer burden based on ~$849M in capital spending[86]
Illinois	1 : 1.7	~$170B total ratepayer burden based on ~$100B in capital spending[87]
New York	1 : 2.0	~$6M total ratepayer burden for a ~$3M mile of pipeline[88]

Applying this range (1.7 to 2.8) to Pennsylvania's $11 billion in Act 11 spending suggests total customer costs of roughly $18 to $30 billion over the life of the infrastructure—even if accelerated replacement were to stop after 2025. In practice, however, utilities already have active LTIIPs extending into 2027–2029 and are expected to continue filing new plans on a rolling basis. Meanwhile, Pennsylvania's accelerated replacement framework has no sunset date. As more investment is added to the rate base, it becomes more likely that some assets will remain financially unresolved (i.e. "stranded") as portions of

81 Dorie Seavey, *Rising Massachusetts Gas Bills: What Role Are GSEP and Other Infrastructure Capital Spending Playing?*, LinkedIn, March 23, 2025, https://www.linkedin.com/pulse/rising-massachusetts-gas-bills-what-role-gsep-other-capital-seavey-maxne/.

82 Average based on utilities' Annual Depreciation Reports

83 Dorie Seavey et al., *The Future of Gas in Illinois* (2024), 47, https://buildingdecarb.org/the-future-of-gas-in-illinois.

84 Synapse Energy Economics and Dept. of Energy and Environment, "Formal Case No. 1175: Comments of the District Dept. of Transportation," 2023, 8, https://edocket.dcpsc.org/apis/api/Filing/download?attachId=189594&guidFileName=cf-d288e2-31f0-4744-aae9-64636770dc11.pdf.

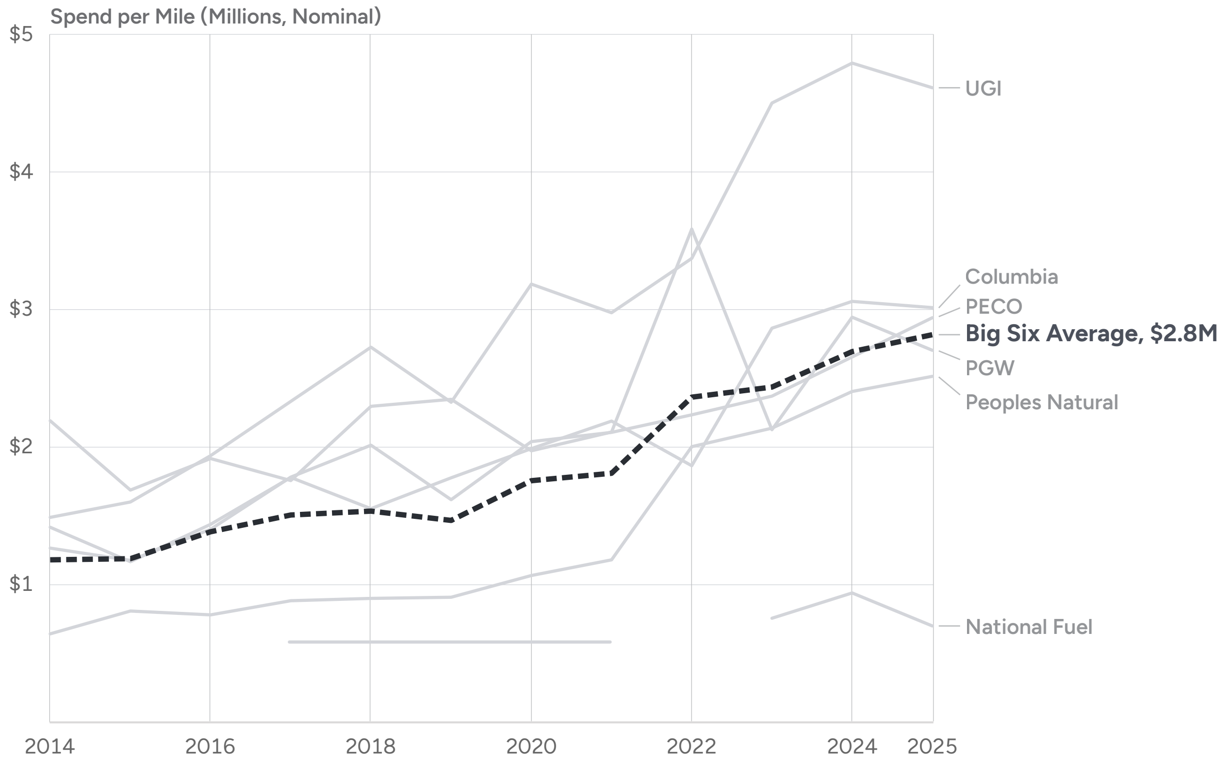
85 Dorie Seavey, "GSEP's Cumulative Costs," GSEP Working Group, October 20, 2023, https://www.mass.gov/doc/seavey-gsep-cost-presentation/download.

86 Office of People's Counsel, State of Maryland, *Maryland Gas Utility Spending, Third Edition* (2025), 39, https://opc.maryland.gov/Portals/0/Files/Publications/Gas%20Utility%20Spending%20Report%20February%202025.pdf?ver=RP_bNtF-Hn7szyL7eLY-Lw%3d%3d.

87 Seavey et al., *The Future of Gas in Illinois*, 9.

88 Michael J. Walsh et al., *The Future of Gas in New York State* (2023), 16, https://buildingdecarb.org/resource/the-future-of-gas-in-nys.

Figure 3.7: **In the past decade, utilities have more than doubled what they are spending to replace a mile of main pipeline; after inflation, the increase so far is 70 percent.**



Data Source: Utility Regulatory Filings. Note: UGI and Columbia report bundled distribution costs, including meters, in their filings

the gas system are retired or underutilized before those costs are fully recovered.

Per-Mile Pipeline Spend

The long-term cost burden of accelerated pipeline replacement is being amplified not only by the scale of investment, but by rising unit costs. In 2025, based on reported spending in utilities' Annual Asset Optimization Plans (AAOPs), the average main replacement spend reached $2.8 million per mile, more than double 2014 levels of $1.2 million. After inflation, this means that average main installation costs have increased roughly 70 percent over the past decade. Applying the same range as above, when investor returns are included, a single mile of new pipeline can ultimately translate into roughly $4.8 to $7.8 million in customer charges over its lifetime.[89]

The amount that utilities spend on main replacements varies substantially across Pennsylvania's gas utilities, as does data availability, as utilities are not required to track or report the metric of "spend per mile," even as it has become an essential metric for comparing utilities.[90] Factors that cause variance in pipeline replacement costs include service density, urban versus rural conditions, pipe material, restoration requirements, and replacement strategy.[91] Despite these disparities, the broader trend is consistent

89 In Pennsylvania, the average service life of a gas main is 71 years, according to the annual depreciation reports filed by the Big Six gas utilities, which means that a pipeline installed today will continue generating returns for decades. Lifecycle analyses consistently show that the total cost to ratepayers of a pipeline is two to three times its upfront capital cost once financing, taxes, and returns are accounted for.

90 While some utilities reported only bundled costs (UGI and Columbia), and therefore may have slightly higher per-mile costs than utilities that broke out main replacement spending from service and meter replacement (Peoples, PGW, National Fuel, PECO), the overall trajectory of growth makes it clear that per-mile replacement costs continue to rise. There is a gap in National Fuel's data; 2017-2021 spending based on business-as-usual spending; 2023-2024 represents accelerated pipeline replacement spending.

91 "Petition of Columbia Gas of Pennsylvania, Inc. for Approval of a Major Modification to Its Existing Long-Term Infrastructure Improvement Plan and Approval of Its Second Long Term Infrastructure Improvement Plan, Docket No, P-2017-," May 5, 2017, 16, https://www.puc.pa.gov/pcdocs/1519764.pdf.

> **“In 2025, new main pipelines installed by the Big Six averaged $40,000 in direct capital costs per connected customer, with some utilities far exceeding that level.”**

Table 3.3: Gas main replacement economics by utility

Data Sources: PHMSA, EIA, and Utility Regulatory Filings

Utility	Customers	Services per mile of main (2024)	Main mile replacement spending ($M), 2025 actual	Main mile replacement spending per customer	Per-mile spending increase since 2014
UGI	700,000	50.3	$4.62	$91,768	209%
Philadelphia Gas Works*	500,000	154.8	$2.71	$17,493	23%
Peoples Natural Gas	700,000	52.5	$2.52	$47,970	289%
Columbia	446,000	57.4	$2.94	$51,298	132%
National Fuel**	215,000	39.9	$0.70	$17,426	70%
PECO	495,000	65.9	$3.02	$45,795	112%

*Earliest available data from 2015

**Earliest available data from 2017

across utilities: pipeline replacement is becoming increasingly expensive.

When these growing costs are divided by the number of connected services, the implications for customer affordability become clear. In 2025, new main pipelines installed by the Big Six averaged $40,000 in direct capital costs per connected customer, with some utilities far exceeding that level.

This variation shows why Pennsylvania’s gas utilities cannot be treated as an undifferentiated group. PGW, for example, has the highest service density in the state, which lowers its direct main-replacement spending per connected customer relative to lower-density utilities such as UGI. That density advantage does not eliminate PGW’s challenges: it still faces legacy urban infrastructure, concentrated affordability pressures, and a very large stock of aging leak-prone mains and services. As of 2021, 60 percent of PGW mains were considered leak prone, 70 percent were more than 40 years old, and 18 percent of services were leak prone, with virtually all of the problematic services made of bare or unprotected steel.[92] Its municipal ownership, however, may give it more latitude to pursue planned retirement, reinvestment, or non-pipeline alternatives than investor-owned utilities. Lower-density systems, by contrast, often face much higher replacement costs per customer because each mile of pipe serves fewer customers, which can make non-pipeline alternatives more economically attractive than like-for-like replacement.

92 Dorie Seavey, *Philadelphia’s Gas Pipe Replacement Plan: How Much Will It Does and Does It Make Sense?* (HEET, 2023), 8, https://assets-global.website-files.com/649aeb5aaa8188e00cea66bb/64ed-1923d85ca415b290215e_Report_PGW-pipeline-replacement-costs.pdf.

Table 3.4: BDC Analysis of Filed LTIIP Accelerated Costs, 2013-2025

Utility	Customers (all classes)	Projected customers in 30 years*	Direct LTIIP costs to date, 2013-2025 ($M)	Estimated total costs by estimated total lifecycle cost for mains** ($M)		Estimated total lifecycle costs per customer**	
				($M) LOW	($M) HIGH	($) LOW	($) HIGH
UGI	700,000	828,000	$2,431M	$4,132M	$6,806M	$4,991	$8,220
Philadelphia Gas Works (PGW)	500,000	591,000	$408M	—	—	—	—
Peoples Natural Gas	700,000	828,000	$3,137M	$5,333M	$8,783M	$6,440	$10,608
Columbia	446,000	527,000	$3,360M	$5,711M	$9,407M	$10,837	$17,849
National Fuel	215,000	254,000	$130M	$220M	$363M	$867	$1,428
PECO	495,000	585,000	$1,546M	$2,628M	$4,328M	$4,492	$7,399
Total	3,056,000	3,613,000	$11,010M	$18,024M	$29,687M	$4,989	$8,217

*Projection assumes 0.56% annual growth rate, based on past 20 years of customer growth in Pennsylvania, per EIA.

**Based on the projected average lifetime of a pipeline (71 years). High and low estimates based on average ratio of direct costs to total costs of 1.7 to 2.8 as discussed in the section "The Real Customer Cost of Capital Spending."

LTIIP Costs by Utility

The Big Six's pipeline spending and costs have continued to increase over time, with a marked acceleration following the passage of Act 11 in 2012. A closer look at accelerated pipeline replacement spending recorded in the utilities' LTIIPs and AAOPs brings the near- and long-term effects of this investment cycle into clearer view. Table 3.4 summarizes direct LTIIP spending on accelerated replacements to date and estimated lifecycle costs across the Big Six.[93] Utilities that began accelerated replacement earlier and at a larger scale, such as Columbia and Peoples, show substantially higher projected per-customer burdens over the full lifetime of the investments than utilities with more recent programs. National Fuel, for example, began its first LTIIP only in 2023 and therefore shows much lower costs to date.

Philadelphia Gas Works (PGW) is shown in Table 3.4 but excluded from the lifecycle cost estimates because, as a municipal utility, it does not earn regulated shareholder returns and therefore cannot be compared with investor-owned utilities. Its inclusion nonetheless underscores that Pennsylvania's gas utilities should be understood as a set of related but not identical systems, with different ownership structures and cost dynamics.

The figures presented reflect only accelerated replacement spending through 2025 and do not account for future LTIIP filings, baseline capital spending, or subsequent expansions of eligible infrastructure—all of which would further increase customer obligations.

These figures show that accelerated pipeline replacement is producing both large aggregate costs and highly uneven customer burdens across utilities. In other states, even smaller projected cost burdens have prompted growing scrutiny of replacement programs, leading regulators and lawmakers to narrow eligible investments, strengthen oversight, and require closer consideration of alternatives.

93 While some LTIIPs (e.g. PGW) also include "baseline" pipeline replacements in their reports, we do not include baseline replacements costs–only accelerated costs enabled by Act 11.

Gas System Expansion Subsidies

Table 3.5: Line Extension Allowance Policies for the Big Six Gas Utilities

Utility	Allowance for new gas connections (as of January 2025)	Calculation Method	Reference
Columbia Gas of Pennsylvania	≤ 150 ft	Footage Allowance[1]	Gas Service Tariff (p. 48)
PECO Energy Company	up to the full extension	NPV[2]	Gas Service Tariff (p. 13)
Peoples Natural Gas Company	≤ 150 ft	Footage Allowance[3]	Gas Service Tariff (p. 23)
UGI Utilities	≤ 150 ft	Footage Allowance[4]	UGI Gas Division: Gas Service Tariff No. 7 & Choice Supplier Tariff No. 7S (p. 35)
Philadelphia Gas Works	up to the full extension	Revenue/Margin Multiplier[5]	Gas Service Tariff (p. 50)
National Fuel Gas Distribution	up to the full extension	Revenue/Margin Multiplier[6]	Gas Service. Tariff (p. 10)

Accelerated pipeline replacement is not the only mechanism through which Pennsylvania's gas policy continues to add long-lived assets to the system. Utilities also maintain line extension allowances (LEAs), which can allow new customers to connect at little or no upfront cost, with unrecovered infrastructure costs embedded in rates and recovered from existing customers over time.

Historically, these subsidies were justified on the premise that customer growth would improve system utilization and spread fixed costs more broadly. But in a context of modest account growth, lower gas use per customer, and rising replacement costs, subsidizing new connections no longer clearly improves system economics. Instead, it can add new long-lived assets and extend customer exposure to future cost recovery.

As per-mile installation costs rise and lifecycle costs far exceed initial capital expenditures, subsidizing new gas connections takes on greater financial significance. Each new extension adds infrastructure that can remain on customer bills for decades, even as demand growth remains weak and system utilization becomes more uncertain.

1 Columbia Gas of Pennsylvania, Inc., "Columbia Gas of Pennsylvania, Inc., Supplement No. 409 to Tariff Gas – Pa. P.U.C. No. 9," 48.
2 PECO Energy Distribution Company, "PECO Energy Company Gas Service Tariff, Supplement No. 4 to Gas-Pa. P.U.C. No. 6," 13.
3 Peoples Natural Gas Company, "Peoples Natural Gas Retail Tariff No. 48-Supplement No. 19," 23.
4 Columbia Gas of Pennsylvania, Inc., "Columbia Gas of Pennsylvania, Inc., Supplement No. 409 to Tariff Gas – Pa. P.U.C. No. 9," 35.
5 Philadelphia Gas Works, "PGW Gas Service Tariff Pa. P.U.C. No. 2 Supplement No. 182," 50.
6 National Fuel Gas Distribution Corporation, *Rates, Rules and Regulations Supplement No. 286 to Gas – Pa. P.U.C. No. 9*, no. 9 (June 2025): 10, https://www.nationalfuel.com/wp-content/uploads/documents/PATariff20250701.pdf.

Pennsylvania's Accelerated Pipeline Replacement Program in Regional Context

Key Takeaways

- Pennsylvania's accelerated pipeline replacement framework is broader in scope and longer in duration than comparable programs in neighboring states.
- Peer programs in Massachusetts, Maryland, and Washington, D.C. were more explicitly tied to a finite set of leak-prone materials or climate objectives, rather than open-ended system modernization.
- As costs rose and as system utilization weakened, several peer jurisdictions revisited, narrowed, or constrained their accelerated replacement programs.
- Pennsylvania has not undertaken a comparable review of cumulative spending, lifecycle costs, or continued system need since Act 11 was enacted.

Accelerated pipeline replacement programs are not unique to Pennsylvania. According to the American Gas Association, as many as 43 states and Washington, D.C., have had some form of accelerated pipeline replacement program enabled by an accelerated cost recovery mechanism.[94] Programs in Massachusetts, Maryland, and Washington, D.C., are especially useful comparisons because they were adopted around the same period as Pennsylvania's Act 11 and were similarly justified as a response to public safety concerns associated with aging, leak-prone gas infrastructure.

Those safety concerns reflect the real hazards of operating pipelines filled with combustible fuel. Methane leaks can be dangerous and harmful to health, and distribution-system failures tied to corrosion or equipment, material, or maintenance problems continue to cause fatalities, injuries, and property damage. Nationally, from 2010 to 2020, there were 256 significant distribution pipeline incidents attributable to those causes, resulting in 13 fatalities, 161 inpatient injuries, and an estimated $1.7 billion in total costs.[95] In Pennsylvania, safety concerns are especially relevant in legacy urban systems such as PGW, which still contains a large stock of aging leak-prone mains and services. The policy question is not whether safety risks should be addressed, but whether accelerated replacement programs are sufficiently targeted to the highest-risk infrastructure and whether alternatives are evaluated before customers are locked into decades of additional gas system costs.

How Peer Jurisdictions Have Responded

In Massachusetts, Maryland, and Washington, D.C., regulators and lawmakers have begun to evaluate whether continued replacement is delivering proportionate safety benefits and whether gas system reinvestment remains aligned with climate and affordability goals. Several have required non-pipeline alternative evaluation, reduced cost caps, or otherwise constrained program scope to protect customers from mounting costs.

Pennsylvania has not made comparable reforms. Act 11 remains broad in scope and unbounded in duration. Rather than limiting accelerated recovery to a narrow set of high-risk pipes, requiring non-pipeline alternative evaluation, or setting a defined replacement horizon, Act 11 defines eligible infrastructure broadly. Eligible costs include those "related to the repair, improvement and replacement of eligible property to enable safe, adequate, reliable, and reasonable service," with eligible property encompassing mains and service lines, meters, relocation costs, and other capitalized expenses.[96] In practice, this broad eligibility allows utilities to continue accelerating capital investment across an

94 Christina Sames, "Pipeline Safety Hearing Energy and Commerce AGA Letter," American Gas Association, January 17, 2024, https://www.aga.org/wp-content/uploads/2024/02/Pipeline-Safety-Hearing-Energy-and-Commerce-AGA-LETTER-January-17-2024-FINAL.pdf.

95 Dorie Seavey, *Leaked & Combusted: Strategies for Reducing the Hidden Costs of Methane Emissions and Transitioning off Gas* (2024), 17, https://assets-global.website-files.com/649aeb5aaa8188e00cea66b-b/65f36ba611a3ba1f964fc783_Leaked-and-Combusted.pdf.

96 Pennsylvania Consolidated Statutes, "Chapter 13. - Title 66 - Public Utilities," July 1, 1978, https://www.legis.state.pa.us/WU01/LI/LI/CT/HTM/66/00.013..HTM.

expansive set of gas assets with no end date, turning accelerated replacement into the new business-as-usual approach to gas system growth.

The breadth of Pennsylvania's framework is evident not only in statute but in utility practice. Columbia Gas, for example, has used a "systemic rather than segment" replacement strategy that replaces non-priority pipe alongside higher-risk segments:[97] Between 2018 and 2024, 42 percent of Columbia's annual replacements were non-priority pipe.[98] While the utility argues that this approach captures economies of scale, it also illustrates how Pennsylvania's framework can extend far beyond the original safety rationale for replacing the highest-risk infrastructure. At the same time, this neighborhood-scale approach highlights where NPAs could be evaluated instead of defaulting to like-for-like gas replacement, even though Act 11 does not require utilities to consider them. In addition, the category of infrastructure considered eligible for accelerated replacement has continued to expand. In 2024, for example, the Public Utility Commission designated pre-1982 Aldyl-A plastic pipe as leak-prone due to embrittlement risks,[99] further widening the net of eligible replacement.

Table 3.6 compares the core design features of accelerated replacement programs in Pennsylvania, Massachusetts, Maryland, and D.C. What distinguishes Pennsylvania is not that peer programs avoided cost escalation altogether but that as costs mounted and questions about long-term gas system need accumulated, those jurisdictions responded by narrowing eligibility, imposing clearer limits on cost recovery or duration, and requiring more rigorous evaluation of alternatives. Pennsylvania's Act 11 framework remains unusual in allowing accelerated recovery across a broad set of assets, with DSIC surcharges of up to 5 percent and precedent for higher levels, but no sunset date or cumulative projected spend, unlike several comparable programs in other states.

Across the region, accelerated replacement programs have followed a recognizable pattern: initial justification on safety grounds followed by rising costs, closer scrutiny, and, in several cases, program reform. Pennsylvania remains an outlier because it has not yet imposed comparable limits or undertaken a comparable reassessment as costs have grown. Act 11 continues to permit open-ended accelerated investment without requiring utilities to demonstrate that continued gas reinvestment is the most cost-effective way to meet evolving thermal needs. Rather than adjusting investment as demand weakens, Pennsylvania's framework continues to favor capital expansion, leaving customers exposed to rising costs. Those rising costs do not remain confined to utility balance sheets or regulatory filings. They are translated into customer bills through rate design and cost-recovery mechanisms, while the state's consumer protection framework is left to manage the consequences. The next section therefore shifts from Act 11 itself to the broader affordability, transparency, and ratemaking issues that determine how those costs are allocated, how visible they are to the public, and how much risk customers ultimately bear.

97 "Petition of Columbia Gas of Pennsylvania, Inc. for Approval of a Major Modification to Its Existing Long-Term Infrastructure Improvement Plan and Approval of Its Second Long Term Infrastructure Improvement Plan, Docket No, P-2017-," 18.
98 Based on BDC analysis of Columbia AAOPs.
99 Docket No. M-2024-3050313: https://www.puc.pa.gov/pcdocs/1846022.pdf

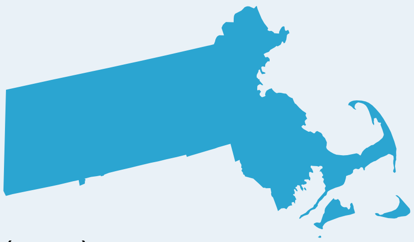
Table 3.6: Regional Comparison of Accelerated Pipeline Replacement Programs

State	Original Legislation / Code	Year passed	Utilities Eligible	Plan Proposal Increments	Criteria	Spending Cap	Time Horizon	Capital Spend to Date (last reported)	Projected Spend at program completion
PA	Act 11: 66 PA Cons Stat § 1350-60 (2024) 52 Pa. Code § 121.3(a)(3)	2012	All Distribution systems (Gas, Electric, Water & Wastewater)	Approval required at least every 5 years	Costs related to the repair, improvement and replacement of eligible property to enable safe, adequate, reliable, and reasonable service	Cap: 5% of of distribution rates, as a bill surcharge; with petition for higher cap allowed	No end date*	$11B (2025)	No “completion” estimate for all utilities*
D.C.	Regulatory Approval(Order No. 17602)	2014	Washington Gas and Light	3-5 years	To enhance overall system resiliency, reliability, and safety and help reach climate goals	No built-in cap; approved on case-by-case basis	2054	$341M (2024)	$4B direct costs ($8-12B including investor returns)
MA	GSEP: MA Gen L ch 164 § 145 (2023)	2014	Gas	6 years, with timeline for removing all leak-prone infrastructure	Improve public safety or reliability; potential to reduce GHGs by reducing system leaks Amended in 2022: may include use of advanced leak repair technology and non-gas-pipeline alternatives, incl. thermal energy networks	Cap: 2% of the company’s total revenue (down from 3% in 2025 and phasing down to 1.5% in 2027), expressed as a bill surcharge	Through 2039	$6.2B (2024)	$41.8B (including returns)
MD	STRIDE: MD Public Utilities Code § 4-210 (2024)	2014	Gas	5 years	Improve public safety or reliability; potential to reduce GHGs by reducing system leaks	Cap: $2 mo. res. customer surcharge	2043	$2.1B (2024)	$9.3B direct costs

*PGW has a projected end date of 2058 for its cast iron replacement; however there is no specification in Act 11 itself that would prevent them from extending this date or enacting a new wave of accelerated cost recovery for other types of pipe.

Reform Activity for Accelerated Pipeline Replacement Programs

The following state snapshots demonstrate how Massachusetts, Maryland, and D.C. have responded as accelerated replacement programs became more expensive and more contested over time.



Massachusetts: Reforming an Overextended Program

- **Program:** Gas System Enhancement Plan (GSEP)
- **Authorized:** 2014
- **Original purpose:** Improve public safety or reliability; potential to reduce GHGs by reducing system leaks

Spending and Impacts

- Initially intended to replace ~6,200 miles of leak-prone gas main between 2015–2039 with a budget of $4.2 billion
- By 2025, direct spending had reached $5.6 billion, less than halfway through the planned replacement period[1]
- Average replacement costs exceeded $3 million per mile
- Revised projections estimate $15.9 billion in direct capital spending by 2039—nearly four times the original estimate[2]
- Total lifetime cost to ratepayers projected to reach $34.4 billion once financing and returns are included;[3] this translates to lifetime bill payments of more than $31,000 per gas customer.[4]

Response and reform[5]

- Legislature and regulators changed eligible investments to include NPAs
- Annual spending cap reduced
- Cost oversight strengthened
- Utilities required to evaluate non-gas-pipeline alternatives to gas main replacement

1 Massachusetts D.P.U., "D.P.U. 24-GSEP-03: Petition of Boston Gas Company d/b/a National Grid for Approval of Its 2025 Gas System Enhancement Plan, Pursuant to G.L. c. 164, § 145, for Rates Effective May 1, 2025," April 30, 2025, 30–32.
2 Seavey, "GSEP's Cumulative Costs."
3 Seavey, "GSEP's Cumulative Costs."
4 Dorie Seavey, *Rising Massachusetts Gas Bills: What Role Are GSEP and Other Infrastructure Capital Spending Playing?*, LinkedIn, March 23, 2025, https://www.linkedin.com/pulse/rising-massachusetts-gas-bills-what-role-gsep-other-capital-seavey-maxne/.

5 "GSEPs Pursuant to 2014 Gas Leaks Act," Mass.Gov, accessed January 12, 2026, https://www.mass.gov/info-details/gseps-pursuant-to-2014-gas-leaks-act.

Maryland: Tightening STRIDE as Costs Rose

- **Program:** Strategic Infrastructure Development and Enhancement (STRIDE)
- **Authorized:** 2013
- **Original purpose:** Accelerate replacement of aging and leak-prone gas infrastructure

Spending and impacts[6]

- Total past and projected STRIDE spending from 2014–2043 estimated at $9.3 billion
- STRIDE costs embedded directly in customer bills through a flat monthly surcharge, shifting recovery outside general rate cases

Response and Reform

- Growing concern from advocates and regulators about rising bills and risk shifting to customers
- Enactment of reforms through the Next Generation Energy Act (2025)
- Utilities now required to:
    - Demonstrate pipeline replacement is necessary for safety or reliability
    - Show that NPAs were evaluated and found insufficient
    - Submit more detailed infrastructure plans for Commission approval prior to cost recovery

6 Office of People's Counsel, State of Maryland, *Maryland Gas Utility Spending, Third Edition*, 21.

Washington, D.C.: Reassessing PROJECTpipes

- **Program:** PROJECTpipes (refiled in 2024 as the SAFE Plan)
- **Authorized:** 2014
- **Original purpose:** Replace leak-prone infrastructure

Spending and Impacts[7]

- Direct capital costs estimated at $1.3–$2.0 billion
- Total long-term ratepayer costs projected at $8–$12 billion including financing and returns
- Originally structured as a multi-decade investment extending into the 2050s

Response and Reform

- Increasing scrutiny as costs escalated and climate misalignment became more pronounced
- In June 2024, the D.C. Public Service Commission rejected Washington Gas's proposed $671.8 million Phase 3 expansion
- The utility refiled a scaled-back $215 million, three-year proposal (the SAFE Plan)
- The Commission extended the surcharge only temporarily, imposing a strict $34 million spending cap through 2025
- Debate over whether the utility's JANA risk model accurately prioritizes high-risk pipe and maximizes risk reduction per dollar spent
- District government testimony argues the utility failed to adequately evaluate NPAs, such as electrification, and has not demonstrated that continued accelerated replacement minimizes stranded asset risk

7 Synapse Energy Economics and Dept. of Energy and Environment, "Formal Case No. 1175: Comments of the District Dept. of Transportation," 8.

Affordability, Transparency, and Revenue Stabilization

Key Takeaways

- Low disconnection rates in Pennsylvania reflect strong consumer protections, not necessarily affordable gas service.
- Pennsylvania's heavy reliance on "black box" rate case settlements limits transparency into authorized returns and the treatment of gas infrastructure costs.
- Alternative ratemaking mechanisms such as weather or revenue normalization can further insulate utilities from declining demand while increasing customer bill exposure.

Pennsylvania has one of the strongest sets of utility consumer protection policies in the country. For gas customers, Chapters 14 and 56 of the Public Utility Code require advance notice before termination, payment arrangements tied to ability to pay, billing-dispute protections, winter shut-off protections for income-qualified households, medical certification safeguards, and additional protections for households enrolled in Customer Assistance Programs (CAPs). Together, these policies help preserve service continuity and reduce involuntary shut-offs.

As a result of these protections, gas service disconnections remain relatively limited, even as financial distress among customers is widespread. Between 2022 and 2024, annual gas service terminations ranged from approximately 3 to 5 percent of residential customers.[100] In 2024, fewer than 1 in 20 households experienced a shut-off.[101] At the same time, however, nearly 1 in 4 households were considered low-income, almost 1 in 11 carried utility debt, and additional indicators of payment distress continue to rise.[102] This constellation of metrics demonstrates that relatively low disconnection rates in and of themselves do not signal an affordable gas system; rather, they reflect the effectiveness of legal safeguards that delay or prevent shut-offs while allowing customers to remain connected despite mounting financial strain.

A broader set of affordability metrics reveals a more concerning picture. Between 2022 and 2024, the number of payment-troubled residential gas customers, defined as customers who failed to maintain at least one payment arrangement over a one-year period, increased by 17.7 percent, outpacing payment-troubled electric customers.[103] Over the same period, 5.6 percent of households had active payment arrangements with their utility and nearly 9 percent of residential gas customers owed money to utilities (excluding CAP participants). Although average arrearage balances declined modestly during this same period—potentially reflecting the stabilizing role of CAP for enrolled households—the overall scale of payment distress remains significant.

These trends show that payment arrangements and shut-off protections function as temporary stabilizers rather than durable solutions to rising gas bills. Legal safeguards reduce disconnections, but many households remain under significant financial strain. Customers continue to cycle through payment plans, accrue arrearages, or rely on assistance programs that address short-term crises without reducing the underlying cost pressures built into gas bills. As delivery charges grow, affordability challenges deepen, particularly for low-income

> **"These trends show that payment arrangements and shut-off protections function as temporary stabilizers rather than durable solutions to rising gas bills."**

100 Pennsylvania Public Utility Commission, *Universal Service Programs & Collections Performance 2024.*
101 *Universal Service Programs & Collections Performance 2024.*
102 *Universal Service Programs & Collections Performance 2024.*
103 *Universal Service Programs & Collections Performance 2024.*

households and communities with high energy burdens. These affordability pressures are intensified by ratemaking mechanisms that reduce the link between how much gas customers use and how much revenue utilities recover.

Revenue-Stabilizing Mechanisms

These affordability pressures are intensified by ratemaking mechanisms that reduce the link between how much gas customers use and how much revenue utilities recover. In addition to traditional ratemaking, Pennsylvania gas utilities have proposed or used mechanisms that stabilize utility revenues when gas sales fluctuate or decline. These mechanisms are often justified as tools to manage volatility or reduce regulatory lag, but they can also weaken the connection between customer usage and customer bills.

Weather Normalization Adjustment

The Weather Normalization Adjustment (WNA) allows utilities to adjust customer bills when gas usage deviates from historical weather norms. In practice, it allows utilities to recover revenue during warmer-than-average winters, even when customers use less gas.[104] As winters warm, this mechanism increasingly functions less as a neutral weather adjustment and more as a revenue-stabilizing tool. In Columbia Gas's recent rate case, Administrative Law Judges recommended ending the WNA pilot after finding that it imposed substantial net costs on customers while providing limited offsetting benefits. Since the 2019–2020 heating season, the pilot produced net customer surcharges totaling $78.9 million—more than 16 times the amount credited to customers.[105] The judges also raised concerns that the WNA permits bill adjustments outside traditional rate cases, weakens conservation incentives, and can require customers to pay for gas they did not use.[106]

104 Pennsylvania Public Utility Commission, "Recommended Decision, R-2025-3053499," October 3, 2025, 490.
105 Pennsylvania Public Utility Commission, "Recommended Decision, R-2025-3053499," 44.
106 Pennsylvania Public Utility Commission, "Recommended Decision, R-2025-3053499," 491.

Revenue Normalization Adjustment

Columbia Gas has also repeatedly proposed a Revenue Normalization Adjustment (RNA), which would allow recovery of a predetermined level of revenue regardless of actual gas sales.[107] The Commission has rejected these proposals, noting that utilities already benefit from multiple revenue-stabilizing mechanisms—including fixed customer charges, purchased gas adjustments, and the DSIC—and that no clear customer benefit has been demonstrated.[108] Like the WNA, an RNA would increase revenue certainty for utilities while weakening the connection between customer usage and customer bills.

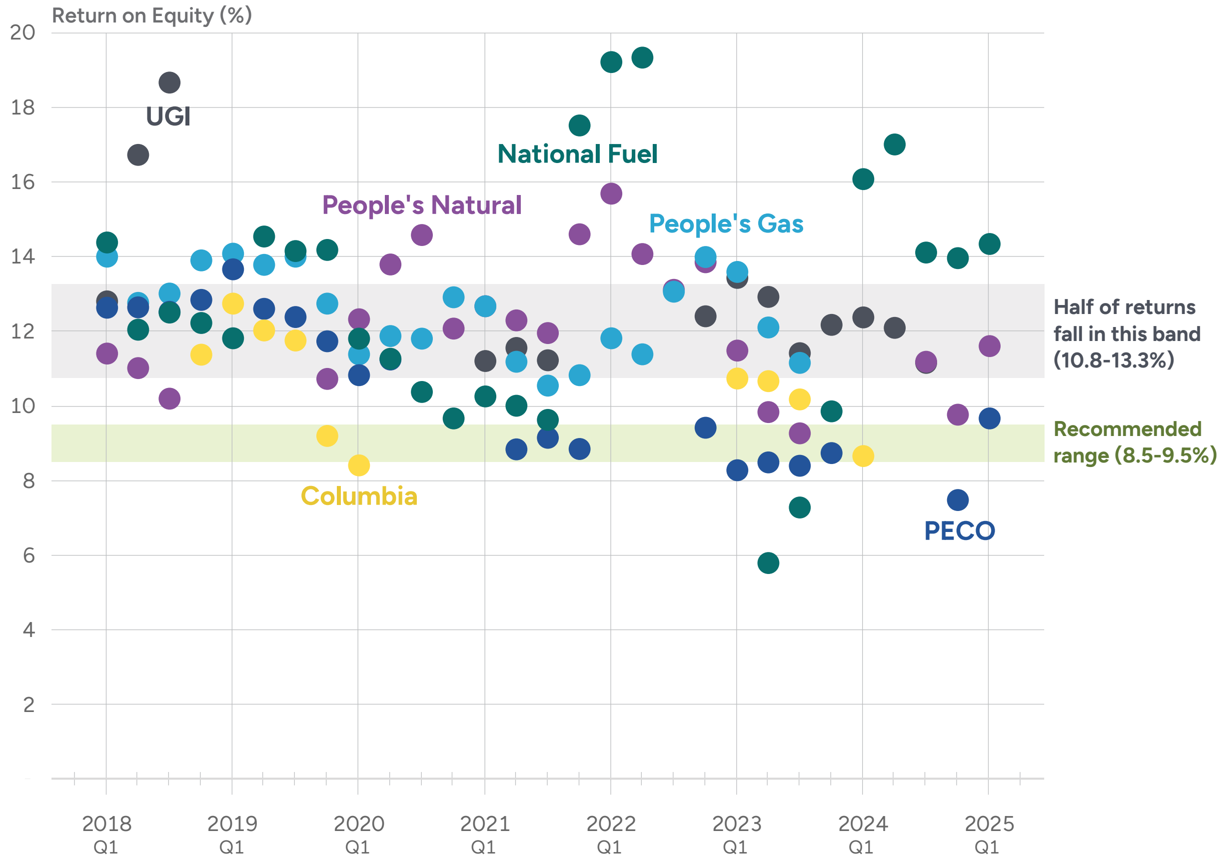
These alternative ratemaking proposals reflect a broader push to stabilize utility revenues as gas demand becomes less predictable. In practice, they can exacerbate affordability challenges by reducing the extent to which lower usage produces lower bills and by insulating utility revenues from warmer winters or declining sales. Revenue-stabilizing mechanisms are only one part of the ratemaking framework that shapes customer bills. Rate case settlements also determine how infrastructure costs, utility earnings, and customer impacts are approved, but Pennsylvania's reliance on black box rate case settlements makes those decisions difficult to evaluate.

Black Box Rate Case Settlements and Limited Rate Transparency

Pennsylvania relies heavily on "black box" rate case settlements, which resolve cases without publicly disclosing how key components such as the return on equity (ROE) are determined.[109] In practice, nearly all gas rate cases in the past three decades have been resolved this way.[110] While the Commission views black-box settlements as an efficient

107 Pennsylvania Public Utility Commission, "Recommended Decision, R-2025-3053499," 498.
108 Pennsylvania Public Utility Commission, "Recommended Decision, R-2025-3053499," 498.
109 Daniel Rothberg, "Southwest Gas Is Looking to Raise Rates. What Should Customers Pay For?," *The Nevada Independent*, February 17, 2022, https://thenevadaindependent.com/article/southwest-gas-is-looking-to-raise-rates-what-should-customers-pay-for.
110 Lillian Federico, "UGI and Intervenors Reach Agreement in Pa. Gas Rate Case," *Commodity Insights, S&P Global Market Intelligence*, July 18, 2025, https://www.capitaliq.spglobal.com

Figure 3.8: Quarterly Return on Equity (ROE) for the Big Six gas utilities, 2018-2025. Based on low-risk investments in utilities, Pennsylvania's consumer advocate office recommends 8.5-9.5% return on equity.[1]



Data Source: March 31, 2025 Quarterly Earnings Report, Attachment A.[2]

1 Phillips, "PECO's Profits Skyrocket Almost 50% after 2025 Rate Hikes."
2 Bureau of Technical Utility Services, "Bureau of Technical Utility Services Report on the Quarterly Earnings of Jurisdictional Utilities for the Year Ended June 30, 2025," 9.

regulatory tool,[111] this approach to ratemaking limits transparency into how much profit is embedded in delivery rates and how capital investments are being judged for reasonableness.

Available earnings data nonetheless indicate that gas utilities continue to earn robust returns. Quarterly Earnings Summary Reports published by the PUC show that gas utilities typically earn between 10 and 15 percent on common equity, with some quarters exceeding authorized benchmarks.[112] These reports also disclose the Commission-approved ROE for the DSIC, which is adjusted quarterly and not shielded by black box settlements. As of early 2025, the approved DSIC ROE for gas utilities (10.25 percent) exceeds that approved for electric and water utilities.[113]

Mark Ellis, a former utility sector executive who now advocates for ROE to be on par with the cost of capital for utilities, states that Pennsylvania utilities (gas and electric) have "the highest profit margins in the country" with an average ROE of 12.8 percent, which "costs Pennsylvania gas and electric ratepayers about $2 billion a year."[114] In contrast, Darryl Lawrence, Pennsylvania's Consumer Advocate, argues that an ROE should

111 Pennsylvania Public Utility Commission, "Veolia Water Pennsylvania, Inc. Settlement, R-2024-3045192, R-2024-3045193," n.d., 19, accessed October 23, 2025, https://www.puc.pa.gov/pcdocs/1847033.pdf.
112 Bureau of Technical Utility Services, "Bureau of Technical Utility Services Report on the Quarterly Earnings of Jurisdictional Utilities for the Year Ended June 30, 2025," 2025, https://www.puc.pa.gov/pcdocs/1888003.pdf.
113 Bureau of Technical Utility Services, "Bureau of Technical Utility Services Report on the Quarterly Earnings of Jurisdictional Utilities for the Year Ended June 30, 2025."
114 Susan Phillips, "PECO's Profits Skyrocket Almost 50% after 2025 Rate Hikes," *WHYY News Climate Desk*, February 25, 2026, https://whyy.org/articles/peco-rate-hikes-profits/.

> **Pennsylvania utilities (gas and electric) have "the highest profit margins in the country" with an average ROE of 12.8 percent, which "costs Pennsylvania gas and electric ratepayers about $2 billion a year"**

be significantly less, closer to 8.5 to 9.5 percent.[115] Figure 3.8, which collects the reported quarterly ROE for Pennsylvania utilities, shows that since 2018, half of the reported ROEs fell into the 10.8-13.3 percent range, with one quarter exceeding this band and one quarter falling below it.

The Commission's market-indicated ROE (a benchmark calculated by the Bureau of Technical Utility Services based on peer utilities) has also increased over time. For gas utilities, the range rose from 7.89–9.04 percent in 2013[116] to 9.53–12.02 percent in 2025,[117] increasing the benchmark for what is considered a reasonable level of return. As that proxy range rises, so does the level of profit that can be incorporated into customer rates.

Rising market-indicated ROEs and limited transparency around allowed returns reinforce a ratemaking framework that rewards capital expansion rather than cost containment. Because earnings are tied to infrastructure investment rather than delivery of affordable thermal service, higher ROEs increase the financial appeal of continued pipeline replacement even as gas demand declines. The result is a system in which customer bills can continue rising even as households use less gas.

115 Phillips, "PECO's Profits Skyrocket Almost 50% after 2025 Rate Hikes."

116 Bureau of Technical Utility Services, "Bureau of Technical Utility Services Report on the Quarterly Earnings of Jurisdictional Utilities for the Year Ended March 31, 2013," 2013, 13, https://www.puc.pa.gov/filing-resources/reports/quarterly-earnings-summary-reports/.

117 Bureau of Technical Utility Services, "Bureau of Technical Utility Services Report on the Quarterly Earnings of Jurisdictional Utilities for the Year Ended June 30, 2025," 23.

Conclusion

Pennsylvania's gas system is becoming more expensive because capital investment continues to outpace customer growth and gas use. Act 11 has helped normalize accelerated reinvestment in gas infrastructure, while opaque ratemaking practices, rising delivery charges, and revenue-stabilizing mechanisms have made customer bills harder to manage and less closely tied to actual consumption.

More than $11 billion in accelerated replacement spending has already been added to the gas asset base, with projected lifetime customer costs of roughly $18 to $30 billion even if accelerated investment stopped after 2025. At the same time, peer jurisdictions have begun narrowing eligible investments, strengthening oversight, and requiring greater evaluation of non-pipeline alternatives. Pennsylvania has not yet undertaken a comparable reassessment.

The central policy challenge for Pennsylvania is how to address aging gas infrastructure without defaulting to broad, open-ended reinvestment in long-lived gas assets. Pennsylvania lacks a clear framework for determining where replacement is necessary, where repair or targeted retirement may be more cost-effective, and where alternative thermal infrastructure could better serve customers over the long term. Any reform of Act 11 should preserve a clear focus on the highest-risk portions of the system, especially older leak-prone infrastructure in dense urban areas where safety and affordability pressures overlap. The next section examines one such alternative: neighborhood-scale building decarbonization as a strategy for reducing future gas reinvestment while meeting thermal needs more affordably.

Chapter 4

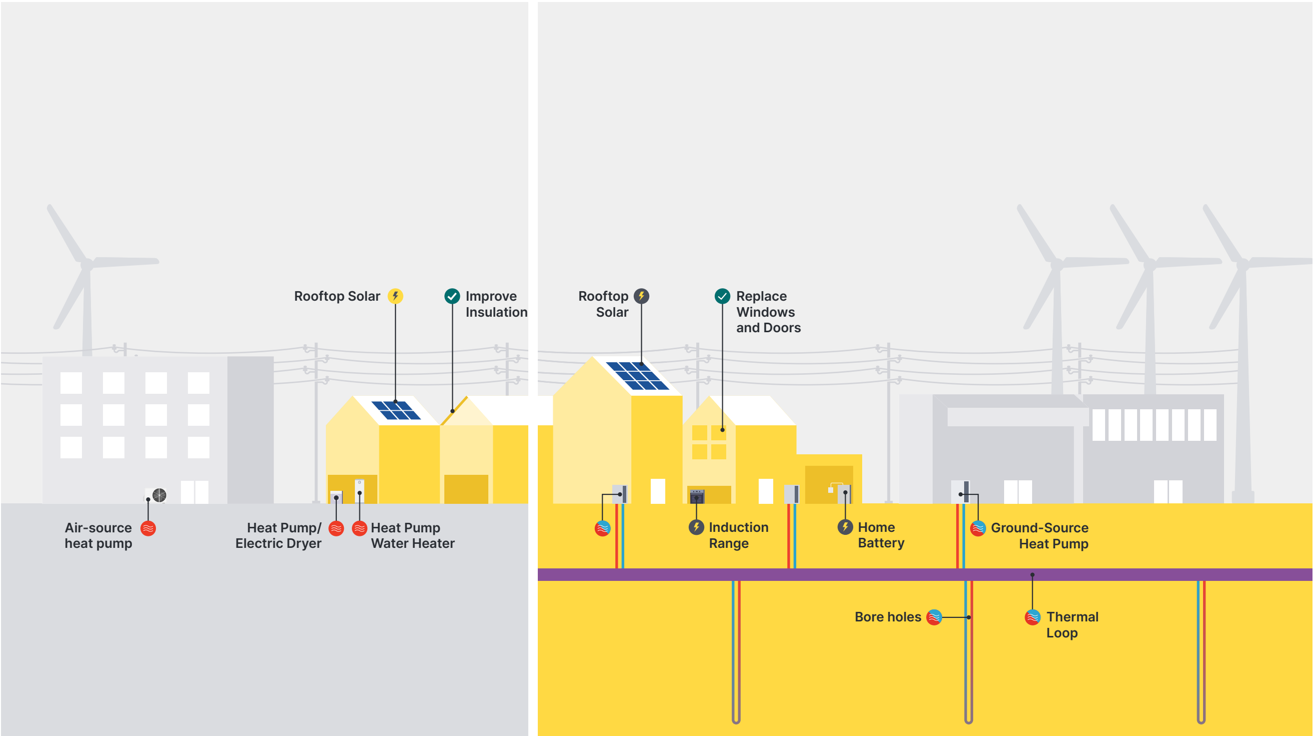
Neighborhood-Scale Building Decarbonization

This chapter examines neighborhood-scale building decarbonization as a system-level strategy for reducing gas system costs, avoiding like-for-like gas pipeline replacement, and scaling clean thermal infrastructure. It shows how social, technical, and economic conditions shape project suitability, and how modeling can help identify where neighborhood electrification or thermal energy networks offer the strongest long-term value in Pennsylvania.

Neighborhood-scale building decarbonization is a thermal-sector strategy that coordinates building electrification, energy efficiency, and shared Thermal Energy Networks (TENs) across street segments, developments, or entire neighborhoods—complementing customer-led, building-by-building upgrades with coordinated neighborhood planning and infrastructure investment. The goal is to meet communities' thermal needs for space heating and cooling, water heating, and cooking with modern electric end-use equipment while managing an orderly transition away from the gas distribution system.

By aggregating demand and aligning construction and infrastructure planning, neighborhood-scale approaches can reduce costs, limit disruption, and enable system-level decisions that are difficult to achieve through isolated retrofit projects. In practice, this strategy treats planned gas main replacements as intervention points to retire segments of the legacy gas system and shift investment toward non-gas alternatives. Neighborhood decarbonization can include coordinated deployment of air-source heat pumps, heat pump water heaters, and induction cooking, or—where conditions support it—ground-source heat pumps connected by TENs. TENs should be understood not as a "third" energy delivery system, but as an electrification-enabling approach that can improve heat pump performance and reduce winter peak electric demand relative to stand-alone air-source heat pump retrofits in certain

Figure 4.1: The "Electric Pathway" and the "Thermal Energy Network" pathway for neighborhood decarbonization



areas. For Pennsylvania, this scaled-up strategy offers a practical way to address rising gas delivery costs, aging infrastructure, long-term affordability risks, and the need to grow and sustain a skilled thermal workforce.

System-Level Benefits of Neighborhood-Scale Decarbonization:

- **Avoids unnecessary gas capital expenditures** by replacing aging mains with non-gas-pipeline alternatives.
- **Cuts total project costs and disruption** by bundling upgrades and coordinating construction across multiple buildings.
- **Reduces winter peak demand** and can lower grid upgrade needs through efficiency, load coordination, and TEN-enabled performance gains.
- **Improves reliability and planning** by aligning building upgrades with gas and electric infrastructure decisions.
- **Creates a utility transition pathway** from gas delivery investments to clean thermal service, reducing stranded-asset risk.
- **Advances health, equity, and workforce goals** by prioritizing high-burden communities, reducing on-site combustion, and supporting a predictable pipeline of skilled jobs.

Choosing Neighborhood-Scale Decarbonization Projects

Key Takeaways

- Neighborhood-scale projects are most effective when social, technical, and economic conditions align, rather than when any single factor is considered in isolation.
- Social feasibility is especially important in Pennsylvania because the current Obligation to Serve framework makes widespread participation a major constraint on gas system decommissioning.
- Project selection should prioritize neighborhoods where aging gas infrastructure, community readiness, and favorable site conditions make coordinated transition more feasible, affordable, and durable over time.

To achieve a resilient and sustainable thermal sector, neighborhood-scale projects must be sequenced and managed according to a number of social, technical, and economic factors. Not every neighborhood will be ready for this transition today. However if staged correctly, every neighborhood can eventually be made ready. This section outlines a framework for identifying how and when a neighborhood is ready to be transitioned, according to a dynamic set of criteria. These indicators can help policymakers, regulators, and utilities understand when and where a coordinated thermal transition can deliver the greatest benefits while minimizing cost and disruption to achieve a managed, affordable transition off the gas system.

Table 4.1: Key areas of consideration to assess a potential neighborhood-scale decarbonization project

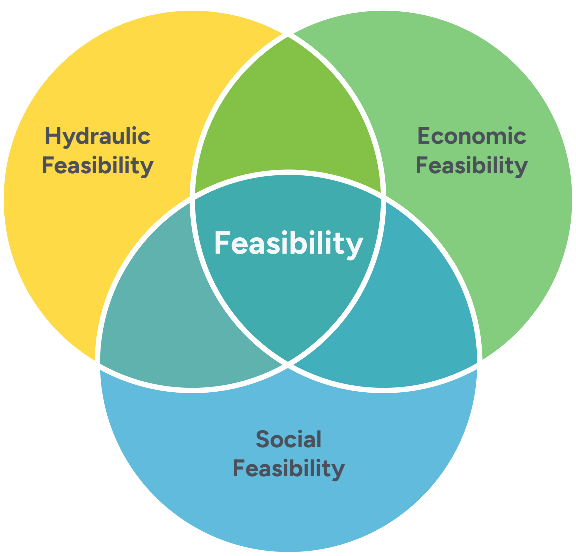
Major category	Description	Example Metrics
Social factors	The willingness of residents, building owners, and the community at large to adopt modern electric appliances, place trust in the ownership structure, engage in home improvement projects, and generally accept change in their environment	• Trust in utilities • Affinity for gas stoves • Understanding of heat pump and induction technology • Openness to adopt the latest, modern technologies • Energy burden and energy security • Neighborhood Norms • Perception of air quality
Technical factors	Suitability for a project to decarbonize based on climate, geology, electric and gas infrastructure, emissions factors, energy demand diversity, waste heat availability, and other factors contributing to the energy and emissions performance of the system	• Hydraulic feasibility of decommissioning gas main • Bedrock type • Neighborhood composition and size • Climate zone • Grid generation mix • Data center or waste heat connection and size • Gas pipeline age and material • Electrical panel capacity
Economic factors	At the intersection of social and technical conditions, economic factors consider existing and future utility rates, workforce readiness, local labor and material costs, and other factors affecting individual and overall project economics	• Drilling cost per foot • Heat pump equipment and installation costs • Gas and electricity rates • Project lifecycle cost • Workforce availability

Social factors

A neighborhood-scale decarbonization project must be technically, economically, and socially feasible to succeed. While there have been studies and utility-provided reporting on what segments of the gas system are technically possible to decommission (often referred to as "hydraulic" feasibility),[118] as well as cost-effectiveness studies comparing like-for-like pipeline replacements to non-gas-pipeline alternatives,[119] little has been said regarding the social feasibility of gas system decommissioning and neighborhood-scale electrification.

This report defines social feasibility as the willingness of individuals and communities to accept, participate in, and advocate for the transition from gas to electric alternatives. Without high social feasibility, a neighborhood-scale decarbonization project cannot succeed. In Pennsylvania, social feasibility is not only a matter of community acceptance; it is also shaped by the rules that govern when and how gas service can be altered or retired. Under the state's current "Obligation to Serve" framework, utilities generally must continue gas service unless all affected customers agree to remove or substitute that service. In practice, this means that without reform of the Obligation to Serve, 100 percent of the customers on a gas main must consent to the removal or substitution of their gas service, creating a significant barrier to widespread transition to clean heat.

Figure 4.2: The three-legged stool of feasibility for a neighborhood-scale thermal transition



The Obligation to Serve in Pennsylvania

66 PA. CONS. STAT. §1501

1501. Character of service and facilities.
Every public utility shall furnish and maintain adequate, efficient, safe, and reasonable service and facilities, and shall make all such repairs, changes, alterations, substitutions, extensions, and improvements in or to such service and facilities as shall be necessary or proper for the accommodation, convenience, and safety of its patrons, employees, and the public. Such service also shall be reasonably continuous and without unreasonable interruptions or delay. Such service and facilities shall be in conformity with the regulations and orders of the commission. Subject to the provisions of this part and the regulations or orders of the commission, every public utility may have reasonable rules and regulations governing the conditions under which it shall be required to render service. Any public utility service being furnished or rendered by a municipal corporation beyond its corporate limits shall be subject to regulation and control by the commission as to service and extensions, with the same force and in like manner as if such service were rendered by a public utility. The commission shall have sole and exclusive jurisdiction to promulgate rules and regulations for the allocation of natural or artificial gas supply by a public utility.

118 For an exploration of NPAs in California according to hydraulic feasibility, see: E3, "Avoiding gas distribution pipeline replacements through targeted electrification in California," Prepared for NDRC, 2024.
119 Utilities in states like New York, California, and Massachusetts are being required to provide cost-benefit analyses comparing NPAs to like-for-like gas replacements. See the following reviews of NPAs: RMI and National Grid, *Non-Pipeline Alternatives: Emerging Opportunities in Planning for U.S. Gas System Decarbonization,* (2024): https://rmi.org/insight/non-pipeline-alternatives/; Lawrence Berkeley National Laboratory, *Non-Pipeline Alternatives to Natural Gas Utility Infrastructure: An Examination of Existing Regulatory Approaches* (2023): https://eta-publications.lbl.gov/sites/default/files/non-pipeline_alternatives_to_natural_gas_utility_infrastructure_1_final.pdf; Switchbox, *Targeted Electrification in NY* (2025): https://www.switch.box/lpp

Table 4.2: Key social factors affecting candidate project selection

Metric	What is it?	How does it affect social feasibility?
Energy Burden and Energy Security	Household energy costs as a share of income; stability of access to energy service.	Shapes receptiveness to bill-reducing offers and protections (e.g., bill guarantees) and willingness to accept equipment changes. Low energy security or unstable service histories can increase skepticism—or, where current service is unreliable or costly, increase interest—depending on perceived risks and protections.
Affinity for Fossil Fuel Appliances	Preferences tied to existing appliances and fuels (especially gas cooking).	Can create resistance and "holdouts," especially around cooking. Demonstrations, induction education, in-home trials/rental programs, and targeted incentives can increase comfort and adoption.
Air Quality	Residents' perceptions of indoor/outdoor air quality and pollution exposure (in addition to measured conditions).	Increases motivation when health benefits are salient; improves buy-in where residents connect electrification to reduced indoor combustion and local pollution burdens.
Trust in Utilities	Community experience with shutoffs, outages, extreme-weather events, billing disputes, and scams; perceived utility credibility.	Determines occupant's willingness to enroll and grant the utility and contractor access to their home. Low trust requires different messengers (community-based partners), stronger consumer protections, and transparent communication on costs, benefits, and data use.
Neighborhood Norms	The influence of peer effects, informal leadership, and social networks on upgrade decisions.	Higher participation is more achievable where early adopters are visible and trusted local leaders can normalize action; where norms favor the status quo, additional outreach, incentives, and phased approaches may be needed.

High social feasibility therefore does more than improve public acceptance. It can also positively influence the hydraulic and economic feasibility of decommissioning pipeline segments. For example, a gas decommissioning project may not be considered hydraulically feasible because "downstream" customers rely on that segment for their gas service; however, if broader customer participation can be secured, the project scope could expand to include both upstream and downstream segments, making decommissioning hydraulically feasible. Similarly, economic feasibility can increase when a community's social feasibility improves. For example, if a neighborhood has individual customers who are already electrifying their equipment, this reduces the total cost to electrify the remainder of the neighborhood, improving the economic feasibility of a gas decommissioning project in that neighborhood.

Even if the Obligation to Serve policy is reformed to allow for a lower consent threshold for replacing gas equipment with modern electric equipment, it is important to reach and maintain high social feasibility for any infrastructure project, as community support is pivotal to project success. While assessing and improving social feasibility is an emerging area of study, the following discussion highlights key social factors that may influence a neighborhood's willingness to pursue a neighborhood-scale decarbonization project.

Scaling neighborhood-scale projects beyond a handful of homes will be difficult without high social feasibility. Educational campaigns, prioritizing areas with high energy burdens or poor air quality, community ownership structures, and subsidized equipment can help overcome the 100 percent buy-in barrier. Beyond increasing the willingness of individuals within a proposed neighborhood-scale project, policy changes, such as reforming the Obligation to Serve law, can help facilitate a neighborhood-scale thermal transition.

Increasing Social Feasibility Through Neighborhood Engagement

Case Study: "Electrify My Block," Bay Area, CA

Neighborhood-scale decarbonization requires a level of coordination and collective decision-making that goes beyond traditional utility programs. PG&E's *Electrify My Block* neighborhood-scale electrification pilot offers practical lessons on how targeted engagement and outreach can build the trust and momentum needed to achieve high participation in a defined geographic area.[1]

Program Approach

The project focused on small, clearly defined "zones" of neighboring homes and paired generous financial support with intensive, relationship-based outreach. Participation was voluntary, but required full or near-full buy-in within each zone, making community trust, clarity, and neighbor-to-neighbor engagement central to program success.

Key Neighborhood Engagement Strategies

- **Lead with transparency and choice:** Outreach materials and conversations quickly addressed skepticism by clearly explaining why households were eligible, what participation involved, and what choices residents retained. Early emphasis on transparency helped counter fears of scams or hidden costs.
- **Use trusted messengers:** The utility's role helped legitimize the effort, but success depended on partnerships with local governments, community organizations, and neighborhood leaders who residents already trusted.
- **Normalize electrification through visibility:** Yard signs, resident testimonials, all-electric home tours, and neighborhood meetings made participation visible and helped shift electrification from an abstract concept to a familiar, achievable upgrade.

1 For more details on the program, see: https://www.switchison.org/electrify-my-block

- **Center neighbor-to-neighbor outreach:** The program intentionally encouraged residents to talk with one another, not only to build momentum, but also to provide reassurance about the legitimacy of the program and the credibility of the opportunity. This neighbor-to-neighbor outreach was a primary way the program achieved full enrollment in individual zones. Neighborhood "Champions" were identified through early adoption and then trained on the program itself, as well as on how to conduct outreach to their neighbors, helping accelerate shifts in neighborhood norms.
- **Meet people where they are:** Outreach combined door-to-door canvassing with phone calls, emails, virtual meetings, direct mail, and follow-ups, recognizing that households differ in availability, language, and comfort with in-person engagement.
- **Start small and build:** Targeting small zones with high readiness allowed the program to build early wins, refine messaging, and accelerate momentum.

Lessons for Pennsylvania

This experience underscores that social feasibility is not fixed, but can be built through deliberate investment in outreach, trusted messengers, and community relationships. For Pennsylvania, neighborhood-scale decarbonization programs will need similarly tailored engagement strategies, especially where high participation is required to retire gas infrastructure or deploy shared thermal systems. In particular, the case suggests that neighbor-to-neighbor outreach may be essential, not incidental, to securing the level of participation needed for neighborhood-scale transition. Pairing technical and economic planning with early, sustained community engagement can reduce holdouts, increase participation, and ensure that neighborhood-scale projects are not only cost-effective, but socially durable.

Economic factors

Economic feasibility is shaped not only by technology costs, but by local market conditions, workforce capacity, and how energy costs are distributed across customers. Utility rate structures, labor availability, and existing energy burdens influence whether neighborhood-scale projects can deliver long-term affordability and advance broader programmatic goals. Many of these economic factors interact with technical and social considerations and are sensitive to project scale and design. Table 4.3 summarizes the key economic factors that affect lifecycle costs, bill impacts, workforce outcomes, and project suitability across different neighborhood contexts.

Technical factors

The technical feasibility of neighborhood-scale projects is shaped less by any single constraint than by how multiple, place-specific factors interact. Climate, geology, building density, infrastructure conditions, and available energy resources all influence system design choices and lifecycle costs. Many of these factors are not fixed barriers but design inputs that can be addressed through project location, scale, technology, and planning. Table 4.4 summarizes the key technical factors that influence feasibility and cost, and illustrates how neighborhood-scale approaches—particularly thermal energy networks—can turn local conditions into cost and efficiency advantages rather than constraints.

Table 4.3: Key economic factors affecting candidate project feasibility, costs, and programmatic goals

Metric	What is it?	How does it affect economic feasibility and project suitability?
Utility Rates	Gas, delivered fuel, and electricity rates, including fixed charges and volumetric charges (and, where applicable, time-varying rates).	A larger gap between electricity prices and other fuels can weaken the near-term bill economics of electrification, especially for stand-alone air-source heat pumps. Higher-efficiency options—such as ground-source heat pumps and, where appropriate, thermal energy networks—can improve operating costs and reduce exposure to winter peak electricity pricing by lowering total electricity use (see Modeling section).
Workforce Availability	Availability of qualified contractors and crews (design, drilling, HVAC, electrical, excavation, controls) to bid, build, and maintain projects.	Limited workforce availability can increase bid prices, extend timelines, and constrain the scale or sequencing of neighborhood projects. Conversely, larger, repeatable neighborhood programs can support apprenticeship pipelines, stabilize contractor demand, and help transition skills from gas construction and related trades.
Existing Electrification and Remaining Gas Load	The share of buildings already electrified and the magnitude of remaining gas throughput in the target area.	Areas with lower remaining gas throughput face higher per-customer delivery costs over time as fixed gas system costs are spread across fewer customers. Coordinated neighborhood decarbonization can accelerate targeted gas retirements, reduce long-term gas cost pressure, and improve the economic case for avoiding new gas capital investments.
Upfront Cost and Financing Access	Upfront capital required (equipment and enabling upgrades) and availability of financing and incentives (rebates, grants, loans, on-bill/tariffed financing, bill guarantees).	High upfront costs and limited financing access can block participation even when lifecycle savings are strong—particularly for low- and moderate-income households and small landlords. Strong incentive design and financing tools (e.g., on-bill repayment, tariffed programs, or bill guarantees) can increase participation, reduce cost of capital, and improve project uptake and equity outcomes.

Table 4.4: Key technical factors and how they impact project lifecycle costs

Metric	What is it?	How does it affect technical feasibility and cost?
Climate Zone	Typical weather conditions throughout the year, including temperature and humidity. Pennsylvania spans zones 4A (mixed-humid), 5A (cool-humid), and 6A (cold-humid)*	The colder the outside temperature, the stronger the case for ground-source heat pumps, as they do not suffer efficiency penalties given the relatively stable year-round ground temperatures. Higher energy efficiency translates to lower utility bills and lower lifecycle costs compared to air-source heat pumps, which still perform well in cold climates but cannot reach the same efficiencies as ground-source systems.
Bedrock Type	Physical composition of the first 300-1,000 feet below the surface (e.g. metamorphic rocks, shale, sand, etc.)	Thermal energy networks frequently include boreholes to exchange energy with the earth. Different bedrock materials vary in how well they can exchange heat with a fluid in a borehole. More conductive materials mean fewer boreholes, which reduces drilling and material costs. Bedrock type is not relevant for neighborhood electrification with air-source heat pumps.
Neighborhood Density	How far apart or close together the buildings in a neighborhood are	More dense neighborhoods, with more customers per mile of gas pipeline, tend to have a lower cost-per-customer threshold for like-for-like gas replacement (e.g. PGW's $19k per customer vs UGI's $95k per customer), which can make these neighborhoods lower priority candidates for neighborhood electrification strictly in terms of cost. However, for thermal energy networks, dense neighborhoods are ideal, as buildings closer together have shorter network lengths, which can cut down on trenching, pipe-laying, and pumping costs, resulting in lower lifecycle costs.
Waste Heat Availability	A heat source on the thermal energy network, such as a data center, ice rink, brewery, or other process load with predictable waste heat that can be added to the loop	Having predictable heat available for the thermal loop can greatly increase heat pump efficiency when buildings need heating, lowering operational costs. Waste heat may also reduce the number of boreholes needed to balance loads on the system, reducing upfront capital costs. Waste heat availability is not applicable for air-source heat pump applications.
Neighborhood Composition	The specific mix of buildings in a neighborhood, including their energy usage patterns, fuel types, and total square footage	In general, larger projects benefit from greater economies of scale. For thermal energy networks, a broader mix of building types provides greater load diversity, making it easier to balance loads on the system (e.g. one building needs heat while another needs cooling), thereby reducing the peak capacity of the thermal resource (e.g., the number of boreholes) and improving energy efficiency of the heat pumps.
Gas Infrastructure Characteristics	The age and material of gas mains serving the neighborhood	Older (50+ years old) or leak-prone (e.g. cast iron, unprotected bare steel) pipes that need to be replaced could instead be decommissioned and replaced with a thermal loop. The capital costs to replace the pipelines could be applied to a neighborhood-scale decarbonization solution. Based on regional pipeline replacement costs and customer density on gas mains, these costs range from ~$19,000-$95,000 per customer, depending on the utility (see Chapter III).
Hydraulic Feasibility	Whether a utility can decommission a gas pipeline or not; often depends on downstream effects and whether local reliability of the gas network could be adversely affected	Whether or not it is deemed hydraulically feasible to decommission a segment of gas pipeline depends on a utility's technical evaluation of that area of the network. However if the reason for hydraulic infeasibility is that downstream customers will be affected, then widening the scope of a neighborhood-scale project to include those downstream customers can in fact make a project hydraulically feasible. Economies of scale also make larger projects beneficial for both neighborhood-scale pathways.
Electric grid infrastructure characteristics	Available capacity and constraints on the local electric system serving the neighborhood (e.g., feeder and substation capacity, transformer loading, voltage limits), and the magnitude/timing of existing loads.	Neighborhood-scale electrification increases electric load. Where feeders, transformers, or substations are near capacity, especially during winter peak, projects may require distribution upgrades (and in some cases customer-side service panel upgrades), increasing upfront costs and extending timelines. Neighborhoods with more available hosting capacity can accommodate added load with fewer upgrades, improving lifecycle costs. Compared with stand-alone air-source heat pump retrofits, thermal energy networks can reduce winter peak electric demand in suitable applications by improving heat pump performance and enabling load diversity, which can reduce or defer the need for some distribution upgrades (see Modeling section).

* Based on ASHRAE Standard 169.

Modeling Neighborhood-scale Pathways in Pennsylvania

Key Takeaways

- Modeling shows that thermal energy networks can outperform stand-alone air-source heat pump pathways in suitable Pennsylvania contexts, particularly by reducing energy use and winter peak demand over the long term.
- Neighborhood electrification can still be the better pathway in smaller or less complex projects, especially where lower upfront cost, simpler ownership, and faster deployment are the priority.
- In Pennsylvania, climate, geology, building mix, and grid conditions all shape which pathway delivers the strongest lifecycle value, making project-specific analysis essential.

To model the suitability of the two neighborhood-scale pathways—electrification with air-source heat pumps and thermal energy networks with ground-source heat pumps—BDC developed a techno-economic modeling tool with engineering firm Buro Happold. This modeling section uses this tool to estimate the lifecycle costs, energy, power, and emissions for three sample projects: two college campuses of different sizes and a residential neighborhood with light commercial space.

To estimate the relative energy and economic performance of each pathway for the sample neighborhoods, the model considers upfront and recurring capital costs for labor, materials, drilling, installation, and others, as well as ongoing energy costs over a 60-year lifespan.

Specific to Pennsylvania, the model considers the local conditions in three cities: Pittsburgh, State College, and Philadelphia, to capture the climatic and geological diversity in the state. These inputs affect the operational efficiency of the heat pumps, ground temperature of the ambient loop in a thermal energy network, and the energy exchange potential of boreholes in a thermal energy network.

Table 4.5: Sample Neighborhoods modeled in this report

Neighborhood	Composition	Building Area
University Campus, 20 buildings	A hospital, 5 offices, 6 lecture halls, 2 large multifamily residences, 2 retail stores, 3 restaurants, and a warehouse	~2.5M ft²
University Campus, 60 buildings	A hospital, 10 offices, 28 lecture halls, 8 large multifamily residences, 4 retail stores, 7 restaurants, and 2 warehouses	~8.0M ft²
Neighborhood, 30 buildings	3 retail stores, an office, 2 outpatient health clinics, 3 small apartments, a school, and 20 single family homes	~350,000 ft²

Neighborhood
30 buildings

University Campus
60 buildings

University Campus
20 buildings

Modeling Results

To understand when coordinated electrification is sufficient and when shared thermal infrastructure delivers greater value, we modeled two pathways across representative Pennsylvania contexts. The results show meaningful differences in energy use, peak demand, and cost drivers over the life of the systems.

Across the 200+ simulations, the model shows that TENs use 27% less energy and 40% less peak power than the electric pathway using air-source heat pumps.

> **"TENs use 27% less energy and 40% less peak power than the electric pathway using air-source heat pumps."**

Figure 4.3: Across all simulations, Thermal Energy Networks cut annual energy use by 27% compared to ASHP-based decarbonization models.

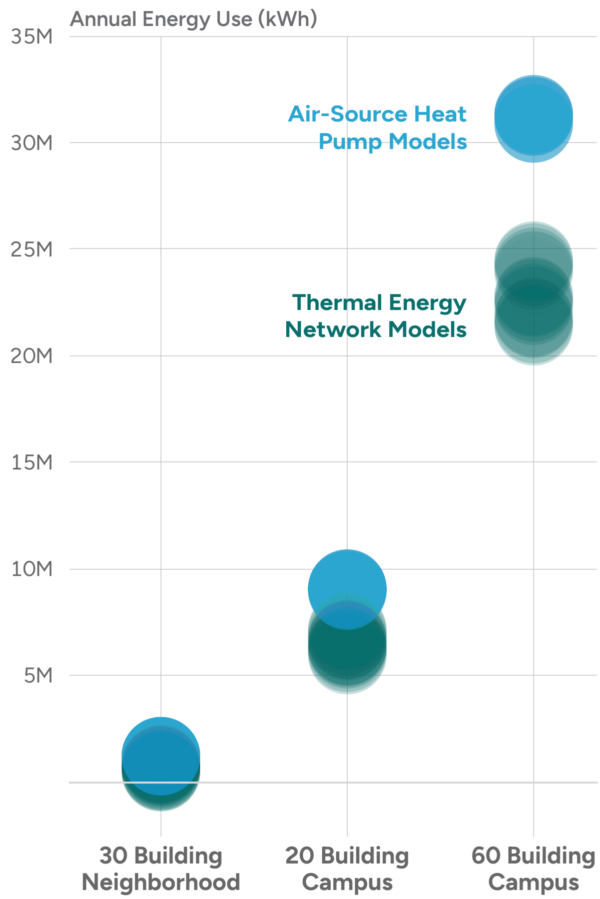


Figure 4.4: Across all simulations, Thermal Energy Networks cut peak power demand by 40% compared to ASHP-based decarbonization models.

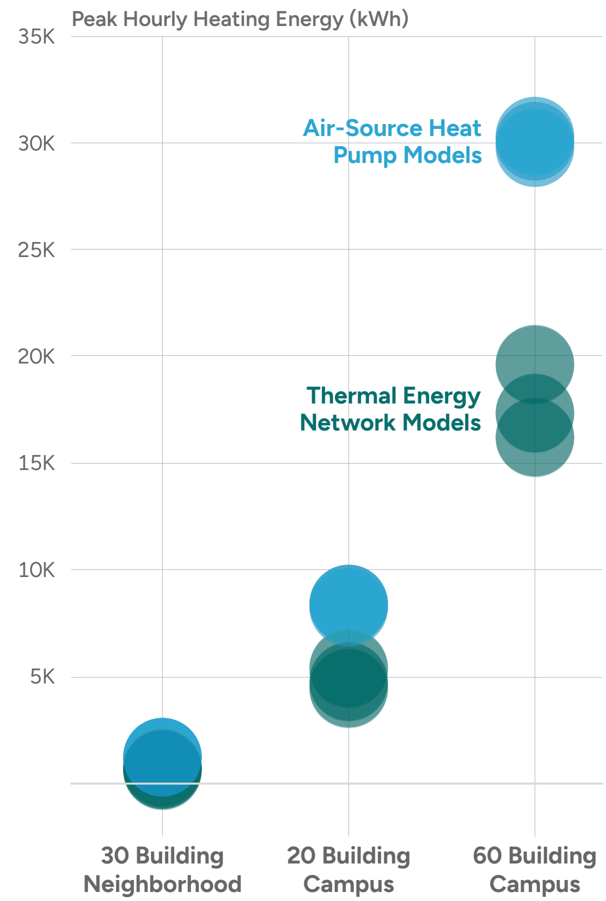


Figure 4.5: **Modeled daily energy use by decarbonization pathway for a 30-building neighborhood in Philadelphia, highlighting the peak and total energy use savings of TENs.**

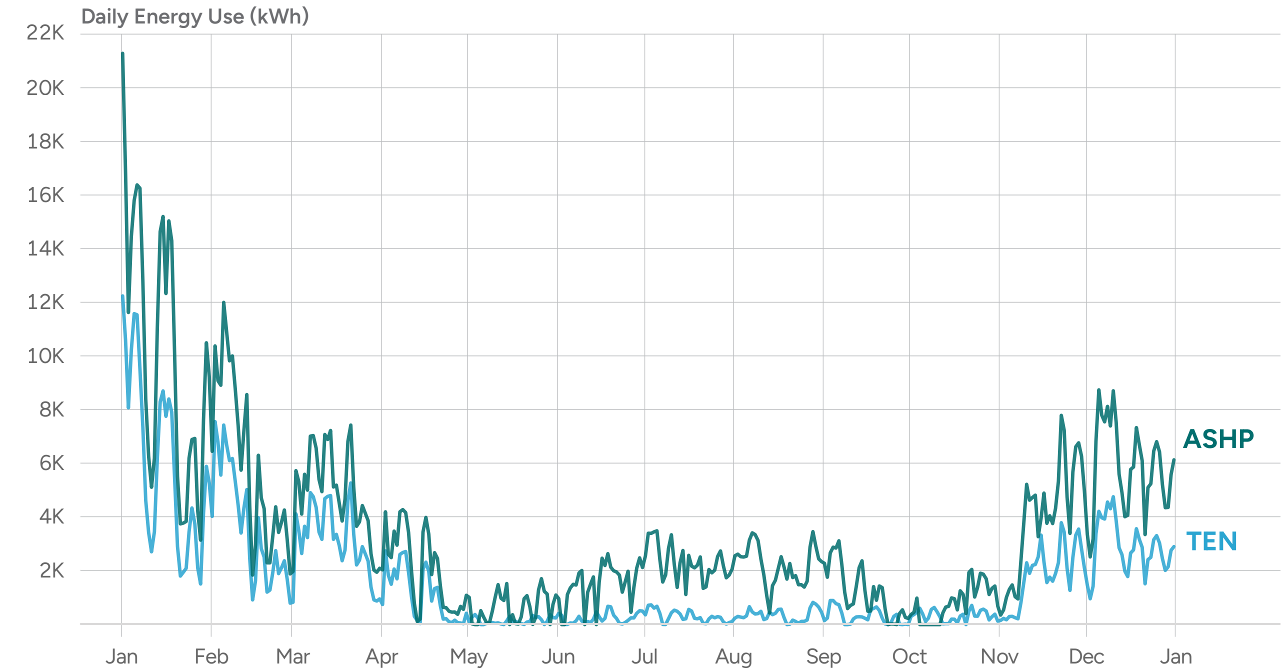
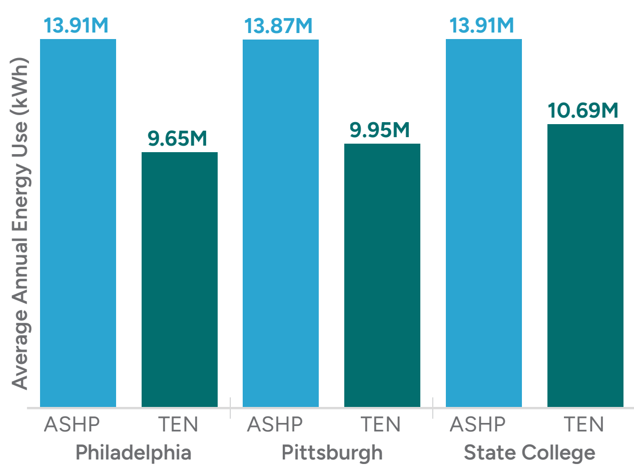


Figure 4.6: **Based on bedrock type and ground temperatures, Philadelphia saw the greatest energy savings for TENs vs. ASHPs.**



Over the 60-year analysis period, capital costs are 10% higher for the electric pathway, largely due to the shorter lifespan of air-source heat pumps compared to ground-source heat pumps. However, TENs do have a higher upfront cost in the first year for drilling and thermal network installation. In other words: neighborhood-scale electrification with air-source heat pumps can be cheaper upfront but can cost more over time due to equipment replacement and higher peak-related impacts.

Thermal Energy Networks (TENs) Pathway

Thermal energy networks can deliver long-term operational savings for buildings and ratepayers by reducing both total energy use and peak electricity demand. Because TENs require significant upfront investment—such as drilling boreholes, installing horizontal piping, and building shared thermal infrastructure—they are best suited for neighborhoods where these costs can be spread across many buildings and offset by long-term performance efficiencies.

TENs tend to offer the greatest value in neighborhoods with very cold climates; larger numbers of connected buildings; dense layouts; access to reliable sources of waste heat (such as data centers, ice rinks, or wastewater facilities); constrained electric grid capacity; and long-term owners or institutions that can benefit from lifecycle cost savings.

Electric Pathway

Neighborhood electrification using air-source heat pumps can provide a lower-cost, faster-to-deploy alternative to continued gas pipeline replacement, particularly for smaller or less complex projects. This pathway is generally better suited for neighborhoods with fewer buildings, limited opportunities for economies of scale, more uniform building types with little load diversity, and geologies with low bedrock conductivity or where a shared thermal network would be more difficult to organize across multiple property owners.

Neighborhood electrification may also be preferable in areas with higher capital costs, a limited specialized thermal workforce, or sufficient electric grid capacity to accommodate additional load without major upgrades. Because each building can generally own and manage its own equipment, this pathway can also be easier to implement in neighborhoods where ownership, operations, and maintenance of shared infrastructure would be difficult to coordinate. Compared to thermal energy networks, this pathway prioritizes speed and lower upfront costs, but offers fewer opportunities to reduce peak demand or achieve long-term system-wide efficiencies.

Implications for Pennsylvania

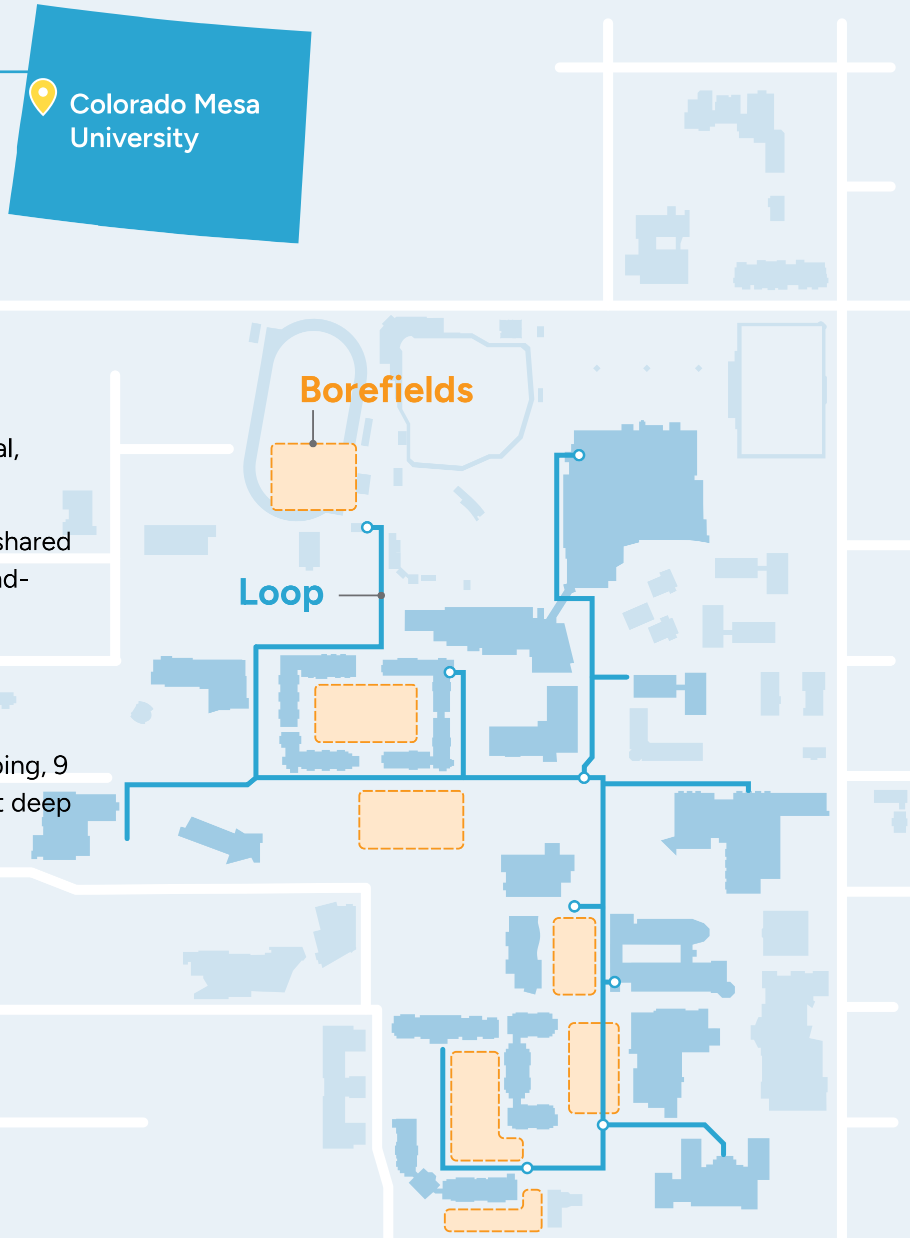
Pennsylvania's climate and geology make it well suited for thermal energy networks. The Commonwealth's cold winters strengthen the case for ground-source systems, which maintain high efficiency by relying on the relatively stable temperature of the earth rather than cold outside air. This stability allows thermal energy networks to avoid the winter performance losses experienced by air-source heat pumps and helps lower energy use and operating costs over time.

Pennsylvania's underlying geology further supports thermal energy networks. The state consists largely of igneous bedrock in the east and sedimentary bedrock in central and western regions, both of which conduct heat efficiently. Higher thermal conductivity reduces the number of boreholes required to balance heating and cooling loads across a network, helping to lower upfront drilling costs and improve overall project economics.

From a workforce perspective, thermal energy networks are also a strong fit for Pennsylvania and its already developed thermal workforce. TENs require substantial labor to install both vertical infrastructure (boreholes) and horizontal piping (the ambient thermal loop), creating demand for drillers, pipefitters, and related skilled trades. Many of these skills closely overlap with those used by oil and gas workers currently employed in drilling, pipelaying, and gas system maintenance.

Installing an ambient thermal loop can be comparable in cost and labor intensity to replacing aging gas mains. This creates an opportunity to decommission end-of-life or leak-prone gas pipelines while maintaining a similar level of employment and project scale. Beyond construction, thermal energy networks also require ongoing operation and maintenance of shared infrastructure, offering durable, long-term employment opportunities for skilled workers as the Commonwealth transitions away from gas-only thermal systems.

Case Study: Colorado Mesa University, a Campus-Scale Thermal Energy Network



Project Overview[1]

- Location: Grand Junction, Colorado
- Buildings served: 20 campus buildings and undergoing expansion (academic, residential, administrative)
- System type: Geothermal network using a shared ambient-temperature water loop and ground-source heat pumps
- Scale: ~1.7 million square feet of connected buildings
- Infrastructure: ~2.5 miles of central loop piping, 9 drill fields, and ~500 boreholes at ~600 feet deep and undergoing expansion[2]
- Savings: More than $15 million in energy costs since 2008[3]

System Design and Operation[4]

Colorado Mesa University built a campus-scale thermal energy network that moves heat among buildings and the ground through a shared underground loop. The system follows a "least energy paths" approach: heat captured from one building can be moved to another building that needs it, while borefields act as a seasonal thermal battery. This load sharing across buildings improves overall system performance and reduces the energy needed for pumping and distribution.

1 Phil McKenna, "A Groundbreaking Geothermal Heating and Cooling Network Saves This Colorado College Money and Water," *Inside Climate News*, February 7, 2026, https://insideclimatenews.org/news/07022026/colorado-college-geothermal-network/.

2 "BDC Presents: Building Decarbonization Meets Water Conservation (Presentation Summary)," August 29, 2024, https://buildingdecarb.org/wp-content/uploads/Summary_BDC-Presents-Building-Decarboniza-tion-Meets-Water-Conservation-1.pdf.

3 McKenna, "A Groundbreaking Geothermal Heating and Cooling Network Saves This Colorado College Money and Water."

4 The images and map of Colorado Mesa were published through the webinar "BDC Presents: Building Decarbonization Meets Water Conservation" on August 29, 2024: https://buildingdecarb.org/wp-content/uploads/BDC-Presents_-Water-Brief-Presentation.pdf. The map represents the campus network as of 2024, which has grown since then.

Measured Outcomes

- Energy efficiency: Campus buildings require about half as much energy for heating and cooling as similar buildings.[5]
- Efficiency performance: The system achieves a winter heating coefficient of performance of 8.9 and an overall coefficient of performance of 5.7.[6]
- Emissions reductions: The campus carbon footprint has been reduced by 10,114 metric tons per year compared with traditional HVAC.[7]
- Water savings: An estimated annual water savings of 10 million gallons, largely because the system reduces reliance on conventional evaporative cooling.[8]
- Grid relevance: Thermal energy networks maintain high efficiency across seasons and reduce strain on the electric grid during peak periods, especially in winter.[9]

Cost and Phasing Strategy

- CMU began planning its first geothermal project in 2007 for a single academic building, then expanded the network as nearby and newly constructed buildings were added.
- BDC reports an initial construction cost of about $20 million, including about $6.4 million for drill fields, with a simple payback of just over 12 years.[10]
- This phased buildout allowed the university to grow the system over time while lowering utility expenses and connecting each new building to shared infrastructure.

Relevance to Neighborhood-Scale Decarbonization in Pennsylvania

- CMU shows how shared thermal infrastructure can serve multiple buildings through one connected loop, use load diversity to improve efficiency, and reduce both operating costs and water use.
- For Pennsylvania, the clearest lesson is that thermal networks can be built incrementally and can support neighborhood-scale decarbonization where multiple buildings can share infrastructure and capture efficiency gains from heat sharing.

5 McKenna, "A Groundbreaking Geothermal Heating and Cooling Network Saves This Colorado College Money and Water."
6 Jessica Silber-Byrne, "Affordable Heat, Efficient Grid: Using Thermal Energy to Save Time, Money, and Energy," *Building Decarbonization Coalition*, September 19, 2024, https://buildingdecarb.org/why-efficiency-matters.
7 "BDC Presents: Building Decarbonization Meets Water Conservation (Presentation Summary)."
8 McKenna, "A Groundbreaking Geothermal Heating and Cooling Network Saves This Colorado College Money and Water."
9 Silber-Byrne, "Affordable Heat, Efficient Grid: Using Thermal Energy to Save Time, Money, and Energy."
10 "BDC Presents: Building Decarbonization Meets Water Conservation (Presentation Summary)."

Neighborhood-Scale Decarbonization as a Thermal Transition Strategy

Neighborhood-scale building decarbonization provides Pennsylvania with a practical, system-level pathway to modernize its thermal sector while addressing rising gas system costs, declining demand, and long-term affordability risk. The analysis in this report shows that coordinated, neighborhood-scale thermal transitions, whether through neighborhood electrification or thermal energy networks, can meet communities' heating and cooling needs at lower long-term cost and risk than continued reinvestment in aging gas infrastructure.

Modeling results demonstrate which Pennsylvania communities are more suited to thermal energy networks and which are more suited to neighborhood electrification. Across Pennsylvania, from small neighborhoods to large campuses, TENs perform best, using 27% less energy and 40% less peak power than neighborhood electrification pathways relying solely on air-source heat pumps, while delivering comparable or lower lifecycle costs over a 60-year period. These efficiency and peak

demand advantages are particularly valuable in Pennsylvania's cold climate, where ground-source systems maintain high performance during winter peaks and reduce strain on the electric grid. For smaller-scale projects, neighborhood electrification with air-source heat pumps tends to offer better lifecycle costs due to the lack of load diversity, free waste heat, and economies of scale to engage a more diverse workforce.

However it is important to note that the viability and impact of neighborhood-scale projects depend on where and how they are deployed. As outlined in this section, social, technical, and economic factors jointly shape project feasibility and outcomes. Neighborhoods with high energy burdens or poor air quality stand to benefit most from coordinated thermal transitions, but successful deployment requires trust, clear communication, and mechanisms that reduce the burden on individual households to navigate complex technology and financing decisions. Technically, favorable geology, compact neighborhood design, aging gas infrastructure, and available electric grid capacity can substantially lower lifecycle costs. Economically, aligning thermal investments with planned gas main replacement, workforce availability, and long-term utility rate trajectories can unlock significant savings while avoiding stranded assets.

Neighborhood-scale decarbonization is best deployed where social readiness, technical conditions, and economic value align. Policy reform can help improve some of these factors, while others depend on more entrenched cultural and social values as well as community-specific histories. When selected and staged strategically, these projects enable the Commonwealth to right-size the gas system, reduce exposure to rising delivery costs, and invest in durable thermal infrastructure that can serve communities for decades.

The next section explores how Pennsylvania can deliberately build and support this thermal workforce to ensure that the shift to clean, efficient neighborhood-scale thermal systems delivers not only lower emissions and lower bills, but also stable, high-quality jobs across the Commonwealth.

Chapter 5

Building a Thermal Workforce

This chapter examines Pennsylvania's thermal transition as a workforce transition and argues that the Commonwealth already has a large, adaptable labor base capable of delivering cleaner heating and cooling across buildings and industry. It shows how a thermal workforce framework can connect existing fossil fuel, utility, construction, and building-trades workers to emerging opportunities in efficiency, electrification, geothermal, thermal energy networks, and clean industrial heat, while highlighting the policy and training conditions needed to scale durable, high-quality jobs.

Pennsylvania's energy history is also a history of workforce adaptation. Across generations, workers in the Commonwealth have adjusted to major shifts in fuels, technologies, and infrastructure, from coal to oil and gas and now toward cleaner, more efficient ways of delivering heat to buildings and industry. Today, that transition is best understood through the thermal sector: the systems and workers responsible for producing, delivering, and managing heating and cooling. This framing matters because many of the workers who have long maintained fossil fuel-based thermal systems will also be needed to build and operate clean thermal systems in the decades ahead.

Pennsylvania enters this transition with significant workforce assets. The Commonwealth's clean energy economy is already growing, with more than 100,000 workers employed across energy efficiency, renewable energy, storage, zero-emission transportation, and clean fuels.[120] Energy efficiency represents the largest and fastest-growing segment, comprising nearly three-quarters of clean energy jobs,[121] underscoring a central point of this chapter: building-level upgrades will drive the largest volume of near-term thermal transition work. HVAC technicians installing heat pumps, electricians upgrading panels and wiring, plumbers installing heat pump water heaters, insulators and

120 Sustainable PGH, *Clean Energy Workforce Needs and Opportunities for Southwestern PA*, 1.
121 E2, *Clean Jobs Pennsylvania 2024* (2024), 1, https://e2.org/wp-content/uploads/2025/02/E2-Clean-Jobs-Pennsylvania-2024_final.pdf.

weatherization professionals improving building envelopes, and engineers, designers, and planners coordinating more complex systems will all remain central to this transition.

Pennsylvania also retains a large fossil fuel workforce with skills directly relevant to the future of thermal infrastructure. Estimates of oil and gas employment vary widely depending on the source and methodology used: industry sources estimate that oil and gas activities supported more than 120,000 direct and indirect jobs in 2022,[122] while other analyses place direct employment closer to 80,000 jobs,[123] or even 50,000.[124] And while the oil and gas drilling workforce has long been central to Pennsylvania's energy economy, it has not provided steady long-term job growth or security. Though the shale gas boom temporarily increased employment in drilling and extraction, jobs in these sectors have remained relatively flat over the past two decades and, in some cases, have fallen back toward pre-fracking levels. Figure 5.2 places that volatility alongside the steadier growth of energy efficiency employment.

The historical ebbs and flows in fossil fuel work challenge narratives that frame the clean energy transition as a threat to workforce stability. Fossil fuel employment, particularly in drilling, has itself been volatile. At the same time, opportunities for workers to apply related skills in adjacent thermal sectors, including geothermal energy and thermal energy networks, are expanding. Drilling expertise and pipeline construction skills are not disappearing in a thermal transition; they are becoming relevant to a different set of infrastructure investments.

Pennsylvania has substantial training capacity to support this work. Workers enter thermal fields through union apprenticeships, trade schools, community colleges, manufacturer trainings, and on-the-job learning, and the Commonwealth has nearly 300 training programs tied to the energy efficiency sector alone.[125] At the same time, stakeholders interviewed for this report voiced concern that this training landscape is fragmented and would benefit from stronger coordination and clearer alignment with long-term thermal transition needs.

Together, these trends point to the need for a thermal workforce framework that looks across fuel categories and focuses instead on the skills, occupations, and institutions needed to deliver heating and cooling through a managed transition.

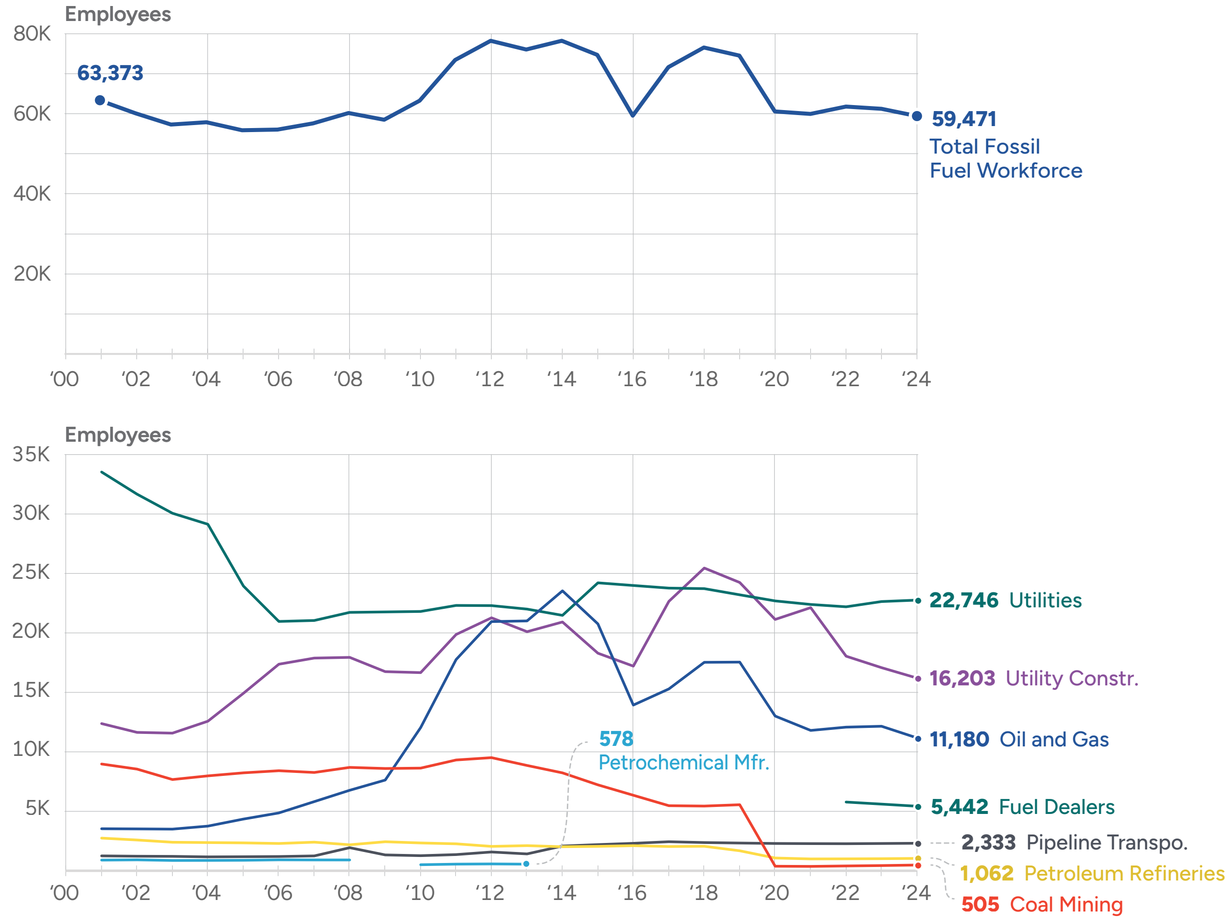
122 FTI Consulting, *Economic and Fiscal Impact of Pennsylvania Shale Gas Development (Marcellus Shale Coalition, 2023)*, 2, https://marcelluscoalition.org/wp-content/uploads/2023/10/Economic-and-Fiscal-Impact-of-Pennsylvania-Shale-Development.pdf.

123 Sean O'Leary, "Oil & Gas: Central to Pennsylvania Politics but Not Its Economy," *Ohio River Valley Institute*, August 7, 2023, https://ohiorivervalleyinstitute.org/10056-2/.

124 Angela Ferritto and Robert Bair, "Union Leaders Push Clean Energy Jobs Agenda in Pennsylvania," *Kleinman Center for Energy Policy*, October 7, 2025, https://kleinmanenergy.upenn.edu/commentary/podcast/union-leaders-push-clean-energy-jobs-agenda-in-pennsylvania/.

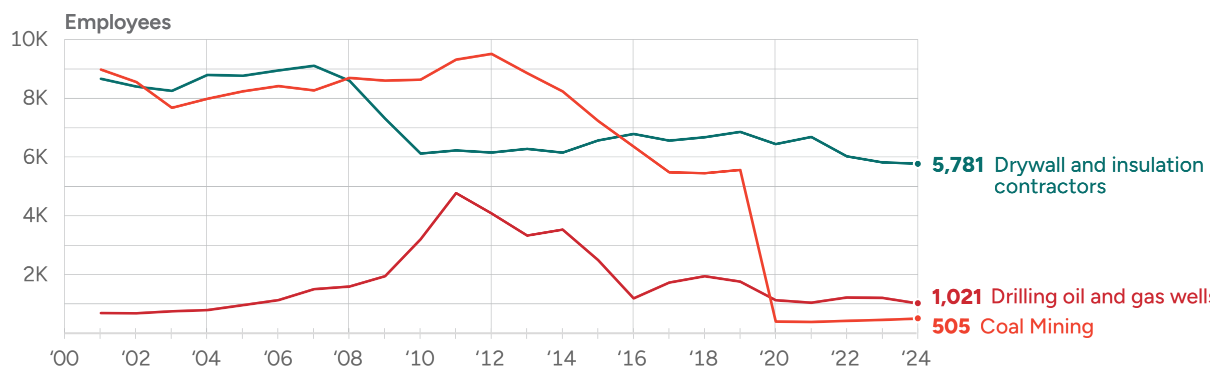
125 Sustainable PGH, *Clean Energy Workforce Needs and Opportunities for Southwestern PA*, 5.

Figure 5.1: (Top) Total fossil fuel workforce related to buildings and heat. (Bottom) Fossil fuel workforce related to buildings and heat by category.



Data Source: Bureau of Labor Statistics.

Figure 5.2: Coal mining and drilling jobs declined heavily since peaking in the early 2010s; energy efficiency jobs have been steady since.



Data Source: Bureau of Labor Statistics

The Thermal Workforce

Key Takeaways

- Pennsylvania already has an estimated 140,000-person thermal workforce spanning fossil fuel, utility, construction, and building energy occupations involved in delivering heating and cooling.
- A thermal workforce framework shifts attention from fuel categories to the services workers provide, showing how skills can transfer and evolve across overlapping fossil and clean thermal systems over time.
- Building-level efficiency and electrification will continue to drive a large share of near-term work, sustaining demand for HVAC technicians, electricians, plumbers, insulators, weatherization professionals, and related trades.
- Union labor and independent contractors play complementary roles in this transition: organized labor is better positioned for infrastructure-scale work, while small businesses and contractors remain essential to building-level deployment.

This report uses the term thermal workforce to describe the full range of workers involved in delivering heating and cooling to buildings across both fossil fuel and clean energy systems. This framework shifts the focus of decarbonization away from fuel categories alone and toward the services the energy system must continue to provide: reliable, affordable heating and cooling. In doing so, it aligns workforce planning with how thermal systems are actually changing over time. Rather than treating fossil fuel jobs and clean energy jobs as separate or competing categories, the thermal workforce framework understands them as part of a longer transition in which skills, occupations, and work functions evolve as technologies and infrastructure change.

The thermal workforce includes gas utility workers, pipeline and utility construction crews, and drillers, alongside electricians, plumbers, HVAC technicians, insulators, and other building energy professionals. It spans union and non-union labor, large utilities and small contractors, and urban and rural communities. It also reflects the reality that the shift from fossil fuel heat to clean heat will unfold over decades, not overnight, and will require workers who can operate across overlapping systems during that transition.

These occupations account for approximately 140,000 workers in Pennsylvania. This broader definition includes not only workers who install and maintain building equipment, but also workers involved in the extraction, processing, transport, and delivery of fuels and infrastructure that still support thermal service today. Over the past two decades, this workforce has remained relatively stable in overall size even as its internal composition has shifted. Independent contractors installing heat pumps, upgrading electrical panels, or insulating homes now far outnumber workers in any single fossil fuel category. Collectively, however, the thermal workforce remains a deep pool of skilled labor capable of delivering safe, efficient heating and cooling under evolving technologies and policy frameworks.

Under this framework, workers are not defined primarily by whether they currently work in fossil fuel or clean energy systems, but by the skills they can carry forward as the thermal sector evolves. A driller who now spends most of the year on oil and gas projects may increasingly apply similar expertise to geothermal and thermal energy network development. A plumber who now installs mostly gas equipment may gradually spend more time installing heat pumps, heat pump water heaters,

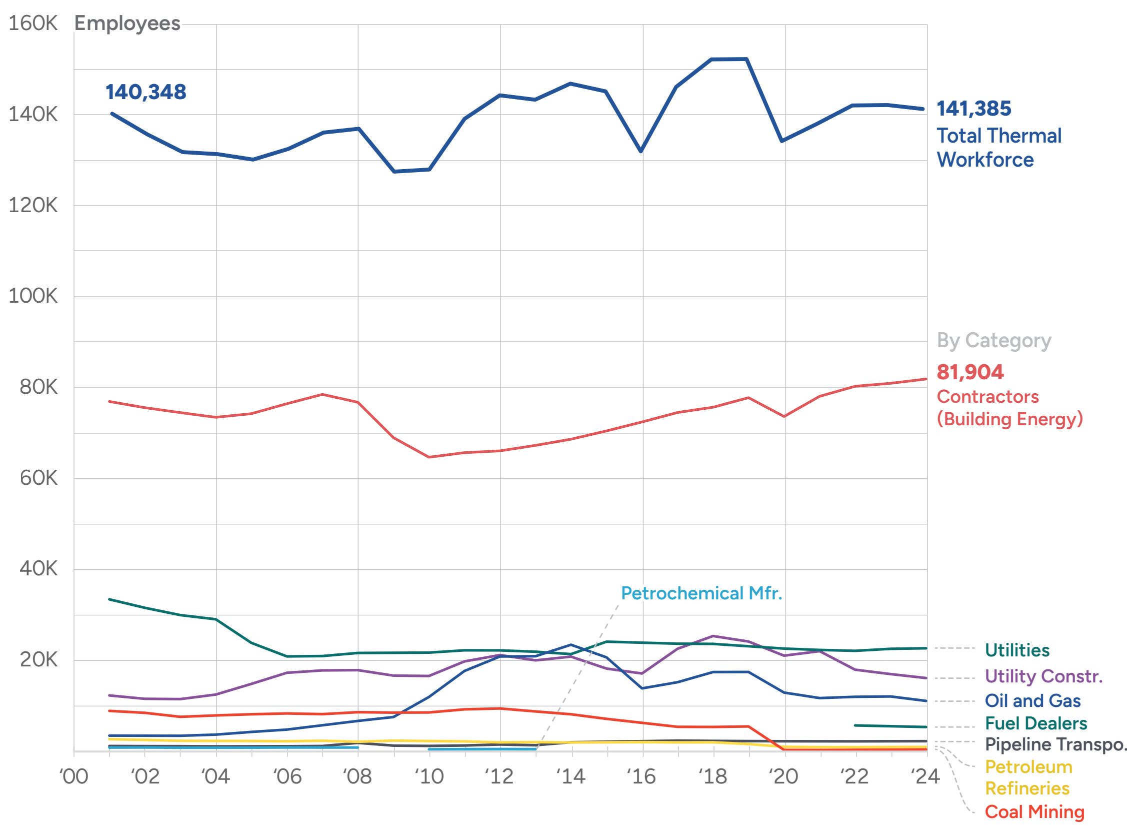
“The shift from fossil fuel heat to clean heat will unfold over decades, not overnight, and will require workers who can operate across overlapping systems during that transition.”

Table 5.1: Thermal Workforce Job Categories

Primary Category	Industry
Oil and Gas	NAICS 211 Oil and Gas Extraction
	NAICS 213111 Drilling oil and gas wells
	NAICS 213112 Support activities for oil and gas operations
Coal Mining	NAICS 21211 Coal mining
	NAICS 213113 Support activities for coal mining
Utilities	NAICS 221 Utilities
Utility Construction	NAICS 2371 Utility system construction
Contractors (Building Energy)	NAICS 23821 Electrical and wiring contractors
	NAICS 23822 Plumbing and hvac contractors
	NAICS 23831 Drywall and insulation contractors
Petroleum Refineries	NAICS 324110 Petroleum refineries
Petrochemical Manufacturing	NAICS 325110 Petrochemical manufacturing
Fuel Dealers	NAICS 457210 Fuel dealers
Pipeline Transportation	NAICS 486110 Pipeline transportation of crude oil
	NAICS 486210 Pipeline transportation of natural gas
	NAICS 486910 Pipeline transportation of refined petroleum

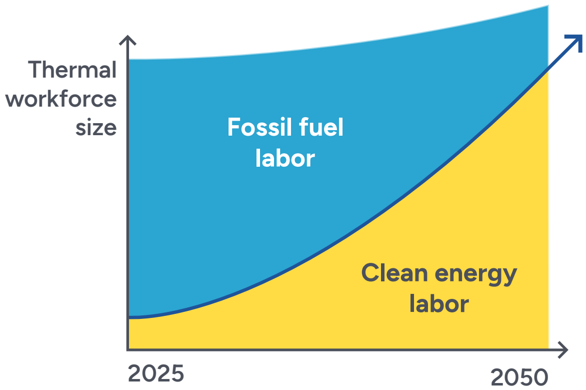
Data Source: Bureau of Labor Statistics

Figure 5.3: (Top) Total thermal workforce employment. (Bottom) Thermal workforce by category.



Data Source: Bureau of Labor Statistics

Figure 5.4: Illustration of the thermal workforce continuum



and related thermal distribution systems. In this way, decarbonization can expand and redirect the scope of work available to Pennsylvania's existing workforce rather than simply displacing it, allowing skills to migrate over time as technologies, infrastructure needs, and market demand change.

As Pennsylvania's thermal transition unfolds, the structure of the workforce will matter as much as its size. A thermal workforce framework helps clarify how work occurs at different scales and through different channels: house-by-house efficiency and electrification will continue to rely heavily on independent contractors and small businesses, while neighborhood-scale electrification and thermal energy networks can create infrastructure-intensive opportunities that are better suited to organized labor. Understanding this distinction is essential to assessing how union and non-union workers can play complementary roles in delivering clean, reliable thermal service.

Organized Labor and the Thermal Workforce

Organized labor has long played a central role in Pennsylvania's energy and industrial economy. From coal, coke, iron, and steel to gas utilities and large-scale infrastructure, unions have supplied the skilled workforce needed to build, operate, and maintain the systems that deliver energy and heat across the Commonwealth. As Pennsylvania confronts a gradual transition away from fossil fuel-based heating, organized labor remains essential not only because of its technical expertise, but because of its capacity to deliver large, complex projects at scale. Aligning thermal transition policy with organized labor is therefore both a workforce and a political imperative: durable, broad-based transition strategies must work for skilled workers and the communities that depend on them.

High-Road Standards in Large-Scale Thermal Projects

Union labor is most prevalent in commercial, industrial, and infrastructure-scale projects rather than individual single-family retrofits. This reflects both the structure of union work and the nature of major construction projects, which are more likely to use Project Labor Agreements (PLAs) and Community Benefit Agreements (CBAs). PLAs can establish consistent labor standards, safety requirements, and hiring practices across large projects, while CBAs can help ensure that projects deliver tangible benefits to host communities, including local hiring, diversity goals, and prevailing wages. Together, these tools can support stable, high-road employment while strengthening public support for large-scale thermal investments.

> **"While some union leadership remains cautious, younger workers increasingly see clean heat infrastructure as a way to future-proof their sector and broaden their skillset."**

Key Unions in Pennsylvania's Thermal Workforce

As of 2024, 11.7 percent of Pennsylvania's workforce was part of a union, compared to 10 percent nationally.[126] Unions with significant relevance to the thermal workforce include, but are not limited to:

- International Association of Heat and Frost Insulators and Allied Workers (AWIU)
- International Association of Sheet Metal, Air, Rail and Transportation Workers (SMART)
- International Brotherhood of Electrical Workers (IBEW)
- International Union of Operating Engineers (IUOE)
- International Union of Painters and Allied Trades (IUPAT)
- International Union, United Automobile, Aerospace and Agricultural Implement Workers of America (UAW)
- Laborers' International Union of North America (LIUNA)
- Operative Plasterers' & Cement Masons' International Association (OPCMIA)
- International Brotherhood of Teamsters (IBT)
- The International Association of Bridge, Structural, Ornamental and Reinforcing Iron Workers (IW)
- United Association of Plumbers, Steamfitters, Refrigeration, and Pipefitters (UA)
- United Brotherhood of Carpenters and Joiners of America (UBC)
- United Steelworkers (USW)
- Utility Workers Union of America (UWUA)

See Appendix D for a description of how these unions contribute to neighborhood-scale decarbonization and thermal infrastructure.

126 "Union Members in Pennsylvania — 2024," Bureau of Labor Statistics, accessed November 6, 2025, https://www.bls.gov/regions/mid-atlantic/news-release/unionmembership_pennsylvania.htm.

Neighborhood-Scale Decarbonization as a Pathway to Union-Scale Work

A central challenge for organized labor in the thermal transition is ensuring sufficient scale and continuity of work. Residential projects pursued one building at a time often lack the size, duration, and coordination needed to support union labor. Neighborhood-scale decarbonization addresses this challenge by aggregating residential demand into infrastructure-scale projects that more closely resemble commercial work. These projects can support PLAs, justify long-term workforce planning, and create more predictable pipelines of work.

For unions that currently install and maintain gas pipelines, such as UA, electrification can be perceived as a threat. Thermal energy networks, however, rely on many of the same competencies used in gas distribution and use pipes that are often similar in size, material, and installation method to those used in the gas system. Stakeholders interviewed for this report also noted that, while some union leadership remains cautious, younger workers increasingly see clean heat infrastructure as a way to future-proof their sector and broaden their skillset.

Cornell ILR's Climate Jobs Institute offers a useful policy model for linking neighborhood-scale decarbonization with workforce planning. Its proposed Carbon-Free Keystone State Act suggests that public buildings like state colleges and universities can serve as "anchors for thermal energy networks, scaling decarbonization into neighboring residential and commercial blocks."[127] As public sector projects, they would also be subject to prevailing wage and high labor standards, but should also prioritize hiring displaced fossil fuel workers and workers from underrepresented communities.[128] This proposal demonstrates how neighborhood-scale decarbonization projects anchored by public institutions, governed by high labor standards, and inclusive of fossil fuels workers could create durable union work while helping existing fossil fuel workers transition into clean thermal infrastructure.

127 Reyna Cohen et al., *A Climate Jobs Program for Pennsylvania* (Ithaca, NY: Cornell University ILR School, Climate Jobs Institute, 2024), 52, https://www.ilr.cornell.edu/sites/default/files-d8/2024-08/ILR_CJI_PA%20State%20Report_0.pdf.
128 Cohen et al., *A Climate Jobs Program for Pennsylvania*, 53.

Independent Contractors and the Residential Thermal Workforce

Independent contractors, including small businesses and sole proprietors outside of unions, form the backbone of Pennsylvania's residential thermal workforce. They perform the majority of building-level work, including home remediation and repair, weatherization, HVAC installation and maintenance, water heater replacement, electrical upgrades, wiring, panel replacements, and, increasingly, heat pump and solar installations. Their work is critical to improving building performance and delivering clean thermal services at the household level.

Existing Capacity and Workforce Constraints

A 2023 survey of Pennsylvania's energy efficiency workforce found that more than 90 percent of responding businesses primarily engaged in HVAC and plumbing work, and that approximately half regularly installed heat pump technologies, including air-source heat pumps, ground-source heat pumps, and heat pump water heaters.[129] These findings suggest that a significant portion of the residential thermal workforce already has relevant clean energy experience, even as gas appliances remain common.

Despite this foundation, independent contractors face several interrelated barriers that limit the pace and scale of residential decarbonization. Workforce capacity is one of the most persistent. In many parts of the state, especially rural areas, there are simply not enough contractors to meet current or projected retrofit demand, limiting the reach of clean heat deployment outside urban centers. Urban areas face similar constraints at scale. In Philadelphia, for example, stakeholders have identified workforce availability as a primary barrier to meeting city-specific energy efficiency goals. Decarbonizing Philadelphia is especially labor-intensive because much of the city's building stock consists of small residential and multifamily structures, while the supply of HVAC technicians, electricians, plumbers, and weatherization specialists remains limited.

Workforce upskilling is an additional challenge. While roughly half of the non-union workforce already works with heat pumps, training the remaining portion presents logistical and financial barriers, especially for small businesses with only a few crew members. Taking workers off job sites for training can strain operations, and many contractors lack access to affordable, coordinated training programs tailored to clean thermal technologies.

Even so, independent contractors will remain indispensable to the thermal transition. Their proximity to customers, flexibility, and deep experience in residential HVAC, plumbing, electrical work, and weatherization position them to drive building-level upgrades that improve comfort, lower energy bills, and reduce emissions. Sustaining the pace of residential decarbonization will therefore require targeted training, workforce development funding, and streamlined programs designed to support non-union contractors and small businesses.

129 Pennsylvania Department of Environmental Protection, *Pennsylvania Energy Efficiency Workforce Needs (Pennsylvania Dept. of Environmental Protection, 2023)*, 23, https://files.dep.state.pa.us/Energy/Office%20of%20Energy%20and%20Technology/OETDPortalFiles/2023_Energy_Report/PA%20EE%20Workforce%20Needs%20Report%20Final.pdf.

Table 5.2: Union and Independent Contractor Roles in the Thermal Transition

Dimension	Union Labor (Neighborhood Scale)	Independent Contractors (Building Scale)
Primary role	Deliver large, coordinated thermal infrastructure and multi-building decarbonization projects	Deliver clean heat through house-by-house and appliance-by-appliance upgrades
Core strengths	Scale, durability, complex project management, standardized safety and labor practices	Flexibility, customer proximity, speed, customized solutions
Clean heat technologies	Thermal energy networks, air- and ground-source heat pump systems, heat pump water heaters, induction and electric stoves, electric dryers weatherization and panel upgrades	Individual air- and ground-source heat pumps, heat pump water heaters, induction and electric stoves, electric dryers, weatherization and panel upgrades
Workforce structure	Unionized crews operating under PLAs/CBAs with long-term, predictable work horizons	Small businesses and sole proprietors responding to local and customer-driven demand
Training model	Formal apprenticeships, union training centers, standardized certification pathways	On-the-job learning, manufacturer trainings, short courses, and small-business programs
Customer interface	Indirect—working with utilities, municipalities, developers, and project sponsors	Direct—trusted relationships with homeowners and small building owners
Role in thermal transition	Enable system-level change by replacing gas infrastructure with clean thermal systems	Ensure quality installs at the building level that increase consumer confidence in electric technologies
Economic function	Anchor large capital investments and reduce system-wide costs through coordinated deployment	Lower per-household costs through targeted upgrades and incremental improvements
How roles complement each other	Build the backbone infrastructure that enables neighborhood-scale transitions away from gas	Complete in-building connections and retrofits that make neighborhood-scale systems functional and affordable

Coordination with Union-Led, Neighborhood-Scale Decarbonization

Independent contractors are not expected to carry the thermal transition alone. Neighborhood-scale decarbonization creates a complementary pathway in which unions and larger contractors take on infrastructure-scale work, such as thermal energy networks and coordinated multi-building projects, while independent contractors continue to focus on house-by-house installations and retrofits. Together, these approaches form a mutually reinforcing thermal workforce ecosystem: unions provide the scale, durability, and project structure needed for system-level transformation, while small businesses ensure that clean thermal technologies reach individual homes efficiently and equitably. Aligning policy and investment around this complementary division of labor will be critical to building a thermal sector that is affordable, resilient, and capable of meeting Pennsylvania's long-term climate and workforce goals.

"Unions provide the scale, durability, and project structure needed for system-level transformation, while small businesses ensure that clean thermal technologies reach individual homes efficiently and equitably."

Southwestern Pennsylvania: A Regional Model for Thermal Workforce Coordination

Southwestern Pennsylvania illustrates how a regional, thermal-sector approach can align workforce development, clean energy deployment, and economic transition. Anchored by Allegheny County and the greater Pittsburgh region, the area has developed a dense ecosystem of institutions working across labor, economic development, climate planning, and workforce training, creating clearer pathways into clean thermal careers.

Key initiatives include:[1]

- **Clean Energy Workforce Roundtable (Sustainable Pittsburgh):** Convening employers, labor, training providers, and community organizations to coordinate workforce needs across clean energy sectors.
- **Southwestern Pennsylvania New Economy Collaborative:** An 11-county coalition focused on inclusive economic development and regional clean energy growth.
- **Pittsburgh Workforce Development Hub:** Led by the City of Pittsburgh, supporting coordinated workforce strategies tied to climate and infrastructure investments.
- **Pittsburgh Canopy Alliance:** A multi-partner initiative linking workforce development to neighborhood-scale climate and infrastructure improvements.
- **Southwestern Pennsylvania Commission's Priority and Comprehensive Climate Action Plan:** Integrating workforce planning with regional decarbonization strategies.

Together, these efforts demonstrate how workforce development is most effective when treated as a regional system, rather than a collection of isolated programs. Southwestern Pennsylvania's approach offers a replicable model for aligning labor, utilities, contractors, and public agencies around the buildout of a durable thermal workforce capable of supporting building decarbonization, industrial transition, and emerging thermal infrastructure.

1 Sustainable PGH, *Clean Energy Workforce Needs and Opportunities for Southwestern PA*, 6.

Opportunities for Growing the Thermal Workforce in Pennsylvania

Key Takeaways

- Pennsylvania has multiple pathways for thermal workforce growth, including geothermal and thermal energy networks, building-level efficiency and electrification, weatherization, and clean industrial heat.
- Many of the skills needed for these pathways already exist in Pennsylvania's workforce, especially in drilling, pipelaying, HVAC, electrical, plumbing, and industrial trades, creating real opportunities for continuity and retraining rather than displacement.
- Thermal energy networks and geothermal infrastructure are especially promising because they can create infrastructure-scale work that aligns closely with existing gas utility, pipeline, and drilling skills while supporting a managed transition for affected workers.
- Scaling these opportunities into durable, high-quality jobs will require coordinated training, supportive labor standards, workforce protections, and sustained project pipelines tied to long-term thermal infrastructure investment.

Pennsylvania's thermal workforce is well positioned to support decarbonization while continuing to mature and evolve. A thermal workforce approach highlights multiple, overlapping pathways for job creation and skill development that build on existing occupations, infrastructure expertise, and regional capacity. These opportunities span infrastructure-scale investments in geothermal and thermal energy networks, continued growth in energy efficiency and electrification work at the building level, and emerging roles in industrial heat and process decarbonization. Together, they show how a thermal-sector framework can support workforce continuity, system affordability, and long-term economic resilience in Pennsylvania. One of the clearest infrastructure-scale opportunities is the growth of geothermal and thermal energy networks, which can draw on existing drilling, piping, utility, and building-trades skills. Pennsylvania already has precedents for this kind of shared thermal infrastructure in district energy systems.

Precedents in District Energy

While thermal energy networks (TENs) are newer to regulated utilities, the underlying concept of shared thermal infrastructure is well established. College campuses, private developments, and other single-owner building clusters have long used district energy systems to lower costs and improve efficiency, offering an important precedent for understanding thermal energy networks as an evolution of proven heat distribution systems rather than speculative new technologies.

District energy systems have been in use for more than a century and have advanced alongside improvements in efficiency and design: first-generation systems were steam-based and coal-fueled, while fifth-generation systems now incorporate features similar to thermal energy networks, including ambient-temperature water loops and building-level heat pumps that extract and reject heat to a shared network.[130] Unlike thermal energy networks, which rely on distributed ambient thermal sources, traditional district energy systems typically generate heat in a centralized location and distribute it through underground piping to provide heating and cooling to multiple buildings.[131] Historically, that heat often came from fossil-fueled cogeneration plants, but newer systems increasingly rely on renewable sources, including geothermal energy and industrial-scale electric heat pumps.

Two Pennsylvania campuses illustrate this evolution especially well.[132] West Chester University's geothermal exchange system, operational since 2014, uses about 900 wells to heat and cool nearly 1.2 million square feet, or almost half of campus buildings. The system operates at coefficients of

130 "Thermal Energy Networks (Definitions)," *Building Decarbonization Coalition*, n.d., accessed April 11, 2026, https://buildingdecarb.org/resource-library/ten-definitions.
131 "Thermal Energy Networks (Definitions)," *Building Decarbonization Coalition*.
132 Building Decarbonization Coalition, "Neighborhood-Scale Building Decarbonization Map," accessed November 12, 2025, https://buildingdecarb.org/neighborhood-scale-projects-map.

performance of 3.4 for heating and 4.8 for cooling, is 47 percent more efficient than the system it replaced, reduces CO_2, SO_2, and NO_x emissions by 37 percent, 73 percent, and 71 percent, respectively, and saves about $1.5 million annually in energy costs. It replaced a decommissioned coal-fired steam plant, showing how shared thermal infrastructure can modernize legacy campus energy systems while improving performance.[133]

Swarthmore College is building a geoexchange system that will replace an aging gas-fired steam network. The project includes up to 900 boreholes across roughly 200,000 square feet and will serve multiple campus buildings, often in conjunction with efficiency upgrades. Together, these examples show that shared thermal systems are already being deployed in Pennsylvania and can deliver measurable cost, efficiency, and emissions benefits.[134]

Geothermal and Thermal Energy Networks

Pennsylvania is well positioned to expand geothermal and thermal energy as part of its broader thermal transition. The Commonwealth has significant potential to harvest, store, and distribute thermal energy for building heating and cooling through thermal energy networks, for direct use in some industrial processes, and, in limited locations, for electricity generation.[135] These opportunities align closely with Pennsylvania's existing skills base, infrastructure expertise, and energy workforce, making thermal energy not only a climate solution, but also a workforce and economic development strategy.

Developing thermal resources at scale will require an expansive thermal workforce, especially skilled drillers capable of constructing both deep geothermal wells and the shallower borefields used in thermal energy networks. Over the past 15 years, development of the Marcellus Shale Formation has made Pennsylvania a national hub for this type of expertise. With targeted retraining, that workforce can help build the next generation of thermal infrastructure.

> **"With its deep experience extracting coal, oil, and natural gas from the ground, Pennsylvania has the know-how and workforce necessary to tap into the next frontier in subsurface energy: geothermal."**
>
> — The Future of Geothermal in Pennsylvania [136]

Thermal Energy Networks

Thermal energy networks (TENs) are a particularly promising opportunity for transitioning portions of the gas utility workforce into clean thermal infrastructure. These systems distribute energy through closed-loop underground pipe networks that, when paired with heat pumps, can efficiently deliver heating and cooling to multiple buildings with diverse energy needs. From a workforce perspective, TENs provide a direct bridge between today's gas system work and tomorrow's clean thermal infrastructure.

Many of the trades most exposed to a long-term decline in gas throughput, especially pipefitters and pipelayers, are already well suited to thermal network construction and operation. Geothermal distribution pipes are typically similar in size and material to gas pipes and are often made of the same high-density polyethylene plastic. As a result, gas utility workers who install, maintain, and repair gas mains and services are often well positioned to perform comparable work on thermal network loops with relatively limited retraining.

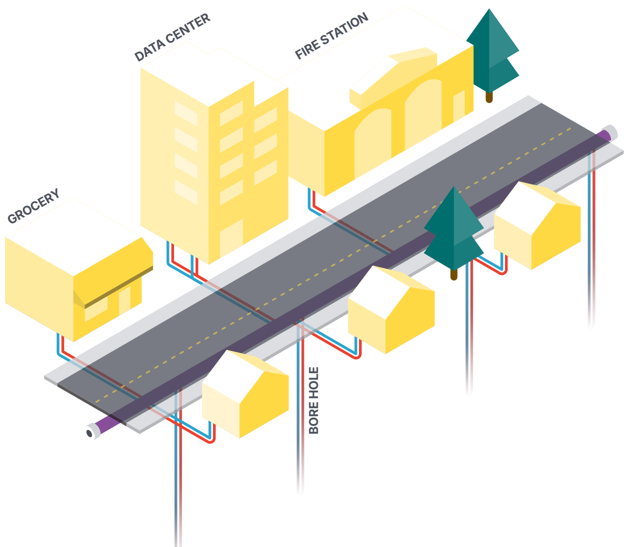
Geothermal Energy

Beyond pipelaying for thermal energy networks, the development of geothermal energy applications creates demand for a wide range of occupations already present in Pennsylvania's energy workforce. According to one recent study, there are close to 40,000 workers "directly involved in drilling, producing, refining, and transporting oil, gas, and

133 Building Decarbonization Coalition, "Neighborhood-Scale Building Decarbonization Map."
134 Building Decarbonization Coalition, "Neighborhood-Scale Building Decarbonization Map."
135 Todd Aagard et al., *The Future of Geothermal in Pennsylvania* (Project Innerspace, 2025), 41–42, chic.
136 Todd Aagard et al., *The Future of Geothermal in Pennsylvania*, 41.

> **“Gas utility workers who install, maintain, and repair gas mains and services are often well positioned to perform comparable work on thermal network loops with relatively limited retraining.”**

Figure 5.5: Illustration of a thermal energy network connecting a diverse set of buildings.



coal, who could immediately benefit from jobs created by the development of next-generation geothermal” in Pennsylvania.[137] In addition to plumbers and pipefitters, there are many other skilled workers who play critical roles in developing geothermal wells and designing, constructing, and maintaining thermal systems, including: geologists, drillers, engineers, landmen, and process engineers.[138] For drilling-specific roles, workforce needs include drillers, assistant drillers, and field technicians responsible for rig operation, borehole installation, equipment handling, and site management—all of which closely mirror existing oil and gas field positions.

137 Todd Aagard et al., *The Future of Geothermal in Pennsylvania*, 21.
138 Todd Aagard et al., *The Future of Geothermal in Pennsylvania*, 21.

From Gas to Geo: Drilling Jobs in the Thermal Transition

Thermal energy networks create immediate, high-skill employment opportunities for Pennsylvania’s existing oil and gas drilling workforce. Many of the competencies used in gas extraction and well development directly transfer to geothermal and thermal network construction, requiring minimal retraining.

According to Brock Yordy, a global drilling trainer, key drilling-related roles in thermal energy network deployment include:

- **Driller:** Rig operation; borehole drilling; product installation; resource extraction; project completion; and regulatory documentation.
- **Assistant Driller:** Rig support; tool handling; product assembly; installation assistance; and site closeout.
- **Field Technician:** Solids control management; tooling layout; product staging; assembly and installation support; and site cleanup.

These roles mirror existing oil and gas field positions, reinforcing that thermal energy networks represent a continuation and evolution of subsurface and thermal energy work, rather than a departure from it. With Pennsylvania’s deep bench of experienced drillers, the Commonwealth is uniquely positioned to scale thermal infrastructure while preserving high-quality, family-sustaining jobs.

Employment Impacts and Managed Transition

At scale, thermal energy networks can support substantial and sustained employment. A recent study by the Building Electrification Institute (BEI) examining workforce impacts for Philadelphia Gas Works found that if 50 to 100 percent of buildings larger than 50,000 square feet in Philadelphia were connected to thermal energy networks, between 3,000 and 8,000 annual full-time jobs would be required between 2025 and 2050.[139] Importantly, the study concluded that these jobs would rely on skill sets very similar to those already found in the gas workforce.

This finding underscores a central advantage of a thermal-sector approach: decarbonization need not be an abrupt or destabilizing workforce shift. When implemented through a managed, multi-decade transition, thermal energy networks can allow workers to move gradually from gas-only infrastructure toward clean thermal systems as retirements, hiring cycles, and infrastructure needs evolve. BEI's analysis found that such a transition would not negatively affect PGW's workforce under current retirement and hiring trends, demonstrating that job loss is not an inevitable outcome of clean heat policies when planning is deliberate and coordinated.[140] PGW offers a concrete example of how a large, legacy gas utility can operationalize a managed transition within an urban, unionized workforce.

139 Building Electrification Institute, *Philadelphia Building Decarbonization Workforce Impacts and Opportunities | Economy League of Greater Philadelphia* (2023), 8, https://www.economyleague.org/resources/philadelphia-building-decarbonization-workforce-impacts-and-opportunities.

140 Building Electrification Institute, *Philadelphia Building Decarbonization Workforce Impacts and Opportunities | Economy League of Greater Philadelphia*, 28.

Philadelphia Gas Works: A Model for the Thermal Utility Transition

Philadelphia Gas Works (PGW), the nation's largest municipally owned gas utility, provides a rare, utility-scale test case for how gas utilities can evolve into thermal service providers while maintaining workforce stability and job quality.

Analysis by the Building Electrification Institute finds that pairing building electrification with thermal energy networks creates substantially more employment than electrification alone—and, critically, that a managed, multi-decade transition would not reduce PGW's existing workforce, given current hiring and retirement trends.[1] The findings underscore that workforce risk is not inherent to decarbonization, but to how the transition is structured.

The central insight from the PGW case study is that positioning a gas utility to become a thermal utility expands, rather than contracts, its role in the energy system. In fact, "Positioning PGW to invest, own, and expand in decarbonization technologies will not only provide new revenue opportunities for the utility and the City, but also would offer the best chance for protecting current gas workers."[2] While decarbonization may be conceived as a threat for utility business models and workforce stability, it is in fact an opportunity to develop the next era of heating and cooling.

PGW demonstrates that neighborhood-scale decarbonization does not need to be an existential threat to gas workers. When utilities are enabled to evolve, decarbonization becomes a pathway for workforce continuity and long-term system relevance.

1 Building Electrification Institute, *Philadelphia Building Decarbonization Workforce Impacts and Opportunities | Economy League of Greater Philadelphia*, 26.

2 Building Electrification Institute, *Philadelphia Building Decarbonization Workforce Impacts and Opportunities | Economy League of Greater Philadelphia*, 7.

Utility Leadership and National Momentum

Across the country, utilities are increasingly exploring TENs as part of their long-term business strategies. As of April 2026, thirteen states have enacted legislation explicitly authorizing, encouraging, or otherwise advancing TENs, often with provisions related to labor standards, workforce transition, and utility participation. Utility ownership is significant because it can help projects scale in both infrastructure deployment and workforce development while leveraging existing rights-of-way, financing capacity, and operational expertise. If early pilots continue to build support among workers, customers, communities, lawmakers, and utility leadership, this model could contribute to a broader regulatory shift in which gas utilities and their workforces evolve into thermal utilities and a broader thermal workforce.

This momentum is already translating into real projects. Twenty-six utility-owned thermal energy networks (UTENs) are currently advancing across eight states: Colorado, Maryland, Massachusetts, Minnesota, New Jersey, New York, Washington, and Illinois.[141] Eighteen gas and dual-fuel utilities are behind these efforts, pivoting toward a model of thermal utility service focused on delivering heating and, through heat pumps, cooling, rather than gas as a fuel. Eversource Energy, for example, is expanding beyond its flagship UTEN in Framingham, Massachusetts, while National Grid's geothermal network pilot in Boston is expected to break ground next.

The Framingham project, which went live in June 2024 as the first utility-led thermal energy network in the United States, offers an early workforce proof point. Built using a mix of union and non-union labor, the project showed that gas pipelayers could transition effectively to thermal network construction.[142] It also revealed a key constraint: a limited supply of qualified drillers. Pennsylvania, with its existing drilling workforce, is especially well positioned to meet this demand and scale similar projects more rapidly.

Workforce Protections and Policy Design

Gas utilities and gas utility workers are understandably concerned about the effects of a clean energy transition on their livelihoods. A thermal-sector framework directly addresses these concerns by emphasizing continuity of skills, gradual transition, and the preservation of high-road jobs. Recent legislation in states such as New York, Colorado, and Maryland includes a number of provisions for labor involvement and protection, ensuring that the workers today are prioritized for the good jobs of the future.[143]

By positioning gas utilities as future thermal utilities, and gas workers as part of a broader thermal workforce, Pennsylvania can shift the narrative from displacement to adaptation. Thermal energy networks and the broader geothermal economy offer a pathway for the state's existing oil and gas workforce to expand its scope of work and remain central to the energy system over a long transition period.

> **"By positioning gas utilities as future thermal utilities, and gas workers as part of a broader thermal workforce, Pennsylvania can shift the narrative from displacement to adaptation."**

141 "Thermal Energy Networks (State Legislation)," *Building Decarbonization Coalition*, n.d., accessed April 21, 2026, https://buildingdecarb.org/resource-library/tens-state-leg.

142 Jessica Silber-Byrne, "Case Study: Framingham, Massachusetts," *Building Decarbonization Coalition*, 2025, https://buildingdecarb.org/resource/case-study-framingham-massachusetts.

143 Ana Maria Camargo et al., *The Future of Heat: Thermal Energy Networks as an Evolutionary Path for Gas Utilities Toward a Safe, Equitable, Just Energy Transition*, August 2024.

Energy Efficiency and Electrification

Energy efficiency and electrification represent the most immediately scalable component of Pennsylvania's thermal workforce. For workers already employed in electrical, HVAC, plumbing, and building performance trades, the transition to clean thermal systems is largely an extension of existing work rather than a departure from it. Even without thermal energy networks, projected growth in energy efficiency and electrification alone is expected to significantly increase demand for skilled thermal labor across the Commonwealth.

A 2023 workforce analysis conducted for the Pennsylvania Department of Environmental Protection (PA DEP) identified strong growth trajectories across six occupations that are central to delivering clean heat in buildings:[144]

- Electricians
- Floor, Ceiling, and Wall (FCW) Insulation Workers
- Plumbers, Pipefitters, and Steamfitters
- Heating, Air Conditioning, and Refrigeration (HVAC/R) Mechanics and Installers
- Construction and Building Inspectors, including energy auditors and Home Energy Rating System (HERS) raters
- Other Construction and Related Workers

These occupations form the backbone of building-level thermal work. They are generally accessible, family-sustaining jobs that do not require a four-year degree, expanding participation in the thermal workforce across regions and communities.[145] Employment projections underscore the scale of this opportunity: based on Bureau of Labor Statistics data, the 2023 Pennsylvania Energy Efficiency Workforce Needs Report projects that by 2032 electrician jobs will grow by approximately 17 percent, HVAC/R jobs by 21 percent, and plumber and pipefitter jobs by 22.5 percent.[146] These trends indicate that energy efficiency and electrification will continue to anchor thermal workforce growth over the coming decade, even as more advanced thermal infrastructure comes online.

Workforce structure varies by market segment. In the residential energy efficiency and electrification sector, most workers are independent contractors or employees of small businesses. In contrast, commercial and larger-scale projects are more likely to engage union labor affiliated with building trades such as the International Brotherhood of Electrical Workers (IBEW), the United Association of Plumbers and Pipefitters (UA), and SMART. Together, these complementary workforce models enable clean thermal deployment at both the building and neighborhood scale.

Weatherization

Weatherization workers ensure that homes and buildings are properly insulated, sealed, and prepared to deliver efficient, reliable heating and cooling. Weatherization is fundamental to the thermal transition because it reduces energy demand, lowers customer bills, improves comfort and resilience, and enables electrification and other clean thermal systems to perform effectively.

Pennsylvania has already made substantial investments in this workforce. The Clean Energy Center at Pennsylvania College of Technology operates a nationally recognized training program offering weatherization certification and Quality Control Inspector credentials. Funded by the Pennsylvania Department of Community and Economic Development as part of the Weatherization Assistance Program, the initiative has enrolled more than 22,000 trainees since 1985 across three core tracks: residential building performance, commercial energy efficiency, and building electrification and solar PV.[147]

Weatherization workers also play a critical role in protecting vulnerable households. Local agencies coordinate with the Department of Human Services and the Department of Community and Economic Development to serve Low-Income Home Energy

144 Pennsylvania Department of Environmental Protection, *Pennsylvania Energy Efficiency Workforce Needs*, 2.
145 Pennsylvania Department of Environmental Protection, *Pennsylvania Energy Efficiency Workforce Needs*, 9.
146 Pennsylvania Department of Environmental Protection, *Pennsylvania Energy Efficiency Workforce Needs*, 12.

147 "Clean Energy Center Expands | Pennsylvania College of Technology," accessed April 11, 2026, https://www.pct.edu/magazine/articles/2025/02/18/clean-energy-center-expands.

> **“As clean thermal technologies scale, a strong weatherization workforce will remain essential to making that transition durable, equitable, and cost-effective.”**

Assistance Program (LIHEAP) customers facing heating system failures during winter months. This work includes repairing or replacing heating equipment, addressing pipe and fuel line issues, improving building envelopes, and correcting safety hazards such as broken windows and air leaks.

By linking workforce training with direct household assistance, Pennsylvania is strengthening a segment of the thermal workforce that delivers immediate affordability, health, and resilience benefits while preparing the building stock for a managed transition to lower-emission heating systems. As clean thermal technologies scale, a strong weatherization workforce will remain essential to making that transition durable, equitable, and cost-effective.

Industrial Decarbonization

Industrial heat is both a major challenge and a major workforce opportunity within Pennsylvania’s thermal transition. Energy-intensive industries such as steel, cement, glass, chemicals, food processing, and paper manufacturing rely on high-temperature thermal processes that have historically depended on fossil fuels.[148] Today, manufacturing contributes more than $113 billion to Pennsylvania’s state domestic product, supports roughly 11 percent of jobs, and accounts for approximately one-third of statewide greenhouse gas emissions, the largest share of any single sector.[149] Globally, iron and steel, chemicals, and cement production together account for nearly 60 percent of industrial emissions, underscoring the central role of industrial heat in the broader decarbonization challenge.[150]

148 Goodenbery et al., *A Roadmap for Industrial Decarbonization in Pennsylvania*, 6.
149 Goodenbery et al., *A Roadmap for Industrial Decarbonization in Pennsylvania*, 4.
150 Jeffrey Rissman, *Zero-Carbon Industry: Transformative Technologies and Policies to Achieve Sustainable Prosperity* (Columbia University Press, 2024), 3.

A thermal-sector lens helps clarify both the scale of the opportunity and the urgency of action by focusing attention on industrial heat infrastructure, especially industrial boilers. According to Evergreen Action, Pennsylvania is home to 798 industrial boilers, the seventh-highest number of any state. These boilers generate heat and steam for a wide range of industrial processes and are a significant source of climate and air pollution.[151] Collectively, boilers are responsible for an estimated 5 to 10 percent of industrial carbon dioxide emissions and roughly 6 percent of industrial nitrogen oxide (NOx) emissions nationwide.[152] Boiler pollution is also unevenly distributed: about 20 percent of Pennsylvania's industrial boilers are located in disadvantaged communities, where boilers emit far more pollutants than boilers in non-disadvantaged areas.[153]

Advances in clean thermal technologies are expanding the range of industrial heat applications that can transition away from fossil fuels. Electric boilers, industrial heat pumps, and thermal energy storage systems are now commercially available and technically viable for many low- and medium-temperature industrial processes, particularly those operating below 200°C.[154] In these applications, electrified alternatives can deliver meaningful emissions reductions while maintaining reliability and performance compared with legacy fossil-fueled equipment. Framing industrial decarbonization around clean heat, rather than as a diffuse collection of hard-to-electrify challenges, helps clarify where near-term progress is most feasible. A thermal-sector lens highlights industrial heat as a discrete, addressable system, creating clearer pathways for emissions reduction while laying the groundwork for longer-term transitions in higher-temperature processes.

Clean Industrial Heat as a Workforce Opportunity

The deployment of clean industrial heat technologies represents a major opportunity for workforce continuity and growth in Pennsylvania's industrial regions. As facilities adopt electric boilers, industrial heat pumps, thermal energy storage, and related systems, demand will increase for skilled workers who are already central to the Commonwealth's thermal workforce. Rather than displacing existing industrial labor, clean thermal retrofits can expand the scope of work

> **"A thermal-sector lens highlights industrial heat as a discrete, addressable system, creating clearer pathways for emissions reduction while laying the groundwork for longer-term transitions in higher-temperature processes."**

151 Sierra Club and Evergreen Action, "Industrial Boiler Pollution in Pennsylvania," May 2025, https://www.sierraclub.org/sites/default/files/2025-05/state-boiler-factsheet-pennsylvania.pdf.
152 Sierra Club and Evergreen Action, "Industrial Boiler Pollution in Pennsylvania."
153 Sierra Club and Evergreen Action, "Industrial Boiler Pollution in Pennsylvania."
154 Sierra Club and Evergreen Action, "Industrial Boiler Pollution in Pennsylvania."

for occupations that already support industrial operations today.

More than 210,000 Pennsylvanians are already employed in these occupations, including: electricians; HVAC/R mechanics and installers; plumbers, pipefitters, steamfitters, and pipelayers; boilermakers; welders; insulation workers; construction laborers and equipment operators; and industrial machinery installation, repair, and maintenance workers.[155]

These occupations generally pay above the statewide median wage, with unionized positions offering even higher compensation and stronger benefits.[156] As programs such as RISE PA, the Commonwealth's $396 million industrial decarbonization initiative,[157] scale up, investments in clean industrial heat can simultaneously reduce emissions, strengthen industrial competitiveness, and expand stable, high-road employment opportunities within Pennsylvania's thermal workforce.

Structural Barriers to Industrial Decarbonization

Even with this growing technological potential, industrial decarbonization is often treated as separate from residential and commercial building decarbonization and relegated to a so-called hard-to-electrify category. The sector is also challenging for regulators because industrial systems are complex and because manufacturing remains a source of high-quality jobs, making policymakers cautious about requirements that could affect competitiveness.[158] These dynamics help explain why, even as Pennsylvania reduced net economy-wide emissions by 17.6 percent between 2005 and 2019, industrial emissions increased by nearly 11 percent over the same period.[159]

155 BW Research Partnership, "RISE PA Workforce Assessment," Memorandum, [bw] Research Partnership, February 24, 2024, 4.
156 BW Research Partnership, "RISE PA Workforce Assessment," 6.
157 Pennsylvania Department of Environmental Protection, "RISE PA," accessed February 6, 2026, https://www.pa.gov/agencies/dep/programs-and-services/energy-programs-office/rise-pa.
158 Rissman, *Zero-Carbon Industry: Transformative Technologies and Policies to Achieve Sustainable Prosperity*, 3.
159 Goodenbery et al., *A Roadmap for Industrial Decarbonization in Pennsylvania*, 8.

Community Health and Co-Benefits of Clean Industrial Heat

Decarbonizing industrial heat also delivers direct and localized public health benefits alongside long-term climate gains. Many of Pennsylvania's highest-emitting industrial boilers are concentrated in a relatively small number of communities, including Mon Valley in Allegheny County, where decades of steelmaking have contributed to persistently poor air quality and exacerbated "generational health disparities and social inequalities."[160]

Reducing combustion-based industrial heat through electrification and other clean thermal alternatives can significantly lower exposure to particulate matter and toxic air pollutants. These reductions improve community health outcomes while also supporting a durable transition away from legacy industrial infrastructure in regions that have historically borne a disproportionate share of environmental harm.

Challenges and Enabling Conditions for a Scaled Thermal Workforce

Pennsylvania has a strong foundation for building a thermal workforce, but several structural barriers continue to slow the pace and scale of the transition:

- **Inertia of business-as-usual infrastructure investment:** Much of Pennsylvania's thermal workforce remains tied to maintaining and replacing fossil fuel infrastructure, particularly gas systems. Without clear alternatives, capital investment and labor demand continue to flow toward like-for-like replacement rather than clean heat solutions. Overcoming this inertia will require framing the thermal transition as a managed evolution of the sector, making continuity of work visible to workers, and avoiding false binaries between fossil fuel and clean energy careers.
- **Fragmented workforce training and coordination:** Pennsylvania has more than 300 workforce training programs related to

160 PennFuture, "Mon Valley Campaigns."

construction, energy, and the skilled trades. While this breadth is an asset, it also creates coordination challenges, with programs varying widely by region, occupation, and funding source. Greater regional coordination, potentially led by counties, workforce boards, or utility service territories, could help align curricula, credentials, and recruitment with emerging thermal-sector demand.

- **Misalignment between job availability and workforce readiness:** Across both union and non-union stakeholders, a common refrain is that workers will be ready when jobs materialize. Scaling the thermal workforce therefore requires pairing long-term infrastructure planning with workforce development so that training programs prepare workers for durable, high-quality jobs tied to sustained project pipelines rather than short-term or stop-start markets.
- **Challenges for small businesses and independent contractors:** Independent contractors and small businesses face distinct barriers to full participation in the thermal transition. Upskilling often requires taking crews off job sites, straining already thin margins, while access to training and program information remains uneven. Targeted technical assistance, streamlined program design, and dedicated funding for small-business training will be critical to fully mobilizing this segment of the workforce.
- **Uneven contractor availability, especially in rural areas:** Contractor density remains a challenge in many rural parts of the Commonwealth, where few qualified firms may be available to perform energy efficiency or electrification work. Without intentional strategies, such as regional contracting models, mobile crews, or incentives to expand service areas, clean heat deployment risks remaining concentrated in urban and suburban markets.
- **Political headwinds:** Pennsylvania's thermal workforce transition faces persistent political resistance. The strength of the oil and gas lobby continues to shape state energy policy and public narratives around jobs, often amplifying misinformation about clean energy's impacts on workers. National and state trade associations, including the American Gas Association, American Petroleum Institute (API), Marcellus Shale Coalition, and Pennsylvania Independent Oil & Gas Association, have invested heavily in advocacy to prolong fossil fuel dependence. Pennsylvania, as the second-largest natural gas-producing state, producing nearly 20 percent of U.S. gas in 2023,[161] has become a focal point for this activity. In 2022, API spent $1.8 million in Pennsylvania, more than in any other state,[162] and it continues to spend close to $2 million annually to support oil and gas interests and oppose clean energy policies.[163] Countering misinformation and building credible, worker-centered pathways into clean thermal careers will be essential to broadening support for the transition.
- **Funding instability:** Thermal workforce programs also remain vulnerable to boom-and-bust cycles tied to federal funding timelines. This instability makes it harder for employers, training providers, and workers to plan for the long term. More durable, state-level thermal workforce programs could help stabilize training, employment, and employer planning while supporting a more consistent pipeline of clean thermal work

Building a Durable Thermal Workforce for Pennsylvania

Pennsylvania's thermal future will be built by its historic and continually evolving workforce. From oil and gas drillers to electricians, HVAC technicians, and weatherization professionals, the foundation of that workforce is already in place. A thermal-sector approach reframes decarbonization not as a narrow technological shift, but as a broader evolution in how heat is produced, delivered, and managed across buildings and industry, creating continuity between past, present, and future work.

161 U.S. Energy Information Administration, "Which States Consume and Produce the Most Natural Gas?," October 30, 2024, https://www.eia.gov/tools/faqs/faq.php?id=46&t=8.

162 Aly Shaw, "The American Petroleum Institute Loves Pennsylvania, As Its Lobbying Shows," *Little Sis*, May 22, 2023, https://littlesis.org/news/the-american-petroleum-institute-loves-pennsylvania-as-its-lobbying-shows/.

163 "Pennsylvania's Lobbying Disclosure Registration," Pennsylvania Dept. of State, accessed November 11, 2025, https://www.palobbyingservices.pa.gov/Public/wfSearch.aspx.

Thermal energy networks, energy efficiency and electrification, and clean industrial heat represent a coherent and scalable portfolio of work aligned with Pennsylvania's labor landscape. These pathways draw on overlapping occupations, shared skill sets, and complementary roles across the union and non-union workforce. Organized labor brings scale, apprenticeship pipelines, and long-term operations capacity, while independent contractors provide flexibility, speed, and deep integration into residential and small-building markets. Viewed through a thermal-sector lens, these workforce segments reinforce one another rather than compete.

A thermal workforce framework helps resolve one of the central tensions of the energy transition: how to reduce emissions while preserving high-quality jobs. By emphasizing managed, multi-decade transitions rather than abrupt shifts, workers currently maintaining fossil fuel systems can see a future for their skills in clean thermal infrastructure. In this model, decarbonization becomes an opportunity for workforce expansion and adaptation, not displacement.

Scaling a durable thermal workforce will require intentional policy design, sustained investment, coordinated training systems, and predictable project pipelines that give workers and employers confidence to adapt. By centering equity and expanding access to training, capital, and meaningful work, especially for frontline communities and small businesses, Pennsylvania can remain an energy state while becoming a leader in delivering clean, affordable, and reliable heat for decades to come.

> **"From oil and gas drillers to electricians, HVAC technicians, and weatherization professionals, the foundation of that workforce is already in place."**

Chapter 6

Conclusion

Energy systems do not change all at once, and Pennsylvania is already living in the "mid-transition," where legacy fossil infrastructure and emerging clean thermal solutions operate side by side. The central question is no longer whether the thermal sector will evolve, but whether the Commonwealth will guide that evolution in a way that protects households, maintains safety and reliability, and avoids locking customers into long-lived gas system costs that no longer align with changing demand, climate goals, and affordability constraints.

Pennsylvania now faces a consequential choice. It can continue defaulting to like-for-like replacement of aging gas infrastructure, even as customer demand shifts and the long-term cost burden of that system grows. Or it can pursue a managed gas transition that right-sizes the gas system over time while directing investment toward cleaner, lower-risk thermal alternatives. This report argues that a managed path is both more affordable and more durable.

Neighborhood-scale decarbonization offers a practical near-term strategy in targeted places. By coordinating efficiency, electrification, and thermal energy networks in areas where gas infrastructure is aging and energy burdens are high, Pennsylvania can avoid unnecessary like-for-like replacement, reduce the risk of paying for overlapping systems, and build experience with new models of thermal service. Not every community will move at the same pace, but sequenced projects can create the standards, confidence, and institutional capacity needed to scale this transition over time.

This shift does not require abandoning Pennsylvania's energy workforce. The skills that have long sustained the gas system, including drilling, pipefitting, electrical work, HVAC installation, system operations, and maintenance, are also foundational to building and operating the next generation of thermal infrastructure. A thermal-sector framework makes it possible to treat this transition as an evolution of work and institutions rather than a simple story of displacement, supporting high-road jobs, workforce continuity, and new opportunities for unions, contractors, and communities across the Commonwealth.

An affordable thermal future for Pennsylvania will require coordinated action from regulators, legislators, utilities, state and local governments, agencies, advocates, communities, businesses, and organized labor. That work can begin now: reform Act 11, strengthen oversight of long-run bill impacts, pilot neighborhood-scale alternatives, align gas and electric planning with long-term thermal needs, and invest in the workforce systems needed to support durable implementation. By centering affordability, customer protection, and workforce stability, Pennsylvania can build on its history as an energy state while becoming a leader in delivering clean, reliable, and affordable heating and cooling for decades to come.

“The central question is no longer whether the thermal sector will evolve, but whether the Commonwealth will guide that evolution in a way that protects households, maintains safety and reliability, and avoids locking customers into long-lived gas system costs that no longer align with changing demand, climate goals, and affordability constraints.”

Chapter 7

Appendices

Stakeholder Analysis

Perspectives on Pennsylvania's Thermal Transition

The Building Decarbonization Coalition (BDC) interviewed 16 stakeholders representing 13 Pennsylvania-based organizations between July and November 2025 to glean their expertise and insights related to the Commonwealth's energy policy, workforce, housing, and other relevant topics. Participants represented a broad cross-section of Pennsylvania's building energy landscape, including:

- Labor and workforce development organizations
- Consumer advocacy organizations
- Regional planning entities and local government officials
- Environmental and policy advocacy organizations
- Climate financing and lending institutions
- Health-focused advocacy groups

This appendix synthesizes key themes from those discussions. To preserve confidentiality while reflecting substantive contributions, insights are organized thematically rather than attributed to specific organizations. Quotes are attributed by stakeholder type only and may be lightly edited for clarity.

Cross-Cutting Findings

Finding 1: Economic framing consistently outperforms other messaging

Across stakeholder groups, there was strong agreement that building decarbonization must be framed primarily in economic terms. Messages centered on jobs, affordability, reliability, comfort, and consumer choice resonate more effectively than abstract climate arguments.

- Labor representatives emphasized job continuity, skill transferability, and long-term employment pipelines.
- Advocates in southwestern Pennsylvania noted that linking clean energy to economic revitalization and cost reduction is especially persuasive.
- Health and environmental advocates reported that affordability and reliability arguments often gain more traction than public health messaging alone.

The implication is clear: successful policy campaigns must lead with economic security and tangible household benefits.

Finding 2: Workforce engagement requires scale, certainty, and long-term planning

Interviewees consistently emphasized that unions prioritize steady, high-quality employment supported by long-term project pipelines.

- Electrical workers are generally enthusiastic about electrification.
- Pipefitters and gas workers require clearer pathways showing how their skills translate into thermal energy networks (TENs), geothermal systems, and district-scale projects.
- Large-scale initiatives—such as neighborhood retrofit programs or TEN deployments—are more likely to secure union buy-in than small, fragmented projects.
- Workforce strategies must account for market segmentation: commercial construction is largely unionized, while residential retrofit work is predominantly non-union.

Several stakeholders noted that western Pennsylvania unions already maintain curricula in solar, wind, and geothermal technologies, suggesting institutional readiness if policy and project pipelines align.

Finding 3: Affordability concerns dominate rate and regulatory debates

Affordability emerged as one of the most urgent and politically salient issues.

Consumer advocates described:

- Persistent bill increases and growing household payment stress.
- Limited transparency and capacity to challenge specific line items in rate cases.
- The resource intensity of meaningful rate case participation.
- Mechanisms such as weather normalization adjustments that stabilize utility revenue but may weaken usage-based price signals.

Stakeholders also observed a perceived pattern in which utilities request elevated revenue increases, anticipating partial approval. These dynamics underscore the importance of regulatory reform and stronger consumer participation in rate-setting proceedings.

Finding 4: Pennsylvania's regional diversity demands tailored strategies

Stakeholders emphasized that Pennsylvania is not a monolith. Regional political culture, economic history, and infrastructure conditions require differentiated approaches.

- **Philadelphia** faces aging infrastructure, environmental justice concerns, and the added complexity of a municipally owned gas utility.

- **Pittsburgh and Allegheny County** combine strong labor institutions with emerging clean-tech ambitions, while navigating ongoing ties to natural gas development.
- **Southwestern Pennsylvania** requires economic transition messaging that respects its coal and gas heritage.
- **Rural delivered-fuel regions** may respond to energy independence narratives and present opportunities to leapfrog gas infrastructure entirely.
- **Mid-sized cities** such as Harrisburg, Scranton, State College, and Allentown may offer tractable pilot environments with less bureaucratic complexity.

Effective strategy will require region-specific political and economic alignment.

Finding 5: Electrification must be paired with home repair and bill protections

Stakeholders consistently emphasized that electrification cannot succeed as a standalone climate strategy.

- Pennsylvania's aging housing stock—among the oldest in the nation—often requires substantial deferred maintenance. Pairing electrification with: Whole-home repair; Energy efficiency upgrades; Solar integration; and Bill protection mechanisms is critical to ensure that households experience improved comfort and stable or reduced energy costs.
- Stakeholders also identified a "middle-income gap": households too affluent for assistance programs but unable to finance upgrades independently.
- Without integrated program design, electrification risks exacerbating affordability challenges rather than alleviating them.

Finding 6: Thermal energy networks present promise—and governance questions

Thermal energy networks (TENs) were widely viewed as a promising alternative to continued gas pipeline replacement, particularly in dense urban areas.

Stakeholders highlighted:

- Union-scale employment potential.
- Opportunities to leverage waste heat (including from data centers).
- Cost advantages in certain high-density contexts.

However, significant uncertainty remains regarding:

- Ownership and governance models (utility-owned, municipal, cooperative, or hybrid).
- Statutory authority and regulatory classification in Pennsylvania.
- Financing structures.

Clarifying governance pathways will be essential to moving TENs from concept to implementation.

Stakeholder Perspectives by Sector

Labor & Workforce Development

Labor stakeholders emphasized project scale, long-term certainty, and skill continuity. Workforce providers highlighted looming retirements and the need to expand training pipelines, including K–12 career and technical education pathways. Pre-apprenticeship programs are successfully connecting underrepresented communities to union jobs.

A consistent theme was the importance of demonstrating how pipefitters, drillers, and gas utility workers can transition into geothermal and thermal network projects. Small, short-term projects are insufficient to justify training investments; large-scale initiatives create stability and confidence.

> **"There's a huge opportunity in Pennsylvania since it's always been an energy state. It has a long history of coal and natural gas development and it's at an interesting crossroad. Some of our labor partners in the building trade are increasingly more interested in how they can get involved in this type of work"**
>
> **"Trade unions want to see concrete ways we can transition the economy through scale up projects will allow for union contractors are able to engage more easily."**
>
> — Labor and Environment Coalition Representative, 2025

Consumer Advocacy

Consumer advocates underscored the complexity of Pennsylvania's rate-setting process and the resource constraints facing intervenors. They described structural challenges in contesting utility line items and noted the increasing strain on low-income households, including limitations within Percentage of Income Payment (PIP) programs.

Affordability messaging, paired with regulatory reform, was seen as essential to maintaining public support.

Regional Planning & Local Government

Local officials highlighted the intersection of climate goals, housing quality, and economic development. Many jurisdictions face significant deferred maintenance in older housing stock. Whole-home repair programs were described as both popular and underfunded.

Stakeholders emphasized that heat pump deployment must be paired with efficiency and, in some cases, solar to avoid bill increases when gas prices are low

> **"For the Built to Last program, a lot of our clients are in no-heat situations so they often are very excited for very efficient home heating and cooling"**
>
> **"We're doing everything we can to hedge against cost increases so we started to look into pairing full electrification with solar projects."**
>
> — Local clean energy program administrator, 2025

Policy & Environmental Advocacy

Advocates stressed that progress in building electrification is constrained more by policy design and incentives than by technology readiness. Messaging must be regionally tailored, particularly in areas with strong fossil fuel identities.

Affordability and reliability arguments were reported to outperform purely environmental or health-based messaging. Some stakeholders suggested that trusted local messengers—such as public safety officials—could play a role in expanding acceptance.

> **"Our local coalition has centered around bringing community, environmental, and labor partners together in alignment for what a**

vision looks like for decarbonizing public housing"

" Building retrofits, especially through the whole home repair program, can be a way to lower operating costs through energy efficiency, but it depends on if gas is cheaper in the area, impacting the actual bill savings"

"Energy efficiency and electrification must be paired to lessen concerns around grid capacity and bill increases"

— Community organizing group (economic justice), 2025

Financing & Program Design

Financing institutions identified structural gaps in household-scale lending, particularly for projects too large for credit cards but too small for traditional home equity products.

Stakeholders emphasized the importance of:

- Tiered incentives to promote high-efficiency systems.
- Creative product framing (e.g., subscription-style models).
- Long-term program stability to build contractor and consumer confidence.

"Nobody wants to replace their heat pump or furnace, so it's our job to make it affordable for them."

"Replacing your furnace or heat pump is a significant investment, but its too big to put on a credit card and too small to use home equity loan on so what can customers do? This is why financing, rebates, and other methods are critical for filling the gaps"

— Energy efficiency and clean energy lender, 2025

Looking Ahead: Coalition Development

The stakeholder engagement process laid the groundwork for continued collaboration. Participants expressed interest in sustained coordination across labor, advocacy, planning, and financing sectors to:

- Develop shared messaging and data resources;
- Advance pilot projects in targeted communities;
- Build political support for home repair funding, thermal network pilots, and regulatory reforms.

This coalition-building effort reflects growing recognition that Pennsylvania's thermal transition will require coordinated action across sectors, regions, and institutions.

Utility Disconnection Protections

Many of these utility disconnection protections stem from the Responsible Utility Consumer Act in 2004 which lived under Chapter 14 in Pennsylvania Consolidated Statutes, with required renewal every 10 years. To fully and effectively administer these protections, the Public Utility Commission updated Chapter 56 to codify chapter 14's protections. When the Responsible Utility Consumer Act was not reenacted in 2024, the PUC released a statement that these protections remain in place until amended to provide certainty for utilities and all affected stakeholders.[164]

Protection	Description	Source
Winter shut-off moratorium	Prohibits termination of residential utility service for non-payment during the winter heating season (December 1–March 31) for income-qualified households, ensuring continued access to essential heat.	52 Pa. Code § 56.100
Medical certification	Requires utilities to postpone termination when a licensed medical professional certifies that loss of service would endanger a customer's health or aggravate a serious medical condition.	52 Pa. Code § 56.111
Payment arrangements	Requires utilities to offer customers payment plans based on ability to pay before terminating service and prohibits termination while the customer is complying with the agreed-upon arrangement.	52 Pa. Code § 56.151
Notice requirements	Mandates advance written notice before termination, including information on how to avoid shut-off, available assistance programs, and the customer's right to contact the PUC.	52 Pa. Code §§ 56.91–56.98
Customer Assistance Program (CAP) protections	Provides income-based billing, enhanced termination protections, and opportunities for arrearage reduction or forgiveness for enrolled low-income customers.	52 Pa. Code § 56.2
Dispute protection	Prohibits termination of service while a customer has an active billing dispute pending with the utility or the PUC.	52 Pa. Code § 56.151
Holiday and weekend limits	Prohibits terminations on weekends, state or federal holidays, and on days when utility offices are closed, preventing shut-offs when assistance is unavailable.	52 Pa. Code § 56.322

164 Pennsylvania Public Utility Commission, "Statement of Policy: Subset of Chapter 14, Title 66 of the Pennsylvania Public Utility Code," December 12, 2024, https://www.pacodeandbulletin.gov/Display/pabull?file=%2Fsecure%2Fpabulletin%2Fdata%2Fvol55%2F55-2%2F36.html.

Methodology

This report evaluates the drivers of heating costs in Pennsylvania by combining public datasets on gas infrastructure, utility finances, customer trends, affordability indicators, and Act 11 implementation filings with original analysis and data normalization. The report focuses on Pennsylvania's Big Six gas utilities—Peoples Natural Gas, Philadelphia Gas Works, National Fuel Gas Distribution, UGI Utilities, Columbia Gas of Pennsylvania, and PECO Energy—because these utilities collectively represent the majority of gas customers and distribution infrastructure in the Commonwealth.

This appendix describes the report's approach and key data sources, documents how Act 11 filings were collected and standardized, and summarizes inputs and assumptions for neighborhood-scale modeling. It also provides a metric-by-metric source list for the gas system dashboard, customer and demand trends, affordability metrics, and rate case and energy insecurity indicators.

Where metrics are not directly reported in source documents, the analysis derives them using transparent calculations described below.

"BDC analysis" refers to calculations performed by the authors to clean, normalize, and derive metrics (e.g., growth rates, per-customer values, and bill component splits) from the listed sources.

Data sources

The analysis draws on the following primary source categories:

1. **Pipeline and system characteristics**: Pipeline and Hazardous Materials Safety Administration distribution and transmission datasets, used to quantify miles of mains and services, pipeline vintage, and pipe material categories.
2. **Utility depreciation and accounting references**: Utility depreciation reports, used to compile typical asset lives (e.g., average useful life of distribution mains).
3. **Utility financials**: Utility financial data sourced from S&P Capital IQ Pro and cross-checked against Annual LDC Reports where available, used to track gas plant asset values over time and normalize results on a per-customer basis.
4. **Customers, sales, and prices**: U.S. Energy Information Administration datasets, used to track customer counts and usage trends, and to construct bill component approximations using delivered and citygate prices.
5. **Pennsylvania PUC materials**: PUC press releases for rate case bill impacts and the Pennsylvania Universal Service Report for energy insecurity metrics.
6. **Act 11 program filings**: Long-Term Infrastructure Improvement Plans and Annual Asset Optimization Plans collected from the Pennsylvania PUC website, used to assemble a utility-by-utility view of accelerated pipeline replacement budgets, reported work, and progress.
7. **Neighborhood-scale modeling inputs**: U.S. Geological Survey ground composition references and Typical Meteorological Year datasets for weather and ground temperature inputs, plus modeled network lengths based on a representative ambient-loop sketch.

Act 11 pipeline replacement and LTIIP dataset

Our goal was to provide a structured, utility-by-utility and comprehensive view of Act 11 implementation through the Long-Term Infrastructure Improvement Plans and Annual Asset Optimization Plans filed by utilities from 2013-2025.

Sources and Process

- We used the PA PUC document search tool to locate each utility's LTIIP and AAOP filings
  - LTIIP and AAOP filings were located using docket numbers and filing histories, then compiled into a standardized dataset capturing plan periods, proposed and reported work, and reported costs where available.
    - AAOPs are used to reconcile planned versus actual activity where the utility provides sufficient detail. The analysis notes variability in comprehensiveness, category definitions, and consistency across utilities and years.
    - The dataset reflects that most utilities have filed multiple LTIIPs over time (often in 3–5 year windows), while some utilities have fewer plan iterations during the period of analysis.
    - The corresponding docket numbers for the most recent LTIIPs are below.

Limitations

- **Inconsistent cost categorization:** Some utilities aggregate categories (mains/services/other) in ways that limit discrete cost-to-asset mapping.
- **Partial reporting:** Some utilities report Act 11-enabled work clearly but do not consistently report baseline replacement programs in the same format, requiring caution when discussing "total replacement activity."
- **Non-aligned filings:** In some cases, AAOP reporting differs from other municipal or agency filings (e.g., city-specific budget submissions for PGW). Where discrepancies exist, the report documents them and treats estimates conservatively.

Utility	LTIIP	Docket #
UGI	Third Long Term Infrastructure Improvement Plan, 2025-2029	P-2024-3050769
PGW	Third Long Term Infrastructure Improvement Plan, 2023-2027	P-2022-3032303
Peoples Natural Gas	Combined Distribution Long-Term Infrastructure Improvement Plan, 2021-2025	P-2020-3021942
Columbia	Third Long-Term Infrastructure Improvement Plan, 2023-2027	P-2022-3037388
National Fuel	First Long-Term Infrastructure Improvement, 2023-2027	P-2022-3034957
PECO	Second Long-Term Infrastructure Improvement, 2023-2027	P-2022-3034521

Neighborhood-Scale Modeling Section

Our goal was to illustrate how neighborhood-scale solutions like neighborhood electrification and thermal energy networks can improve lifecycle costs and emissions outcomes under representative Pennsylvania conditions. We used an Excel-based feasibility modeling tool developed by Buro Happold to run a parametric assessment of varying parameters noted in the report. The model considered prototypical building energy demand profiles from NREL ResStock and ComStock, weather conditions, ground temperatures, heat transfer of bedrock material for boreholes, HVAC equipment efficiency curves, and other technical inputs to perform an energy model of both thermal energy networks and standalone air-source heat pumps.

Data input sources

- **Ground composition:** USGS reference (Philadelphia as igneous/anorthosite; State College and Pittsburgh as sedimentary/shale-sandstone context).
- **Weather:** TMYx for air temperature and ground temperature at 2-meter depth.
- **Network length:** 4,000; 6,000; and 8,000 feet based on an ambient-loop overlay sketch serving ~20 buildings in a representative neighborhood geometry (~1.1 miles).

Key modeling choices

- The modeled neighborhoods are intended to be illustrative, not predictive of every local condition.
- Results are presented comparatively across scenario types to support planning discussion, not as site-specific engineering designs

Limitations

- We did not report comprehensive cost information given the uncertainty around infrastructure-scale thermal energy networks at this time
- The energy model follows best practices but fluctuations in weather, installation quality, and operation from users can affect accuracy, these results are illustrative only to show directionality and overall magnitude of results across the TENs and ASHP solutions.

Gas System Dashboard

Sources referenced for the Gas System Dashboard

Big Six Gas Infrastructure

Metric	Source	Notes/Calculation
Miles of distribution mains	2024 PHMSA data	
Avg. annual growth of mains	2024 PHMSA data	BDC analysis of 2024 PHMSA data
Miles of service lines	2024 PHMSA data	
Avg. annual growth of services	2024 PHMSA data	BDC analysis of 2024 PHMSA data
Miles of interstate transmission lines	2024 PHMSA data	
Useful life of a gas main	Average of 2024 Depreciation Reports, Big Six Gas Utilities	
Gas mains 65+ years old in Big Six territory	2024 PHMSA data	BDC Analysis of 2024 PHMSA Data
Gas mains in PGW territory 65+ years old	2024 PHMSA data	BDC Analysis of 2024 PHMSA Data
Miles of Main by Age (Vintage)	2024 PHMSA data	BDC Analysis of 2024 PHMSA Data
Leak-prone pipe by utility and total	2024 PHMSA data	BDC Analysis of 2024 PHMSA Data Material categories: Leak-prone includes: unprotected bare steel, cast/wrought iron, reconditioned cast iron, and ductile iron Risk of all other distribution pipe depends on the intersection of age and material.

Gas System Costs

Metric	Source	Notes/Calculation
Total value of gas utility assets, Big Six (2024)	Utility financials	BDC Analysis of utility financials sourced from S&P, Capital IQ Pro database. Also available in annual LDC reports.
Growth in gas utility assets per customer (2000-2024)	Utility financials	BDC Analysis of utility financials sourced from S&P, Capital IQ Pro database. Also available in annual LDC reports.
Gas utility asset value per customer (2024)	Utility financials	BDC Analysis of utility financials sourced from S&P, Capital IQ Pro database. Also available in annual LDC reports.
Growth in Gas Utility Assets, Big Six (2013–2024)	Utility financials	BDC Analysis of utility financials sourced from S&P, Capital IQ Pro database. Also available in annual LDC reports.
Avg. spending per mile of main, Big Six	LTIIPs and AAOPs	BDC Analysis using data collected from Long-Term Infrastructure Replacement Plans and Annual Asset Optimization Plans. Some utilities report bundled costs, including meters, in their filings.
Average spending per customer per mile of main	2024 PHMSA Data; Utility websites and regulatory filings	BDC Analysis of 2024 PHMSA Data; Customer Count reported on utility websites and regulatory filings

Gas Customers and Demand

Metric	Source	Notes/Calculation
Customers, all classes	EIA Number of Natural Gas Consumers for Pennsylvania	BDC Analysis of EIA Customer Count for Pennsylvania
Annual average growth for all customer classes	EIA Number of Natural Gas Consumers for Pennsylvania	BDC Analysis of EIA Customer Count for Pennsylvania
Residential, commercial, industrial customers, respectively	EIA Number of Natural Gas Consumers for Pennsylvania	
Annual average growth for residential, commercial, and industrial customers, respectively, since 2000	EIA Number of Natural Gas Consumers for Pennsylvania	BDC Analysis of EIA Customer Count for Pennsylvania
Overall change in residential gas use (2000-2024)	EIA Natural Gas Consumption by End Use	BDC Analysis of Volumes Delivered to Residential Consumers
Change in residential gas use per customer (2000-2024)	EIA, multiple tables	BDC Analysis of EIA data
Gas consumption by sector (2000-2024)	EIA Natural Gas Consumption by Sector	We excluded gas for vehicle fuel given how minor it is compared to other sectors

Energy Affordability

Metric	Source	Notes/Calculation
Portion of gas bill that pays for infrastructure	EIA, Natural Gas Prices	BDC Analysis of EIA data. We use total delivered cost (full bar height of both colors), then use citygate price to split up the bar (citygate = commodity cost, leftover is "delivery charge").
Portion of gas bill that pays for gas itself	EIA, Natural Gas Prices	BDC Analysis of EIA data. We use total delivered cost (full bar height of both colors), then use citygate price to split up the bar (citygate = commodity cost, leftover is "delivery charge").
Average monthly residential gas bill (year round and heating season), 2025	The 2026 Rate Comparison Report prepared by the Bureau of Technical Utility Services for the PA PUC	BDC Analysis based on customer bills by utility, and averaged across the state using a weighted average of bills across utilities based on the number of residential customers for each.
Growth in average residential gas bill, 2015 to 2025	The 2016 and 2026 Rate Comparison Report prepared by the Bureau of Technical Utility Services for the PA PUC	BDC Analysis of heating (15 mcf) and non-heating (2 mcf) average bills by utility. UGI and People's figures are averaged in the 2016 report to compare to their consolidated equivalents in the 2026 report. Total "year-round" average increase is based on the average heating and non-heating bills, estimating 8.5 Mcf per year, in line with usage estimates in the 2026 report. Year-round averages are not included in earlier versions of the PUC report. Average growth across all utilities uses a simple average across the six large gas utilities.
Average requested rate base increase by IOUs in PA	Utility financials	BDC Analysis of utility financials sourced from S&P, Capital IQ Pro database. Also available in annual LDC reports.

Average Bill Increases, Before and After Major Rate Case, By Utility

Company	Date	Docket	Avg. bill prior to increase	Avg. bill after increase	Increase %
Columbia Gas of Pennsylvania	Mar 2024	D-R-2024-3046519	$118.16	$128.06	8.9%
	Mar 2022	D-R-2022-3031211	$123.24	$128.96	4.7%
	Mar 2021	D-R-2021-3024296	$100.77	$109.10	7.3%
	Mar 2018	D-R-2018-2647577	$91.63	$95.74	3.1%
	Mar 2016	D-R-2016-2529660	$77.33	$83.05	4.7%
	Mar 2014	D-R-2014-2406274	$87.12	$92.71	4.6%
	Sep 2012	D-R-2012-2321748	$67.17	$78.16	10.0%
PECO Energy Co	Mar 2024	D-R-2024-3046932	$97.98	$110.23	11.3%
	Mar 2022	D-R-2022-3031113	$95.31	$103.88	7.6%
	Mar 2010	D-R-2010-2161592	$90.00	$94.41	3.4%
Peoples Natural Gas Co. LLC	Oct 2010	D-R-2010-2201702	$73.09	$85.02	10.9%
Peoples TWP LLC	Apr 2013	D-R-2013-2355886	$79.22	$94.94	14.7%
UGI Central Penn Gas Inc.	Jan 2011	D-R-2010-2214415	$87.03	$95.45	7.4%
UGI Penn Natural Gas	Jan 2017	D-R-2016-2580030	$78.53	$82.99	3.5%
UGI Utilities Inc.	Jan 2025	D-R-2024-3052716	$103.57	$110.51	5.9%
	Jan 2022	D-R-2021-3030218	$92.49	$96.93	3.4%
	Jan 2020	D-R-2019-3015162	$81.54	$84.67	2.1%
	Jan 2016	D-R-2015-2518438	$51.77	$56.11	3.3%

Energy Insecurity Metrics for Residential Gas Customers

Metric	Source	Notes/Calculation
Low-Income Customers, Confirmed and Estimated	2024 Universal Service Report, Pennsylvania PUC	As of 2024, 25% of gas customers in PA were estimated to be low-income, while 16.2% of customers were confirmed to be low-income. Confirmed low-income customers have been determined to be low-income by the utility, and is generally defined as being at or below 150% of the Federal Poverty Income Guidelines. Estimated Low-Income Customers is based on the total (maximum) population of low-income customers in the utility's service territory, which is based on census data.
Customers with Payment Arrange-ments	2024 Universal Service Report, Pennsylvania PUC	The gas industry has an overall 12.2% increase in customers with payment arrangements from 2022 to 2024. A payment arrangement with the utility or PUC is one in which the customer agrees to pay an unpaid balance.
Payment-Troubled Customers	2024 Universal Service Report, Pennsylvania PUC	From 2022 to 2024, the number of payment troubled gas customers in-creased by 17.7% (compared to an increase of 9.2% for electric customers). The overall proportion of payment-troubled customers increased slightly, by half a point, from 2022-2024. A Payment-Troubled Customer is defined as having failed to maintain at least one payment arrangement over a one-year period.
Customers in Debt	2024 Universal Service Report, Pennsylvania PUC	Customers in debt have from 2022 to 2024 by 11%. Customers in debt include those who are on a payment arrangement and those who are not. Debt that is on a payment arrangement is considered active and is often easier to collect than debt not on a payment arrangement. Debt that is not on a payment arrangement is more at risk and may eventually become "uncollectable debt," which can lead to an increase in gross write-offs, that are in turn recovered through rates by all ratepayers. Factors affecting the number of customers in debt include: income level and ability to pay; utility collection practices; utility termination practices; and bill affordability. CAP recipients are not included in the number of customers in debt or the amount owed to utilities.
Average Arrearages	2024 Universal Service Report, Pennsylvania PUC	Overall, the average unpaid balance carried by gas customers has de-creased by 13.1% from 2022 to 2024. The total Average Arrearage is calcu-lated by dividing the total dollars in debt by the total number of customers in debt. An arrearage (debt) is the amount carried by each customer with an overdue balance.
Residential Customer Service Terminations	2024 Universal Service Report, Pennsylvania PUC	There were 89-125k service terminations per year from 2022-2024, which is equivalent to 3-5% of customers losing their gas service. PGW had the most service terminations, with an average of 5.5% customers losing service, while Columbia had the fewest, with 2.71% of customers being disconnected.

Neighborhood-Scale Workforce Chart

Labor Unions Who Can Help Build Clean Green Neighborhoods

Note that the job roles listed here speak to the broad capabilities of different unions and how they may contribute to neighborhood-scale decarbonization based on their skills, interests and jurisdictions; this can vary significantly by state and region.

Union	Role in Neighborhood-Scale Decarbonization	Description of Work
International Association of Heat and Frost Insulators and Allied Workers (AWIU)	• Insulators • Asbestos Abatement Workers	Weatherization, including insulating walls and attics to improve building's energy efficiency
International Association of Sheet Metal, Air, Rail and Transportation Workers (SMART)	• Sheet Metal Worker • Engineeer • Manfacturing • Service Technicians • CAD Detailer	Designing, manufacturing, and servicing of energy efficient air movement equipment and insulated duct systems; installation of metallic ductwork and architectural metal; installation of HVAC heat pumps and heat pump water heaters; TAB (testing adjusting and balancing), duct cleaning, condensing unit maintenance; engineering and design of ductwork system inside buildings; manufacturing of EV batteries, electric school buses
International Brotherhood of Electrical Workers (IBEW)	• Electricians, Low Voltage (equipment and in-building wiring and connections) • Lineman and Groundsmen (High Voltage, Utility) • Installations (solar panels, EV chargers, backup battery systems)	Connecting heat pumps and electric equipment; connecting and configuring solar panels and in-home battery systems; upgrade and re-size electrical panel as needed; upgrade wall receptacles and circuitry to accommodate electric equipment (e.g. induction stove, electric dryer, heat pumps); utility-side maintaince and service upgrades for poles, wires, transformers, and other electric infrastructure; installing electric vehicle charging stations
International Union of Operating Engineers (IUOE)	• Operating Engineers (Equipment Operators, Mechanics, Drillers, Inspectors, and Surveyors) • Stationary Engineers (Building and System Maintenance)	Surveying where to excavate; digging trenches for pipes; drilling shafts and boreholes for thermal energy networks; street paving; system maintenance in large buildings; inspection throughout construction process
International Union of Painters and Allied Trades (IUPAT)	• Drywall Finishers and Glaziers	Installation of energy-efficient windows; drywall building and repair as needed for insulation and equipment installation
International Union, United Automobile, Aerospace and Agricultural Implement Workers of America (UAW)	• Machinists • Manufacturing • Engineers • State Scientists	Electric vehicle and battery manufacturing; complex machinery manufacturing, such as heat pumps; research and development; analysis and testing
Laborers' International Union of North America (LIUNA)	• Laborer	Remediation of asbestos, mold, cleanup, demolition; assist with digging holes and vibrating concrete
Operative Plasterers' & Cement Masons' International Association (OPCMIA)	• Cement Mason	Pours and sculpts, shapes and colorizes cement

Union	Role in Neighborhood-Scale Decarbonization	Description of Work
International Brotherhood of Teamsters (IBT)	• Truck Drivers and Transporters	Transports cement, water, and building materials to and from site
The International Association of Bridge, Structural, Ornamental and Reinforcing Iron Workers (IW)	• Ironworkers	Installation of structural steel, rebar, and tension cable
United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada (UA)	• Pipelayers / Loopers • Plumbers • Pipefitters • Installers (HVAC heat pumps and heat pump water heaters)	Installation of geothermal pipes and service pipes; installation of smaller pipes without welding and larger pipes with welding; install HVAC heat pumps and heat pump water heaters
United Brotherhood of Carpenters and Joiners of America (UBC)	• Carpenters	Rough framing, wood and metal construction for buildings of all types
United Steelworkers (USW)	• Pipelayers and pipefitters • Manufacturing	Manufacturing and installation of pipes for thermal energy networks; manufacturing of poles used to provide electrical power
Utility Workers Union of America (UWUA)	• Pipelayers and pipefitters • Electricians and Engineers	Depending on region and utility: Installation of pipes; operation and maintenence of thermal energy networks; installation and maintenance of utility-scale renewables (wind, solar, hydro-electric)

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