



PHILADELPHIA BUILDING DECARBONIZATION WORKFORCE IMPACTS AND OPPORTUNITIES

**COMPLETED OCTOBER 2023
UPDATED FEBRUARY 2024**



TABLE OF CONTENTS

Executive Summary	03
Introduction	10
Background	12
An Optimal Time for Planning Decarbonization	12
The Role of Philadelphia Gas Works and its Workforce	16
Skill Sets of the PGW Workforce	18
Overview of Analysis	21
The Analysis: Cost and Employment Results	24
Considerations for a Gas Workforce Transition	27
A Long Decarbonization Transition	27
District Energy Networks	29
Full and Hybrid Electrification	33
Decarbonized Gas	35
Centering the Workforce in Decarbonization Plans	38
Summary of Key Findings	39
Conclusion	42
Acknowledgements	43
APPENDIX A: PGW Union Employees' Skills and Proficiencies ...	44
APPENDIX B: Methodology	45



EXECUTIVE SUMMARY

Recognizing the local, regional, and global threats posed by climate change, governments and civil society are implementing actions to decarbonize our energy system and transition our economy away from fossil fuels. The City of Philadelphia, in alignment with governments around the world, has pledged to achieve carbon neutrality by 2050 and to deploy equitable strategies that will create good quality, family-sustaining jobs for residents and workers. Over 40% of Philadelphia's 2019 community-wide greenhouse gas (GHG) emissions came from energy used in residential, commercial, and industrial buildings, and roughly 40% of building-based GHG emissions came directly from the on-site combustion of natural gas. Given this, a significant part of the City's building decarbonization efforts will entail transitioning away from gas as a dominant energy source in buildings.¹

The decarbonization of buildings, already underway in Philadelphia, poses a potential challenge for the City's municipally-owned gas utility, Philadelphia Gas Works (PGW). Serving Philadelphia for over a century, this public revenue-generating natural gas provider employs over 1,500 employees and annually serves over 500,000 customers.²

The City of Philadelphia and its municipal utility, PGW, share a common goal: to protect the livelihoods of the dedicated utility and administrative workers at PGW who collectively hold decades of training, experience, and public service.



¹ Philadelphia Office of Sustainability, "2019 Greenhouse Gas Inventory." April 2022. <https://www.phila.gov/media/20220418144709/2019-greenhouse-gas-inventory.pdf>

² PGW, "Fueling the Future: 2022 Annual Comprehensive Financial Report," City of Philadelphia, 2023, <https://www.pgworks.com/about-us/pgw-financials>.

This report provides an assessment of the workforce implications of adopting decarbonization technologies in Philadelphia. Conducted in partnership by the Building Electrification Institute (BEI) and the Economy League of Greater Philadelphia (ELGP), this report focuses on the “decarbonization pathways” explored in the 2021 *PGW Business Diversification Study*³ to:

- Evaluate the skill sets of current gas utility workers and the overlap with the skill sets required for the four decarbonization pathways included in the *PGW Business Diversification Study*,
- Quantify the potential job impacts that would occur across three of the pathways (electrification, hybrid electrification, and district energy networks), and
- Identify key opportunities and considerations to ensure gas utility workers are valued and supported in a long-term transition away from fossil fuels.

THE DECARBONIZATION PATHWAYS

<p>Electrification</p> <p>All fossil fuel-burning appliances and systems are replaced with efficient, all-electric alternatives like induction stoves and heat pumps for space heating, space cooling, and water heating.</p>	<p>District Energy Networks</p> <p>Pipeline networks powered by renewable energy – like geothermal – that heat or cool buildings using shared water and heat distribution systems.⁴</p>	<p>Decarbonized Gas⁵</p> <p>Utilities use existing gas pipelines to distribute gas alternatives that create fewer GHGs, such as synthetic gas, hydrogen, or biomethane from waste biogas or gasified biomass.</p>	<p>Hybrid Electrification</p> <p>Some fossil fuel-burning systems are replaced with efficient electric appliances. A gas or oil furnace or boiler is kept for back-up heating.</p>
--	---	---	---

This report is meant to inform and support Philadelphia’s carbon neutrality commitment by identifying both workforce opportunities and challenges that will need to be addressed as a result of building decarbonization. The report identifies where workforce transitions could be made between fossil fuel and decarbonization industries, as well as opportunities for planning a fair, long-term transition for workers.

³ Energy & Environmental Economics, Econsult Solutions Inc., Portfolio Associates, “Philadelphia Gas Works Business Diversification Study.” December 2021, <https://www.phila.gov/media/20211207134817/PGW-Business-Diversification-Study-2021-12.pdf>omic Forum, 19 July 2021, <https://www.weforum.org/agenda/2021/07/us-fossil-fuel-consumption-eia/>.

⁴ Networked steam loops were not included in the four diversification pathways. However, this technology does offer additional skill set alignment with gas utility workers. More research and stakeholder engagement would be needed to understand potential PGW ownership structures and the investment needed for a steam loop operated by clean energy.

⁵ Decarbonized gas faces major cost and supply constraints that prevent it from being a viable long-term decarbonization pathway for the majority of Philadelphia buildings. See pages 33-34 for more info.

This report finds that it is possible to decarbonize Philadelphia’s buildings and protect gas workers throughout a multi-decade, planned transition away from fossil fuels. By deploying multiple fossil fuel-free technologies – including large-scale district geothermal networks – and collaborating closely with the existing workforce, the City can create new economic opportunities for PGW and new career paths for its workers. These findings demonstrate that solving climate change, creating good family-sustaining jobs, and prioritizing, valuing, and rewarding existing fossil fuel workers can all be complementary.

Context

Since the 1970s, momentum has been growing in the U.S. and globally to adopt cleaner, renewable energy sources to reduce reliance on fossil fuels and mitigate global climate change. This momentum has only intensified, as energy use and consumer preferences shift toward decarbonized energy sources. In 2020, electricity surpassed gas as the main home heating source in the U.S. Federal economic legislation – like the 2022 U.S. Inflation Reduction Act – is accelerating the economic vitality of decarbonization technologies and energy efficiency in buildings.⁶ Meanwhile, jobs in the clean energy sector have grown exponentially, while many fossil fuel industries have experienced minimal or stunted growth.^{7, 8, 9}

In Philadelphia, the use of electricity as the predominant residential heat source has more than doubled since 2005, while utility gas usage declined by 11.1% (See **Figure A**). Additionally, building decarbonization technologies such as air source heat pumps and weatherization improvements can help Philadelphia realize broader social equity and public health goals. These include improving indoor air quality, particularly for low-income Philadelphians in neighborhoods with the worst air pollution.¹⁰

⁶ John Larsen, Ben King, Hannah Kolus, Naveen Dasari, Galen Hiltbrand, and Whitney Herndon, “A Turning Point for US Climate Progress: Assessing the Climate and Clean Energy Provisions in the Inflation Reduction Act.” Rhodium Group, 12 August 2022, <https://rhg.com/research/climate-clean-energy-inflation-reduction-act/>.

⁷ Deloitte Center for Energy Workforce Development, “The natural gas utility workforce in a decarbonizing world.” Deloitte, 2022, <https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/future-of-natural-gas-workforce.html>.

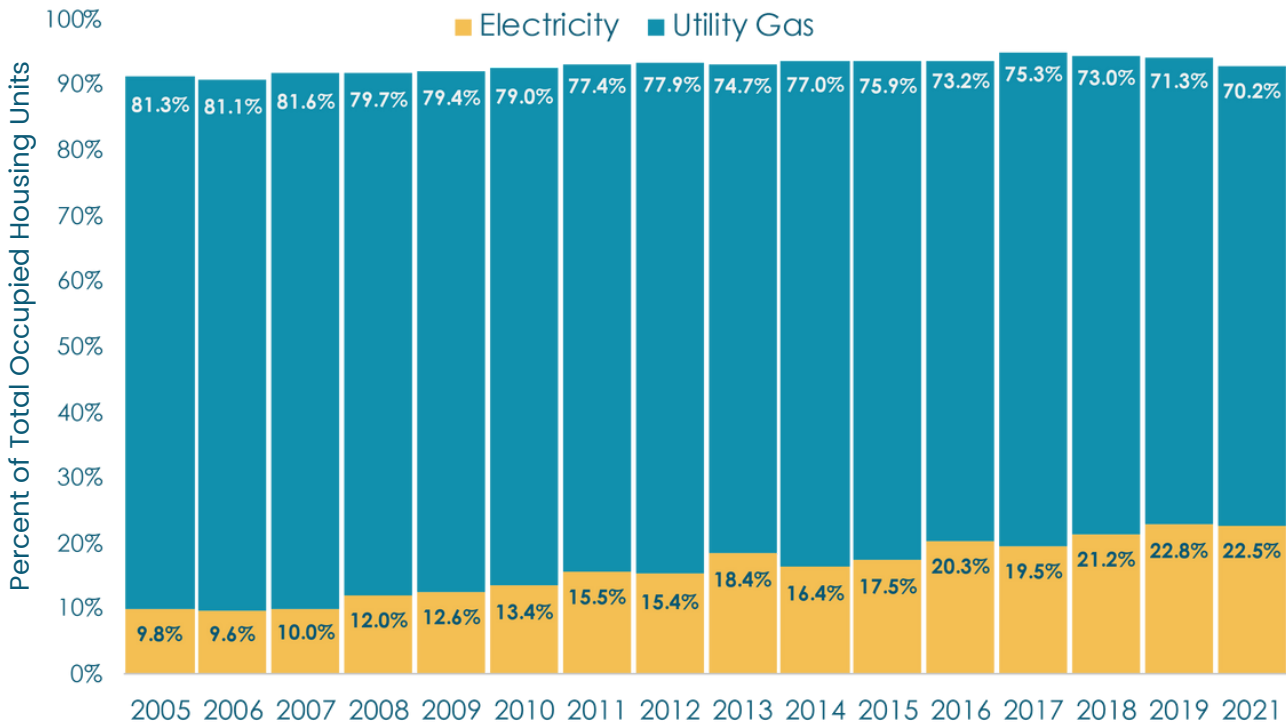
⁸ Mike Scott, “Pandemic Accelerates Decline and Fall of Fossil Fuel Producers.” Forbes, 5 June 2020, <https://www.forbes.com/sites/mikescott/2020/06/05/pandemic-accelerates-decline-and-fall-of-fossil-fuel-producers/?sh=2203c070f639>.

⁹ Victoria Masterson, “US fossil fuel consumption is at its lowest in 30 years. Here’s why.” World Economic Forum, 19 July 2021, <https://www.weforum.org/agenda/2021/07/us-fossil-fuel-consumption-eia/>.

¹⁰ Brady Seals, “Indoor Air Pollution: the Link between Climate and Health.” RMI, 5 May, 2020, <https://rmi.org/indoor-air-pollution-the-link-between-climate-and-health>.

Electric heat pumps provide highly efficient space heating and cooling, typically resulting in energy bill savings that can help alleviate energy poverty across Philadelphia, and will provide more reliable cooling for many households that have long lacked access to sufficient cooling.¹¹ With sufficient funding and planning, there is also an opportunity to address buildings' deferred maintenance needs in coordination with decarbonization retrofits, resulting in significantly improved housing quality and safety.

FIGURE A: Residential Heating Fuel Sources in Philadelphia



SOURCE: U.S. Census Bureau, American Community Survey (U.S. Census Bureau did not release 2020 data.)

To realize these benefits, a long-term planning effort to transition away from gas equipment and infrastructure is required. **A shared priority for stakeholders across the City is to pursue a collaborative planning effort that protects and supports Philadelphia's existing utility workforce throughout a building decarbonization transition.**

A central concern for the City and PGW will be the impact that building decarbonization could have on PGW's current and future utility workforce. PGW remains a stronghold of municipal employment opportunities that require limited post-secondary education credentialing, offer family-sustaining wages, provide favorable benefits, and offer opportunities for employee collective bargaining via unionization.

¹¹ EPA, "Heat Islands and Equity", <https://www.epa.gov/heatislands/heat-islands-and-equity>.

Current PGW employees earn above-average wages and have access to a variety of equipment, vehicle, and customer service trainings currently unavailable to other similarly credentialed employees. The expertise of PGW's leadership and workers must be considered, consulted, valued, and supported through the planning of any decarbonization transition.^{12, 13}

Findings

This report outlines the potential impacts to the gas utility workforce as a result of four potential decarbonization pathways. The report does not recommend specific job transitions, but instead assesses skill set alignments between existing gas and burgeoning decarbonization employment opportunities, and provides an initial assessment of differences in wages or benefits.

The goal of this report is to inform future stakeholder conversations about the decarbonization transition and how gas utility workers' wealth of knowledge, expertise, experience, and public service can be supported and rewarded throughout this transition.

The findings of this report are as follows:

- **Philadelphia's decarbonization efforts will take decades.** There will be a long-term need to strategically maintain, repurpose, and decommission gas pipelines. Current gas utility workers do not need to fear that building decarbonization means they will lose their jobs overnight.
- **Deploying multiple decarbonization technologies through a long-term, planned transition would provide the greatest economic and workforce innovation opportunities for PGW and the City of Philadelphia.** A combination of building electrification and district energy networks powered by geothermal energy could require between 6,000 to 12,000 full-time jobs annually across the building retrofit and utility infrastructure sectors, with many jobs requiring similar skill sets from the current gas utility workforce.
- **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.** If state regulatory barriers are amended, PGW could expand its services and provide a solid foundation for retaining, reskilling, and expanding its existing workforce.

¹² Leadership of the Gas Workers Employees Union Local 686 participated in interviews and offered key insights underpinning this analysis. PGW leadership did not participate in background research and interviews, but reviewed a final report draft and offered comments, many of which the project team incorporated.

¹³ A qualitative sentiment shared by a member of Gas Works Employees Union Local 686 as part of this analysis.

- **The construction, operations, and maintenance of large-scale district energy networks – powered by geothermal or other renewable energy – would provide significant job opportunities for current gas utility workers.** If 50% to 100% of Philadelphia’s buildings over 50,000 square feet were connected to district energy networks, an estimated 3,000 to 8,000 annual full-time jobs would be required from 2025–2050, with very similar skill sets to the current gas workforce.
- **Building electrification will require thousands of building retrofit and electric infrastructure jobs, although there may be limited job transition opportunities for the current gas workforce.** Those with skills in the building trades and construction would benefit most from the transition, but would be unlikely to retain the same level of wages and benefits offered by PGW, particularly in the small residential sector, without significant changes to the current policy landscape.
- **Decarbonized gas use in buildings theoretically offers the simplest transition for current gas workers, but it presents significant cost and regulatory barriers, and may result in limited job creation and minimal impacts on building emissions,** which make it an unlikely sole candidate for meeting the City’s building decarbonization goals. Decarbonized gas such as hydrogen will be best suited as a solution for hard-to-electrify industrial and transportation uses.
- **As part of a long-term planning process, there is an opportunity to look beyond building decarbonization strategies and make investments in other sectors to help mitigate any potential job losses for gas workers.** For example, water infrastructure and sewer construction and maintenance require similar skill sets as those possessed by current gas utility workers. It will be important to work closely with workforce partners to identify these opportunities and ensure these jobs match the level of wages and benefits that gas utility workers currently receive.
- **The City of Philadelphia and PGW must engage and include the existing workforce, including current gas workers, throughout the decarbonization planning process to create a fair, multi-decade transition strategy.**



Philadelphia has the opportunity to lead by example for hundreds of communities across the country who are grappling with the accelerating impacts of climate change and a shared goal to protect existing workers.

Creating a fair, multi-decade decarbonization strategy will require continued communication and engagement between leadership across the City of Philadelphia and PGW. It will also require elevating the expertise and experience of the existing workforce, including gas utility workers, and decarbonization experts who can further identify worker opportunities and feasible strategies for decarbonization. By coming together, sharing information, and debunking misconceptions, there will be increased opportunity to proactively formulate balanced plans that equitably solve climate change, create good family-sustaining jobs, and prioritize, value, and reward existing fossil fuel workers.



INTRODUCTION

Recognizing the local, regional, and global threats posed by climate change, governments, private sector actors, and the broader public are implementing actions to decarbonize our energy system and transition away from fossil fuels. The City of Philadelphia, in alignment with governments around the world, has pledged to achieve carbon neutrality by 2050 and to use equitable strategies to achieve this goal that will also create good quality, family-sustaining jobs for residents and workers. Because roughly 40% of Philadelphia's GHG emissions come from gas use across its residential, commercial, and industrial buildings, a significant part of the City's decarbonization efforts will require transitioning away from gas as a dominant energy source in buildings.¹⁴

Building decarbonization poses a potential challenge for the City's municipally-owned gas utility, Philadelphia Gas Works (PGW). Serving Philadelphia for over a century, this public revenue-generating gas provider employs over 1,500 employees and annually serves over 500,000 customers.^{15, 16}

The City of Philadelphia and PGW share a common goal: to protect the livelihoods of the dedicated utility and administrative workers at PGW who collectively hold decades of training, experience, expertise, and public service.



¹⁴ Philadelphia Office of Sustainability, "2019 Philadelphia Greenhouse Gas Inventory Summary"

¹⁵ PGW, "Fueling the Future: 2022 Annual Comprehensive Financial Report," City of Philadelphia, 2023, <https://www.pgworks.com/about-us/pgw-financials>.

¹⁶ Philadelphia Office of Sustainability & Philadelphia Gas Works (PGW), "Philadelphia Gas Works Business Diversification Study," City of Philadelphia, December 2021, <https://www.phila.gov/2021-12-09-about-the-philadelphia-gas-works-business-diversification-study/>.

This report provides an assessment of the workforce implications of adopting decarbonization technologies in Philadelphia. Conducted in partnership by the Building Electrification Institute (BEI) and the Economy League of Greater Philadelphia (ELGP), this report focuses on the “decarbonization pathways” explored in the *2021 PGW Business Diversification Study*.¹⁷ It uses both quantitative analysis and expert interviews to:

- Evaluate the skill sets of current gas utility workers and the overlap with the skill sets required for the four decarbonization pathways included in the *PGW Business Diversification Study*,
- Quantify the potential job impacts that would occur across three of the pathways (electrification, hybrid electrification, and district energy networks), and
- Identify key opportunities and considerations to ensure gas utility workers are valued and supported in a long-term transition away from fossil fuels.

This report is meant to inform and support Philadelphia’s carbon neutrality commitment by identifying both workforce opportunities and challenges that will need to be addressed as a result of building decarbonization. The report identifies potential opportunities for workforce transitions between fossil fuel and decarbonization industries, and opportunities for long-term planning that will be necessary for a fully fair, long-term transition for workers.

This report finds that it is possible to decarbonize Philadelphia’s buildings and protect gas workers throughout a multi-decade, planned transition away from fossil fuels. By deploying multiple fossil fuel-free technologies, including large-scale district geothermal networks, and collaborating closely with the existing workforce, the City can create new economic innovation opportunities for PGW and career paths for its workers. These findings demonstrate that solving climate change, creating good family-sustaining jobs, and prioritizing, valuing, and rewarding existing fossil fuel workers can all be complementary.

¹⁷Energy & Environmental Economics, Econsult Solutions Inc., Portfolio Associates, “Philadelphia Gas Works Business Diversification Study.” December 2021, <https://www.phila.gov/media/20211207134817/PGW-Business-Diversification-Study-2021-12.pdf>

BACKGROUND

An Optimal Time for Planning Decarbonization

The City of Philadelphia's commitment to carbon neutrality mirrors both national and international pledges as well as private market investment trends away from the use of fossil fuels as a dominant energy source.^{18,19}

With concerns of both irreparable damage to the global climate as well as depleting non-renewable energy supplies, there is increased movement towards renewable and decarbonized energy sources. Momentum has been growing in the U.S. since at least the 1970s, but has intensified as evidence mounts of the danger in nearing and passing many climate thresholds.²⁰

Government policy and private investment backing decarbonization reflect an increased social and financial desire among the U.S. populace to end polluting practices in favor of adopting more efficient, clean energy practices.²¹ As evidence, electricity surpassed gas as the main home heating source in the U.S. for the first time in 2020, according to the U.S. Energy Information Administration, and national fossil fuel industries saw minimal to stunted business and employment growth in the past few decades.^{22, 23, 24, 25}

The recent enactment of the Inflation Reduction Act by the U.S. Congress in August 2022 marked a watershed moment for the near future of renewable energy and decarbonization technologies. Included within the legislation was a series of tax incentives, rebates, and other opportunities for decarbonization technologies such as solar panels, all-electric air source heat pumps, ground

¹⁸ Congressional Research Service, "U.S. Climate Change Policy." United States Congress, 28 October 2021, <https://crsreports.congress.gov/product/pdf/R/R46947>.

¹⁹ Deloitte, "2023 Renewable Energy Industry Outlook," Deloitte, 2022, <https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/renewable-energy-outlook.html>.

²⁰ Brad Plumer, "Climate Change Is Speeding Toward Catastrophe. The Next Decade Is Crucial, U.N. Panel Says." The New York Times, 21 March 2023, <https://www.nytimes.com/2023/03/20/climate/global-warming-ipcc-earth.html>.

²¹ Alec Tyson and Brian Kennedy, "Two-Thirds of Americans Think Government Should Do More on Climate." Pew Research Center, 23 June 2020, <https://www.pewresearch.org/science/2020/06/23/two-thirds-of-americans-think-government-should-do-more-on-climate/>.

²² Susan Phillips, "For the first time, electricity beat out natural gas to heat homes nationwide." WHYY, 9 June 2022, <https://whyy.org/articles/electric-heat-natural-gas/>.

²³ Deloitte Center for Energy Workforce Development, "The natural gas utility workforce in a decarbonizing world." Deloitte, 2022, <https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/future-of-natural-gas-workforce.html>.

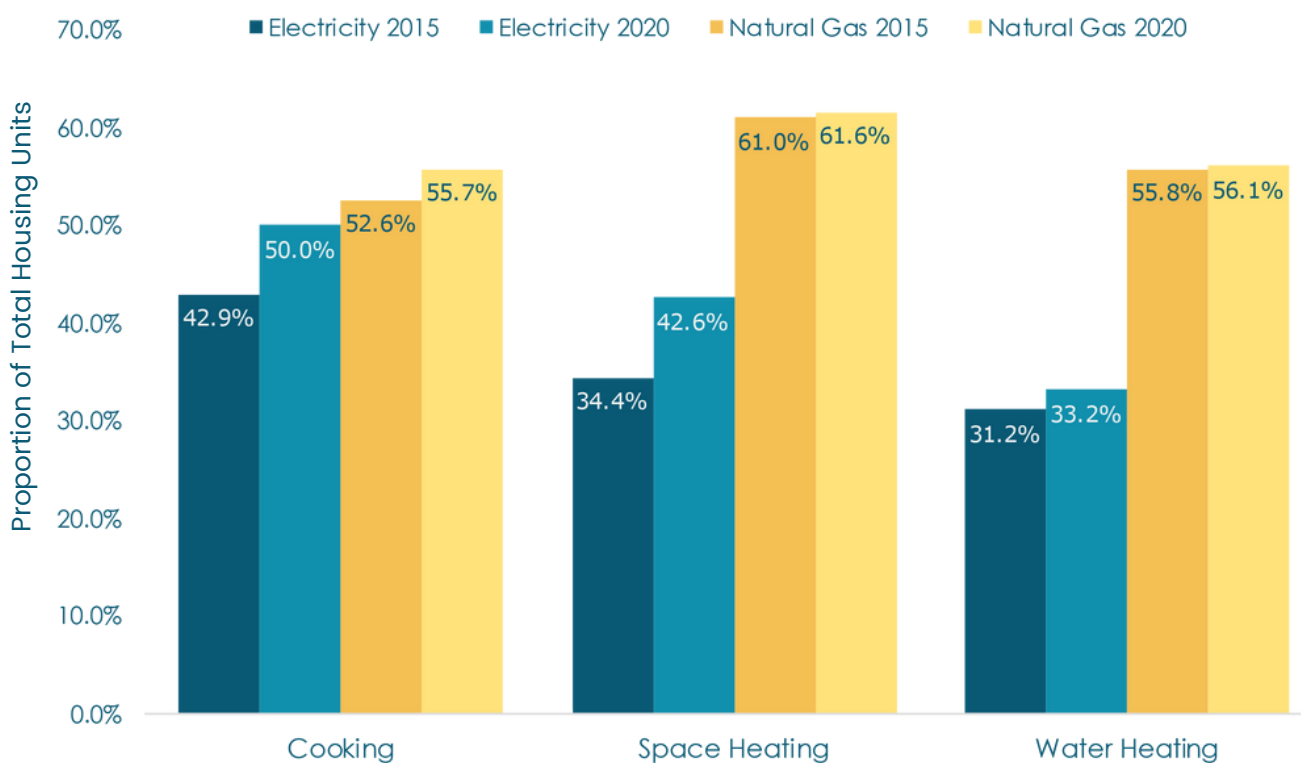
²⁴ Mike Scott, "Pandemic Accelerates Decline and Fall of Fossil Fuel Producers." Forbes, 5 June 2020, <https://www.forbes.com/sites/mikescott/2020/06/05/pandemic-accelerates-decline-and-fall-of-fossil-fuel-producers/?sh=2203c070f639>.

²⁵ Victoria Masterson, "US fossil fuel consumption is at its lowest in 30 years. Here's why." World Economic Forum, 19 July 2021, <https://www.weforum.org/agenda/2021/07/us-fossil-fuel-consumption-eia/>.

source heat pumps, heat pump water heaters, and energy efficient building retrofits.²⁶ Private investment in renewable energy reached a record high of \$10 billion annually in 2022, and the Inflation Reduction Act will only intensify market transformation toward decarbonization in the coming years.²⁷

This social, political, and financial momentum away from fossil fuel use has also been manifesting in and around the City of Philadelphia for some time. The most recent Residential Consumption Survey from the U.S. Energy Information Administration shows significant increases in electricity end use among residential homes in the Mid-Atlantic Region between 2015 and 2020.²⁸ As illustrated in **Figure 1**, gas remains the dominant end use fuel for homes in Pennsylvania, New Jersey, and New York in both 2015 and 2020, but electricity use saw significant increases across household uses like cooking and space heating in the span of only five years.²⁹

FIGURE 1: Fuel End Uses in Middle Atlantic Homes



SOURCE: Residential Energy Consumption, U.S. Energy Information Administration

²⁶John Larsen, Ben King, Hannah Kolus, Naveen Dasari, Galen Hiltbrand, and Whitney Herndon, “A Turning Point for US Climate Progress: Assessing the Climate and Clean Energy Provisions in the Inflation Reduction Act.” Rhodium Group, 12 August 2022, <https://rhg.com/research/climate-clean-energy-inflation-reduction-act/>.

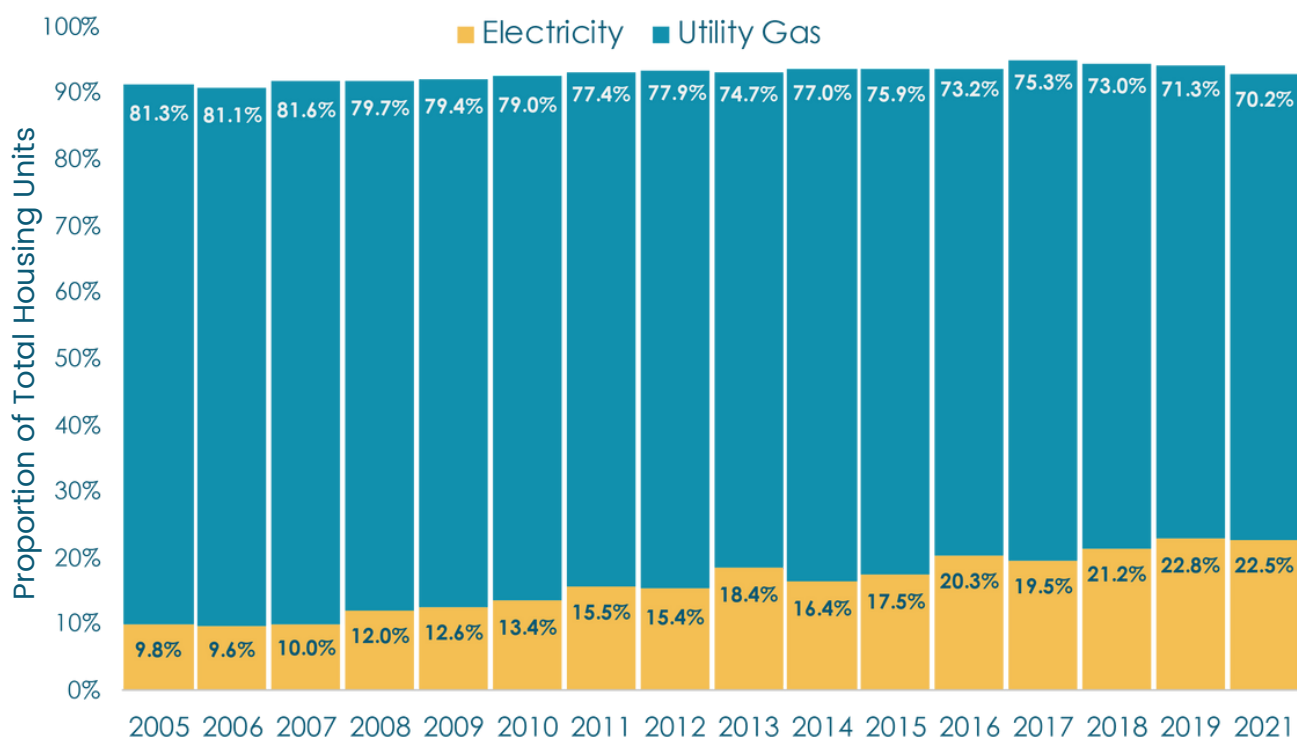
²⁷Deloitte, “2023 Renewable Energy Industry Outlook,” Deloitte, 2022, <https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/renewable-energy-outlook.html>.

²⁸U.S. Energy Information Administration, “Residential Energy Consumption Survey (RECS).” U.S. Energy Information Administration, 2022, <https://www.eia.gov/consumption/residential/data/2020/>.

²⁹U.S. Energy Information Administration, “Use of energy explained.” U.S. Energy Information Administration, 2022, <https://www.eia.gov/energyexplained/use-of-energy/>.

The City of Philadelphia’s fuel use mirrors national and regional trends. As **Figure 2** details, household estimates from the U.S. Census Bureau’s American Community Survey show that although utility gas remains the predominant fuel source for heating residential homes in Philadelphia, electricity usage has grown significantly in the past 17 years. As of 2021, over a fifth of the city’s occupied residential homes use electricity for their heating needs – a rate that has more than doubled since 2005. The proportion of households using utility gas, on the other hand, declined by 11.1% in the same period.

FIGURE 2: Residential Fuel Sources in Philadelphia (2005-2021)



SOURCE: Residential Energy Consumption, U.S. Energy Information Administration

Building decarbonization technologies can help realize broader social equity and public health goals. These include improving indoor air quality, resulting in improved health outcomes for the low- and moderate-income communities of color who live in neighborhoods with the worst air pollution in Philadelphia and suffer disproportionate health impacts.³⁰ Electric heat pumps provide highly efficient space heating and cooling in one appliance, typically resulting in energy bill savings that can help alleviate energy poverty across Philadelphia. They can also provide cooling for the many households that lack reliable cooling and often face higher urban heat island effects.³¹

³⁰ Brady Seals, “Indoor Air Pollution: the Link between Climate and Health.” RMI, 5 May, 2020, <https://rmi.org/indoor-air-pollution-the-link-between-climate-and-health>.

³¹ EPA, “Heat Islands and Equity”, <https://www.epa.gov/heatislands/heat-islands-and-equity>.

With sufficient funding and planning, there is also an important opportunity to address buildings' deferred maintenance needs and broader health and safety retrofits in coordination with decarbonization retrofits, resulting in significantly improved housing quality and safety. Decarbonization technologies have proven to stimulate economic and job growth, and this is expected to continue as a result of federal funding opportunities, increased private investment, and changing consumer habits.^{32, 33}

This report did not assess non-building decarbonization industries for opportunities to transition utility workers. For example, water and sewer infrastructure investments may offer significant job transition opportunities for the City's current gas workforce, given the overlap of piping skills. The City needs to significantly invest in water, wastewater, and stormwater infrastructure to protect Philadelphians against water pollution and the rising threat of flooding as a result of climate change, and this investment has the potential to create thousands more good-quality local jobs for residents, especially if the City includes appropriate skill and labor requirements to match the benefits of current gas utility workers.

Given the urgent need to address climate change and the growing momentum toward renewable energy sources, **a shared priority across the City, PGW, and local labor unions must be to pursue a long-term, collaborative planning effort that protects and supports Philadelphia's existing utility workforce throughout a building decarbonization transition.**



³² Lauren Cozzi and Brian Motherway, "The importance of focusing on jobs and fairness in clean energy transitions." International Energy Agency, 6 July 2021, <https://www.iea.org/commentaries/the-importance-of-focusing-on-jobs-and-fairness-in-clean-energy-transitions>.

³³ International Energy Agency, "The Oil and Gas Industry in Energy Transitions: World Energy Outlook." International Energy Agency (IEA), January 2020, <https://www.iea.org/reports/the-oil-and-gas-industry-in-energy-transitions>.

The Role of Philadelphia Gas Works and its Workforce

Founded in 1836, PGW is the largest municipally owned gas utility in the country, managing and maintaining a system of over 6,000 miles of gas mains and service pipes that annually serve roughly 500,000 customers.³⁴ It also remains a consistent contributor to the City's municipal budget, adding approximately \$18 million to the City's general fund per fiscal year.^{35, 36}

In addition to its consistent revenue contributions, PGW currently offers an affordable energy option for heating and cooking to much of Philadelphia's population. A comparison of electricity and natural gas rates shows that electricity is currently about four times more expensive than gas on a per kBtu basis. However it's critical to consider that electric heat pump equipment is significantly more efficient than gas equipment. While gas heating systems typically operate at an efficiency of around 80%, electric heat pumps can operate at 300% efficiency or greater, which offers a potential opportunity to reduce energy bills for residents even when gas rates are cheaper than electricity rates.³⁷



³⁴ Philadelphia Gas Works, "About Us," Philadelphia Gas Works, <https://www.pgworks.com/about-us#:~:text=Today%20PGW%20is%20the%20largest,our%20500%2C000%20customers%20each%20year.>

³⁵ City of Philadelphia, "The Mayor's Operating Budget in Brief for Fiscal Year 2023." City of Philadelphia, <https://www.phila.gov/media/20220712100413/Mayors-Operating-Budget-in-Brief-for-FY2023-as-Approved-by-Council-June-2022.pdf>.

³⁶ Philadelphia Gas Works, "Clean Energy Future: Annual Comprehensive of the City of Philadelphia for Fiscal Years Ended August 31, 2021 and 2020," City of Philadelphia, February 2022, https://www.pgworks.com/uploads/pdfs/Philadelphia_Gas_Works_2021_ACFR_-_FINAL.pdf.

³⁷ R. Scott Frazier, "True Cost of Energy Comparisons." Oklahoma State University, October 2023, <https://extension.okstate.edu/fact-sheets/true-cost-of-energy-comparisons-apples-to-apples.html>

Decarbonization technologies such as solar panels, electric vehicles, and all-electric heat pumps have historically been expensive to install and initially only available to higher-wage households and commercial enterprises.³⁸ With increased supply and adoption, combined with generous federal incentives, the industry expects to see lower prices that will make these technologies more affordable and desirable in the long term. In a city with nearly a quarter of the population living in poverty, transitioning to these clean energy technologies will need to be thoughtfully managed to ensure that energy bills remain stable in the process.³⁹

³⁸ Molly Robertson, "Electricity Affordability 101," Resources for the Future, 18 October 2022, <https://www.rff.org/publications/explainers/electricity-affordability-101/>.

³⁹ U.S. Census Bureau, "2021 American Community Survey Five-Year Estimates: S1701 - Poverty Status in the Past 12 Months for the Total Population for Whom Poverty Status is Determined, U.S. Census Bureau, 8 December 2022, <https://data.census.gov/table?q=povrty+in+philadelphia+in+2021&tid=ACSST5Y2021.S1701>.



PGW remains a stronghold of municipal employment opportunities that require limited post-secondary education credentialing and offer family-sustaining wages, favorable benefits, and employee collective bargaining via unionization. As of 2022, PGW employed roughly 1,500 total employees and estimated a total payroll of roughly \$136 million.⁴⁰

The average annual pay for PGW gas workers in 2021 was roughly \$78,000, which is about \$3,000 more than the average annual pay within Philadelphia at that time.^{41, 42} Eligible full-time employees of PGW also have access to generous benefits like a City-established pension plan as well as membership within Gas Works Employees Union Local 686 – a local labor union composed entirely of PGW workers that provides additional health and financial benefits to its members and advocates on their behalf.^{43, 44} As of May 2022, roughly 68% of PGW’s workforce retained union membership.⁴⁵

Skill Sets of the PGW Workforce

PGW’s workforce is racially diverse (over half of workers are non-white) and is highly skilled and trained. Because of the nature of working in a gas utility, most PGW workers are required to exhibit proficiencies in the operation of various equipment, tools, and vehicles to successfully carry out their roles.

Table 1 describes the required skills for the entirety of PGW’s unionized workforce by job category as of May 2022. The most common skills among all workers are the operation of gas equipment (55%), construction tools (44%), and skilled trade vehicles (36%). The use of trucks, vans, and standard passenger vehicles are also required for nearly a third of the workforce.

Most job categories require a variety of proficiencies and expertise; very few show single proficiencies. Among the most versatile employees are equipment technicians and mechanics, pipefitters, and delivery and distribution service workers. Many PGW roles also require additional specialized skills in personnel management, finances and budgeting, human resources and personnel training, as well as customer care and service. These unlisted but equally important skill sets are found across multiple positions but are especially important for workers in administrative and customer service positions.

⁴⁰ PGW, “Fueling the Future: 2022 Annual Comprehensive Financial Report,” City of Philadelphia, 2023, <https://www.pgworks.com/about-us/pgw-financials>.

⁴¹ GovSalaries, “Philadelphia Gas Works Salaries,” GovSalaries, 2023, <https://govsalaries.com/salaries/PA/philadelphia-gas-works>.

⁴² U.S. Bureau of Labor Statistics, “2021 Quarterly Census of Employment and Wages for Philadelphia County, Pennsylvania,” U.S. Bureau of Labor Statistics, 2022, <https://www.bls.gov/data/>.

⁴³ “Sinking Fund Commission” City of Philadelphia, <https://www.phila.gov/departments/sinking-fund-commission/>.

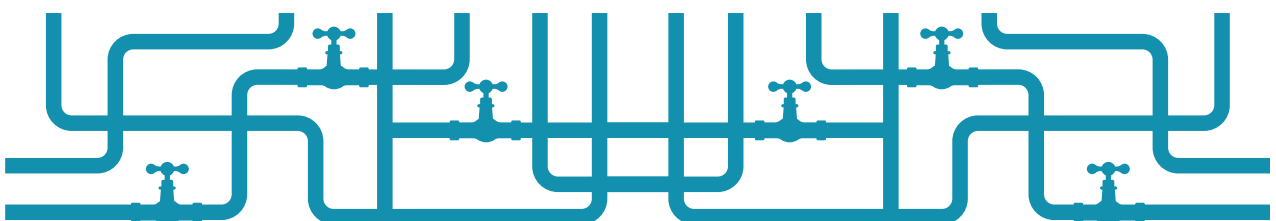
⁴⁴ “Local 686 Gas Workers,” <https://local686gasworkers.org/>.

⁴⁵ Employee demographic data was obtained from PGW leadership and represents all union and non-union employees as of May 2022.

Table 1: Unionized PGW Employees' Equipment Proficiencies

Job Category	Total Employees	Employees with Vehicle and Equipment Proficiencies					
		Trucks/ Vans	Skilled Trade Vehicles	Construction Equipment	Welding Tools	Drafting Tools	Natural Gas Equipment
Customer Service	281	0	0	0	0	0	103
Delivery/ Distribution Services	165	39	104	122	41	0	103
Pipefitting	140	108	108	108	0	32	140
Field Services	110	1	0	2	103	0	104
Pressure Operations	102	81	81	82	0	0	95
Administrative	57	0	0	0	0	0	0
Mobile Equipment Operations	53	52	47	52	0	0	0
Equipment Technicians/ Mechanics	49	31	32	38	20	15	28
Building Maintenance/ General Construction	43	18	0	16	0	0	4
Gas Processing	31	16	0	12	0	1	15
Stock Handling	25	2	23	23	0	0	0
Drafting	14	0	0	0	0	14	0
Welding	11	0	0	11	11	0	0
Meter Services	8	0	0	8	0	0	8

NOTE: Vehicle and equipment proficiencies were derived from PGW job descriptions. All Required Vehicle and Equipment Proficiencies are further detailed in Appendix A.



Working with gas, maintaining and repairing an aged gas pipeline infrastructure, and consistently fixing and restoring gas service to a large urban population requires deep training and expertise.⁴⁶ Opportunities to gain skills and proficiencies at PGW are provided by the utility itself, via formal job training sessions, annual safety compliance training, as well as training related to special and unique needs.^{47, 48} On-the-job training and expertise are honed via teaching and mentorship from established or long-time PGW workers, with more senior workers sharing their skills and knowledge with newer or younger workers at job sites.^{49, 50} When considering the role of gas workers in a decarbonized Philadelphia, it is important to recognize the value of this expertise and prevent any loss in relevant knowledge.⁵¹

PGW has long been a provider of energy in Philadelphia. Moving forward, energy decisions must be made with an understanding of the current assets PGW and its workers provide to the City and its residents. The expertise of PGW's leadership and workers must be considered, consulted, valued, and supported through any transition.^{52, 53}



⁴⁶ Utility Workers of America, "Away from Natural Gas | Opinion," The Utility Worker Magazine, 9 March 2022, <https://uwua.net/2022/03/good-paying-pgw-jobs-would-be-irreplaceable-if-philly-moves-away-from-natural-gas-opinion/>.

⁴⁷ Philadelphia Gas Works, "Philadelphia Gas Works' Response to the 2021 PAPUC Winter Reliability Data Request," Pennsylvania Public Utilities Commission, https://www.puc.pa.gov/media/1725/winter_reliability2021-pgw.pdf.

⁴⁸ J. Baylson, "Memorandum Re: Motion for Summary Judgement: Byrd v. Phila. Gas Works, Civil Action 19-cv-5305, United States District Court, E.D. Pennsylvania, 10 December 2021, <https://casetext.com/case/byrd-v-phila-gas-works-1>.

⁴⁹ Qualitative insight from PGW union members

⁵⁰ J. Baylson, "Memorandum Re: Motion for Summary Judgement: Byrd v. Phila. Gas Works, Civil Action 19-cv-5305, United States District Court, E.D. Pennsylvania, 10 December 2021, <https://casetext.com/case/byrd-v-phila-gas-works-1>.

⁵¹ "Frequently Asked Questions on just transition," International Labour Organization, 2023, https://www.ilo.org/global/topics/green-jobs/WCMS_824102/lang-en/index.htm#:~:text=A%20Just%20Transition%20means%20greening,and%20leaving%20no%20one%20behind.

⁵² PGW's leadership was informed of this report early on, however they did not participate in exploratory interviews. They reviewed a final report draft and offered comments, many of which the project team incorporated.

⁵³ A qualitative sentiment shared by a member of Gas Works Employees Union Local 686 as part of this analysis.

OVERVIEW OF ANALYSIS

The analysis included in this report builds on several years' worth of work in Philadelphia to understand PGW's current business model and plan for the future. In 2021, the City released the *Philadelphia Gas Works Business Diversification Study* (hereafter the *PGW Business Diversification Study*).⁵⁴

The *PGW Business Diversification Study* outlines four potential decarbonization strategies or “pathways” that PGW could potentially pursue to diversify its revenue stream and transition away from gas by 2050. The four decarbonization pathways centered around specific decarbonization technologies that could reduce the city’s GHG emissions from gas.

The pathways can point to potential pilot projects and future business strategies for PGW to help sustain jobs and maintain customer affordability in a decarbonized future. (See **Figure 4** for an overview of these pathways). The *PGW Business Diversification Study* is not a plan for the City of Philadelphia or PGW to follow; rather, it is a first in-depth look at potential decarbonization business opportunities.

⁵⁴ Energy & Environmental Economics, Econsult Solutions Inc., Portfolio Associates, “Philadelphia Gas Works Business Diversification Study.” December 2021, <https://www.phila.gov/media/20211207134817/PGW-Business-Diversification-Study-2021-12.pdf>



Figure 4: The Four Diversification Pathways

Electrification

All fossil fuel-burning appliances and systems are replaced with efficient, all-electric alternatives. Heat pump heating and cooling systems replace gas or oil furnaces or boilers, heat pump water heaters replace gas water heaters, and electric induction stoves replace gas stoves. Over the long term, gas distribution systems will be eliminated and major investment in the electric grid may be needed.

- Benefits: greater energy efficiency, improved air quality, added cooling from heat pumps, and reduced energy costs for many customers.
- Drawbacks: Installation requires significant investments and possible upgrades to electric service or panels. Some building owners may see higher energy bills.

Decarbonized Gas

Utilities use existing gas pipelines to distribute alternatives to gas that produce little or no GHG emissions, such as hydrogen, synthetic natural gas (SNG), or biomethane from waste biogas or gasified biomass.

- Benefit: Biomethane and SNG could more easily be distributed using existing gas infrastructure.
- Drawbacks: Decarbonized gas faces major costs and supply constraints that prevent it from being a viable decarbonization pathway for the vast majority of Philadelphia buildings. Existing pipelines would also need significant upgrades to distribute more than a 7% blend of hydrogen.

Hybrid Electrification

Some fossil fuel-burning systems are replaced with efficient electric appliances, but a gas or oil furnace or boiler is kept as a back-up heating source. Pairing with insulation, building weatherization, and air sealing improves efficiency and further lowers GHG emissions.

- Benefits: Less need for potentially expensive electric upgrades.
- Drawbacks: Requires the operations and maintenance of a large network of gas infrastructure as gas demand decreases significantly, causing major gas rate increases.

District Energy Networks

Water and heat distribution systems heat or cool buildings through shared pipeline networks. *Networked Geothermal* systems serve several buildings through pipe networks. Ground-source heat pumps use the constant temperature deep underground to heat or cool buildings. *Steam Loops* heat buildings using steam that travels through shared pipelines and can be powered by fossil fuels or renewable energy.

- Benefits: District geothermal is very energy efficient, especially in cold climates, resulting in lower operational costs. Systems can last over 50 years because main components are protected underground and inside.
- Drawbacks: Networked geothermal systems have high installation costs due to the need to drill and dig underground. Outdoor space and landscape alterations may be required.

The *PGW Business Diversification Study* offers several recommendations for the City of Philadelphia and PGW. One recommendation is to better understand the impact the different decarbonization pathways would have on PGW's existing workforce over the coming decades and to identify potential mitigation strategies. This stems from the recognition that decarbonization will directly impact the current workforce of PGW, and that proper planning and insights are needed to better understand how gas utility workers can be supported and rewarded in the future. This report offers further assessment of the skill sets and employment opportunities within growing decarbonization fields that could provide favorable transition opportunities for PGW and its workforce.

The analysis for this report utilizes a mixed methodological approach to: (1) quantify and summarize the potential job impacts that would occur across potential decarbonization pathways, (2) evaluate and identify skill set overlaps between the decarbonization pathways and current PGW occupations, and (3) identify key considerations that would help or hinder a transition of gas utility workforce into a decarbonization pathway. The full methodology of this report is detailed in **Appendix B**.

As with any economic shift or industry transition, long-term decarbonization will require proper planning and strategy to navigate workforce transitions. This analysis flips the traditional approach of treating workers as an after-thought in the clean energy transition by making the gas workforce the center of this investigation. This analysis assesses skill set alignments between existing gas and burgeoning decarbonization employment opportunities, while also recognizing where some decarbonization pathways may not offer fair or lucrative transition opportunities for the existing gas workforce.

The goal of this report is to inform future stakeholder conversations about opportunities for worker transitions, the issues that may help or hinder these transitions, and where gas utility workers' wealth of knowledge, expertise, experience, and public service may be supported and rewarded.



THE ANALYSIS: COST AND EMPLOYMENT RESULTS

To better understand the necessary investments and associated employment impacts of a building decarbonization transition, this report analyzes several scenarios that blend the implementation of three of the decarbonization pathways identified by the *PGW Business Diversification Study*.⁵⁵ The decarbonized gas pathway was not included because our research and interviews demonstrated that this pathway faces major cost and supply constraints that prevent it from being a viable decarbonization pathway for the majority of Philadelphia's buildings.^{56, 57} Decarbonized gas, such as hydrogen or biomethane, will likely be best suited as a solution only for very difficult-to-electrify sectors, such as heavy industrial manufacturing. This analysis only includes employment estimates for building retrofit workers, electric utility workers, and district energy network workers under the other decarbonization pathways: electrification, hybrid electrification, and district energy networks powered by renewable sources of energy.

The transition to decarbonized buildings will be both long and multifaceted. It is extremely unlikely that one decarbonization technology is chosen as the only pathway for the entirety of Philadelphia's building stock. Rather, building owners and developers will face a series of choices and incentives in choosing the most appropriate pathway to decarbonize their buildings' energy sources. Therefore, three blended scenarios were chosen to reflect different levels of implementation of these decarbonization pathways. (See **Figure 5.**)



⁵⁵Energy & Environmental Economics, Econsult Solutions Inc., Portfolio Associates, "Philadelphia Gas Works Business Diversification Study." December 2021, <https://www.phila.gov/media/20211207134817/PGW-Business-Diversification-Study-2021-12.pdf>

⁵⁶E3's PGW Business Diversification Study refers to waste biogas, gasified biomass, hydrogen, and synthetic natural gas as "decarbonized gas." Other sources may use the term "renewable natural gas" (RNG), which covers waste biogas, gasified biomass, and synthetic natural gas, but does not typically refer to hydrogen.

⁵⁷American Gas Association via Earthjustice, Rhetoric vs. Reality: The Myth of "Renewable Natural Gas" for Building Decarbonization. <https://s3.documentcloud.org/documents/6988834/Rhetoric-vs-Reality-The-Myth-of-Renewable.pdf>.

Figure 5: Decarbonization Pathway Implementation Scenarios

Blended Scenario 1

**Full Electrification for All Small Buildings /
District Energy for All Large Buildings**

This scenario assumes that district energy networks powered by renewable energy sources (such as geothermal) are more likely to be adopted by Philadelphia’s larger buildings, while electrification is more likely to be adopted by the city’s smaller buildings. This scenario assumes all smaller buildings (under 50,000 square feet) pursue full electrification, and all larger buildings (over 50,000 square feet) pursue district energy. (See **Appendix B** for more detail.)

Blended Scenario 2

**Full and Hybrid Electrification for All Small Buildings /
Split Electrification and District Energy for All Large Buildings**

This scenario assumes that full electrification may not be possible for all smaller buildings, and some of Philadelphia’s smaller buildings may pursue hybrid electrification instead. Similarly, this scenario assumes that district energy may not be possible for all larger buildings, and some larger buildings may pursue full or hybrid electrification instead to decarbonize. (See **Appendix B** for more detail.)

Blended Scenario 3

**Full and Hybrid Electrification for All Buildings /
No District Energy**

This scenario looks at a hypothetical scenario in which district energy is not possible for any buildings in Philadelphia, and shows the results of a high electrification scenario in which most buildings of all sizes pursue full electrification. The small set that are not able to fully electrify choose hybrid electrification instead. (See **Appendix B** for more detail.)

This analysis assesses three main categories of workers:

- Building retrofit workers who work inside of the buildings, including general construction laborers, building envelope and insulation workers, electricians, and heating, ventilation, and air conditioning (HVAC) technicians.
- Electric utility workers who work on grid infrastructure, including the construction, operation, and maintenance of transmission and distribution infrastructure needed to support building electrification.
- District energy network workers who focus on the construction, operations, and maintenance of the underground piping and network infrastructure, powered by geothermal energy, that connects buildings.

Analysis Results

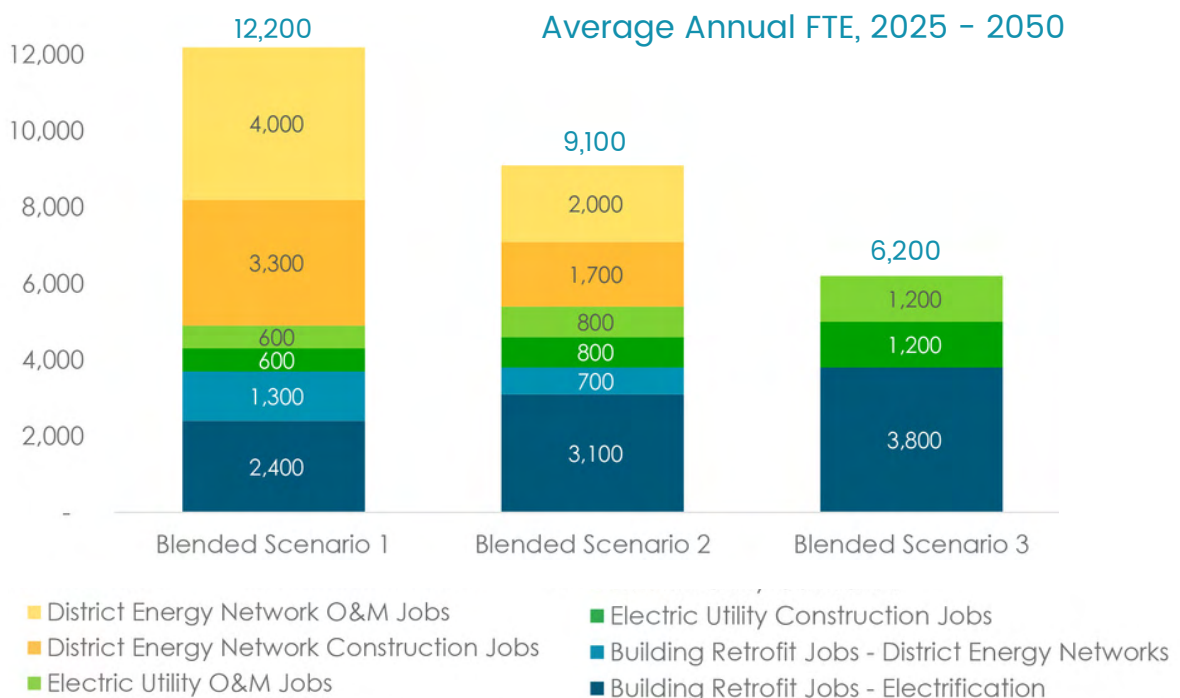
The findings of this analysis (see **Figure 6**) include that:

- **Deploying multiple technologies to decarbonize Philadelphia’s buildings could create 6,000 to 12,000 average full-time jobs annually** between 2025–2050, across the building retrofit and utility infrastructure sectors.
- **Building retrofit workers would face significant job gains from both electrification and district energy work.**
- When adding in the utility infrastructure workers, **investing in the creation of district energy networks powered by geothermal energy creates significantly more total jobs than investing in building electrification.** This is demonstrated in Blended Scenario 1, which includes the highest district energy adoption out of the three scenarios and results in the highest number of average annual full-time jobs.

These estimates do not include any supply chain jobs and do not account for job loss. They also do not indicate that these would all be new jobs in the local economy. The best way to interpret these estimates is the full-time equivalent number of workers required under each scenario.

While the earlier *PGW Business Diversification Study* explored considerations if Philadelphia pursued any one of the pathways in isolation, this blended scenario analysis demonstrates that there is an opportunity to combine the full electrification, hybrid electrification, and district energy network pathways to optimize for annual jobs required. Further research and local validation would be welcome to ground-truth the assumptions built within these estimates.

FIGURE 6: Potential Job Impacts of Blended Scenarios



CONSIDERATIONS FOR A GAS WORKFORCE TRANSITION

To complement the quantitative analysis, the research team conducted several interviews with national and local experts and consulted previous research to better understand the economic, political, and social barriers and opportunities of a transition to decarbonized energy for gas utilities and their workers. We spoke with national leaders working in each decarbonization pathway, regional energy program implementers, representatives from local energy providers, and members of the local gas utility workforce to gain an understanding of the economic and structural implications of adopting these pathways in Philadelphia.⁵⁸

A Long Decarbonization Transition

Any transition from a system dominated by fossil fuels to a largely decarbonized system in Philadelphia will take many decades to complete. National and regional experts agreed that the mass implementation of any of the decarbonization technologies will take time. This is also evident based on the historical trends of Philadelphia residents' adoption of electricity for heating in the past 17 years depicted in **Figure 2**.

Gas will continue as a stable energy source in Philadelphia as new decarbonization technologies are piloted, adopted, and installed in the city. This translates to some sustained job security and stability for PGW's workforce, since decarbonization efforts pursued by the City of Philadelphia are unlikely to translate into direct near-term layoffs for fossil fuel workers. Gas will be used during the transition to a new energy mix, and there will be a long-term need to strategically maintain, repurpose, and decommission gas pipelines. The skill sets and expertise of gas utility workers will continue to be needed throughout this process.

As decarbonization technologies overtake gas in Philadelphia, it will become increasingly important to create appropriate protections and transition options for future fossil fuel workforce contractions. There is still plenty of time and opportunity for City leaders and PGW to collaborate on developing a decarbonization plan. **Buy-in from PGW, the City, and local labor leaders on a just decarbonization plan would open up possibilities of reskilling into new technologies while still maintaining gas as a near-term stable energy source.**

⁵⁸ PGW's leadership was informed of this report early on; however they did not participate in exploratory interviews. They reviewed a final report draft and offered comments, many of which the project team incorporated. Leadership of the Gas Workers Employees Union Local 686 participated in interviews and offered key insights underpinning the analysis.

A multi-decade decarbonization transition also aligns with PGW's current employment and retirement trends, because the gas workforce has been naturally contracting on its own. (See **Figure 7.**) **Under status quo operations, the anticipated retirement rates and current hiring trends at PGW indicate that much of their current workforce would not feel the impact of a decarbonization transition.** Many workers will have reached retirement age and would not be replaced by the time decarbonization technologies overtake gas usage. However, if the City, PGW, and local labor unions do not engage in planning efforts now, increased adoption of decarbonization technologies is likely to limit future employment growth opportunities at PGW.

Analysis of PGW's active pension plan participants as well as their actuarial retirement estimates show the average age of a current PGW worker is roughly 44-years-old, and that roughly 8.4% of PGW's current workers are predicted to retire by 2025, while 18.1% will likely retire by 2030.^{59, 60} From 2008–2021, PGW's active headcount of employees declined by roughly 160 employees (**Figure 7**). While the decline from 2020–2021 may reflect COVID impacts and urban population loss, the trend indicates a broader contraction of the gas utility workforce that aligns with overall gas and petroleum employment declines occurring in Pennsylvania and across the nation.^{61, 62, 63}



⁵⁹ Aon, "Philadelphia Gas Works Pension Plan—Funding: Actuarial Valuation Report for the Plan Year July 1, 2021–June 30, 2022," City of Philadelphia, Sinking Fund Commission, 26 October 2022, <https://www.phila.gov/departments/sinking-fund-commission/sinking-fund-philadelphia-gas-works-pension-plan-reports/#/>.

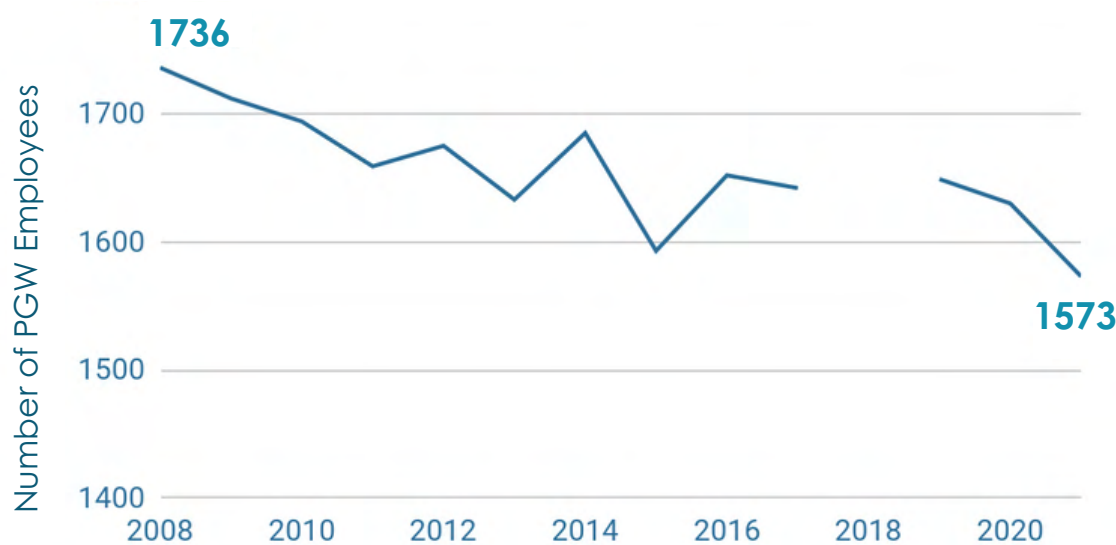
⁶⁰ Estimates of average age and retirement reflect active enrolled participants of PGW's pension plan in fiscal year 2022. Not all active PGW employees are enrolled in the utility's pension plan at any given time. Using the count of active participants in fiscal year 2022 (1,116), roughly 73% of PGW's workers were enrolled that year.

⁶¹ PGW, "Fueling the Future: 2022 Annual Comprehensive Financial Report," City of Philadelphia, 2023, <https://www.pgworks.com/about-us/pgw-financials>.

⁶² Mike Scott, "Pandemic Accelerates Decline and Fall of Fossil Fuel Producers." Forbes, 5 June 2020, <https://www.forbes.com/sites/mikescott/2020/06/05/pandemic-accelerates-decline-and-fall-of-fossil-fuel-producers/?sh=2203c070f639>.

⁶³ BW Research Partnership, "2021 Pennsylvania Energy Employment Report," Pennsylvania Department of Environmental Protection, Energy Programs Office, https://files.dep.state.pa.us/Energy/Office%20of%20Energy%20and%20Technology/OETDPortalFiles/2021EnergyReport/2021_PAEER.pdf.

Figure 7: Number of PGW Employees, 2008 - 2021



SOURCE: PGW Annual Reports submitted to Pennsylvania Utilities Commission.

NOTE: 2018 data is unavailable as no 2018 annual report for PGW could be located on the PUC website.

Workforce Considerations for District Energy Networks

Job estimates from the blended scenario analysis demonstrate how implementation of district energy networks powered by renewable energy offer significant employment opportunities. **If 50% to 100% of Philadelphia’s buildings over 50,000 square feet pursued district energy networks powered by geothermal energy, this would require an estimated 3,000 to 8,000 full-time equivalent employees annually from 2025–2050.** (See Figure 6.)

Previous research as well as expert insights find that **many employment opportunities associated with district energy networks align with the existing skill sets of gas utility workers**, though some reskilling may be needed due to the differences in energy sources. Whether via networked geothermal or steam loops, the installation, operation, and maintenance of these systems will benefit workers with transferable skills in pipefitting, welding, plumbing, drafting, machinery, mechanics, HVAC, building trades, and electrical work.^{64, 65, 66} Many PGW workers already possess similar skill sets. (See **Table 1.**) Therefore, there are ample workforce transition opportunities for gas utility workers in the construction and operation of district energy networks.

⁶⁴Deloitte Center for Energy Workforce Development, “The natural gas utility workforce in a decarbonizing world.” Deloitte, 2022, <https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/future-of-natural-gas-workforce.html>.

⁶⁵Andrew Stumpf, Franklin H. Holcomb, & Josiane Jello, “Geothermal in the Midwest: Geothermal Energy and Its Potential Contribution to Clean Energy for Developing Communities in Illinois and the U.S. Midwest,” Illinois Geothermal Coalition, February 2023, <https://geothermal.illinois.edu/wiki/#wiki-8.4>.

⁶⁶Networked steam loops were not included in the four diversification pathways, however this technology does offer additional skillset alignment with gas utility workers. More research and stakeholder engagement would be needed to understand potential PGW ownership structures and investment needed for a steam loop operated by clean energy.

In particular, **current gas workers skilled in pipefitting would require minimal reskilling to contribute to the construction of a geothermal system.** Most geothermal systems utilize high density polyethylene piping, a material that current gas workers are experienced with, since it is the same type of piping used in the existing gas system.^{67, 68}

Reskilling for gas workers hoping to transition to district energy network systems will center around the differences in energy sources. While many district energy network systems utilize similar equipment and technology to existing gas systems, the water in geothermal networks may require different processing and distribution needs than gas. **Gas utility workers have an abundance of knowledge on the preparation of gas for distribution, but they will likely need reskilling to manage the distribution of other energy sources used in district energy networks.** Experts speculate that some reskilling would be needed for gas workers specialized in processing and pressurization, along with drafters and engineers.⁶⁹ Additionally, the drilling required to install geothermal systems would likely be out of reach for current gas workers due to the extensive qualifications required to operate drilling equipment.⁷⁰ One major benefit to both workers and consumers across Philadelphia, however, is the improved safety of utilizing water in district energy networks, as opposed to flammable gas.



⁶⁷“Oil & Gas,” Pipeline Plastics, 2023, <https://www.pipe.us/oil-gas/>.

⁶⁸Deloitte Center for Energy Workforce Development, “The natural gas utility workforce in a decarbonizing world.” Deloitte, 2022, <https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/future-of-natural-gas-workforce.html>.

⁶⁹Insight from respondent with expertise in networked geothermal workforce training.

⁷⁰Department of Energy, “DOE Announces \$20 Million to Lower Costs of Geothermal Drilling,” Energy.Gov, 4 February 2022, <https://www.energy.gov/articles/doe-announces-20-million-lower-costs-geothermal-drilling>.

Geothermal systems have already been successfully implemented throughout Greater Philadelphia. The City of Philadelphia’s Police Tactical Training Facility, the Enterprise Center, and the Ronald McDonald House employ and benefit from geothermal exchange systems, although these are not “networked” systems that connect multiple buildings to provide shared heating and cooling.^{71, 72} PGW faces financial and legal barriers to creating new networked geothermal energy systems that could connect multiple buildings and facilities in the city.

The construction of district energy networks would require significant upfront investment, but this investment would require thousands of new, high-skilled jobs. The installation of district energy networks could require drilling for boreholes and pipeline installation among the city’s homes, businesses, lots, streets, and sidewalks, but the City already engages in similar excavation work to install, mend, and update its existing underground infrastructure of water mains, sewers, cable, and gas lines.^{73, 74} In fact, the installation of Philadelphia’s gas lines similarly disrupted the local infrastructure as they were installed underneath the city over a century ago.⁷⁵

State regulatory hurdles at the Pennsylvania Public Utilities Commission, as well as local hurdles at the Philadelphia Gas Commission, could create barriers to district energy networks. Overcoming them will require a broad coalition of partners working together, including labor, utility, and environmental stakeholders. Other states have successfully petitioned to allow gas utilities to invest in district energy network systems. In July 2022, representatives of labor unions and environmental groups helped garner support from New York State legislators to enact the Utility Thermal Energy Network and Jobs Act, which not only promotes the development of geothermal energy networks throughout the state but also requires the training of utility workers to work on these projects.⁷⁶ The workforce training requirements preference those who have been displaced by the reduction of gas consumption, distribution infrastructure, and building construction.⁷⁷

⁷¹ Susan Phillips, “Geothermal energy lies right beneath our feet. Could Philadelphia tap into it?” WHYY, 29 April, <https://whyy.org/articles/geothermal-energy-lies-right-beneath-our-feet-could-philadelphia-tap-into-it/>.

⁷² “Case Studies,” Geodelphia, June 2021, <https://geodelphia.org/who-has-geothermal-in-greater-philadelphia/>.

⁷³ Kevin S. Parker (sponsor), “Senate Bill S9422,” The New York State Senate, 25 May 2022, <https://www.nysenate.gov/legislation/bills/2021/S9422>.

⁷⁴ “New York Approves Landmark Thermal Network Legislation,” Geothermal Rising, 6 July 2022, <https://www.geothermal.org/our-impact/blog/new-york-approves-landmark-thermal-network-legislation>.

⁷⁵ Kat J. McAlpine, “Historic, and Loud, Geothermal Drilling Gets Underway,” BU Today, 27 February 2019, <https://www.bu.edu/articles/2019/bostons-biggest-geothermal-system-makes-its-debut/>.

⁷⁶ Audrey Henderson, “Here’s a model for bringing geothermal to urban areas,” Canary Media, 20 December 2022, <https://www.canarymedia.com/articles/geothermal/heres-a-model-for-bringing-geothermal-to-urban-areas>.

⁷⁷ “Philadelphia Gas Works Celebrates 185th Service Anniversary,” PGW, 10 February 2021, <https://www.pgworks.com/community-impact/newsroom/philadelphia-gas-works-celebrates-185th-service-anniversary>.

Given the expected expenditures on the existing gas system required to update aging gas pipelines, there is a strong argument for redirecting a portion of the funds towards the installation of new district energy network projects and reskilling the existing gas utility workforce. Over the next 35 years, it is clear that PGW plans to invest a significant amount of ratepayer funds to replace aging gas mains and service lines across Philadelphia.⁷⁸ In its 2023 rate case before the Pennsylvania Public Utilities Commission, PGW provided an estimate of \$3 billion to replace its remaining inventory of leak-prone cast iron mains through 2058.⁷⁹ A 2023 independent report from the nonprofit, Home Energy Efficiency Team (HEET), estimates that the City of Philadelphia is likely to spend up to \$8 billion over the next 35 years on this replacement activity.^{80, 81, 82} Given the expected expenditures on the existing gas system required to update aging gas pipelines, there is a strong argument for redirecting a portion of these estimated funds towards the installation of new district energy network projects and reskilling the existing gas utility workforce.

With current consumer trends moving towards decarbonized energy, combined with the City of Philadelphia's carbon neutrality pledge, private energy providers will likely have the opportunity to expand their business and investments in district energy networks in Philadelphia. These private energy providers are largely uninhibited by the many regulations public utilities face and can create and own geothermal systems or steam loops. While these circumstances may provide new district energy network job opportunities for the existing gas workforce, private entities are not required to ensure the same benefits or pay offered to unionized jobs, like those of PGW. The operation of district energy networks by private energy providers would also add pressure to PGW's current business model, increasing rates for those remaining on the gas system.

Therefore, it would be highly opportunistic for PGW to begin investing in district energy networks now in order to compete with private energy providers and to help ensure the creation and retention of good-quality, unionized jobs. PGW has the potential to lead the clean energy transition in Philadelphia through the adoption of new technologies and reskilling its existing municipal gas utility workforce.

⁷⁸ "PGW's Pipeline Improvement Map." <https://www.pgworks.com/pipeline-map/>.

⁷⁹ Pennsylvania Public Utilities Commission, Pa. PUC v. Philadelphia Gas Works, Docket No. R-2023-3037933, PGW Interrogatory Response to POWER-01-22 and 01-23).

⁸⁰ The HEET cost projection is higher because it also includes the costs of: replacing service pipes (approximately \$20 million per year), replacing non-cast iron leak-prone mains at a rate of about 6 miles per year, and debt servicing related to capital spending on pipeline replacement (approximately \$21 million per year).

⁸¹ Dorie Seavey, PhD, "Philadelphia's Gas Pipe Replacement Plan: How much will it cost and does it make sense?" HEET, March 2023, <https://heet.org/2023/04/17/to-invest-or-to-innovate-philadelphia-gas-works-8-billion-question/>.

⁸² Pennsylvania Public Utilities Commission, Pa. PUC v. Philadelphia Gas Works, Docket No. R-2023-3037933, Direct Testimony of Dorie Seavey (May 31, 2023).

Workforce Considerations for Full and Hybrid Electrification

Among the scenarios analyzed, both full and hybrid electrification would create a consistent source of employment opportunities. **If 100% of all Philadelphia buildings partially or fully electrified, it would require up to 4,000 full-time building retrofit and electric infrastructure jobs annually by 2050.** (See Figure 6.) Much of this job creation will consist of building retrofit and trade occupations, such as general construction laborers, building envelope and insulation workers, electricians, and HVAC technicians, plus electric utility workers focused on grid infrastructure construction, operations, and maintenance.⁸³

Although a majority of current gas workers do not have experience in electrical wiring and engineering, and therefore would likely not benefit from job creation in those sectors, they do hold extensive skill sets in adjacent building trades required for electrification. Experts in the building trades will see a substantive increase in demand for services such as building insulation, heat pump installation, weatherization, and the installation of solar energy technology.⁸⁴ For instance, many HVAC workers already possess the skill set required to install heat pumps in residential buildings, and some PGW employees retain these skill sets.^{85,86} Therefore, electrification currently offers some limited transition opportunities for PGW's workers.

An important consideration is that there is little evidence that building retrofit workers, particularly in the small residential building sector, would see the same pay and benefits currently offered to PGW's workforce. While some portions of the commercial building retrofit market may be unionized and pay living wages, general construction jobs in Philadelphia do not currently guarantee the pay and benefits that gas utility workers receive, and do not utilize the specialized knowledge that gas utility workers possess.

Recent annual wage estimates from U.S. Bureau of Labor Statistics show Greater Philadelphia's general construction workers earning a mean annual wage of roughly \$66,320 as of May 2022, with regional HVAC mechanics and installers earning roughly \$61,830.⁸⁷ Both occupational categories earn significantly less than PGW workers' mean annual wage of roughly \$78,000.⁸⁸

⁸³ Department of Energy, "DOE Report Finds Energy Jobs Grew Faster Than Overall U.S. Employment in 2021," Energy.Gov, 28 June 2022, <https://www.energy.gov/articles/doe-report-finds-energy-jobs-grew-faster-overall-us-employment-2021>.

⁸⁴ Ibid.

⁸⁵ Occupational Outlook Handbook, "Heating, Air Conditioning, and Refrigeration Mechanics and Installers," U.S. Bureau of Labor Statistics, 8 September 2022, <https://www.bls.gov/ooh/installation-maintenance-and-repair/heating-air-conditioning-and-refrigeration-mechanics-and-installers.htm>.

⁸⁶ J. Baylson, "Memorandum Re: Motion for Summary Judgement: Byrd v. Phila. Gas Works, Civil Action 19-cv-5305, United States District Court, E.D. Pennsylvania, 10 December 2021, <https://casetext.com/case/byrd-v-phila-gas-works-1>.

⁸⁷ GovSalaries, "Philadelphia Gas Works Salaries," GovSalaries, 2023, <https://govsalaries.com/salaries/PA/philadelphia-gas-works>.

⁸⁸ Occupational Employment and Wage Statistics, "May 2022 Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates for Philadelphia-Camden-Wilmington, PA-NJ-DE-MD." U.S. Bureau of Labor Statistics, 25 April 2023, https://www.bls.gov/oes/current/oes_37980.htm#47-0000.

Additionally, while many local building trades and professions are affiliated with national labor unions, not all positions would be guaranteed to offer union membership or the benefits currently offered to PGW workers as employees of the municipally owned utility. This makes transition into these electrification jobs less lucrative for PGW workers.

Full and hybrid electrification face barriers related to costs and infrastructure. The upfront investment cost of installing electric equipment within a building is typically higher when compared with gas equipment, and additional building upgrades, such as electric service and panel upgrades, may be required.⁸⁹ These costs could be partially mitigated with recent federal funding and incentives in the U.S. Inflation Reduction Act, which has dedicated billions of dollars to energy efficient upgrades and the electrification of homes, but an affordability gap for electrification remains.⁹⁰ With just under a quarter of Philadelphia's residents living under the poverty line, electrification will require additional financial incentives for a large number of city residents.⁹¹

In the near-term, the operation of the electric grid would not be significantly impacted with the adoption of some regional building electrification, but over the long term, major infrastructure investments will likely be needed to support increased electric demand due to the acceleration of both building and transportation electrification.⁹² This will likely lead to substantial job growth for highly skilled electrical and utility workers. Gas utility workers would need extensive training and reskilling to benefit.

It is unclear if or how PGW could provide services related to electricity distribution or usage, which is currently offered by other private utilities. Moreover, as electrifying customers move away from the gas network, there is a significant risk that gas prices would increase dramatically for the remaining customers, exacerbating Philadelphia's already high energy poverty rates.⁹³

⁸⁹ Kenneth T. Rosen, David Bank, Max Hall, Irina Chernikova, and Scott Reid, "New York Building Electrification and Decarbonization Costs." Rosen Consulting Group, June 2022, <https://www.nyserda.ny.gov/-/media/Project/Climate/Files/2022-Comments/NY-Building-Electrification-Cost-Full-Report-June2022#:~:text=The%20incremental%20costs%20of%20electrification,%243%2C200%20to%20%2412%2C400%20in%202021.&text=more%20than%2020%20units%2C%20including%20a%20full%20set%20of%20electrical%20appliances.&text=an%20air%20or%20water%20source,%2413%2C000%20to%20%2430%2C100%20per%20unit>.

⁹⁰ U.S. Environmental Protection Agency, "The Inflation Reduction Act," [United States Environmental Protection Agency, 17 April 2023, https://www.epa.gov/green-power-markets/inflation-reduction-act#:~:text=The%20Inflation%20Reduction%20Act%20of,of%20new%20clean%20electricity%20resources](https://www.epa.gov/green-power-markets/inflation-reduction-act#:~:text=The%20Inflation%20Reduction%20Act%20of,of%20new%20clean%20electricity%20resources).

⁹¹ U.S. Census Bureau, "2021 American Community Survey Five-Year Estimates: S1701 - Poverty Status in the Past 12 Months for the Total Population for Whom Poverty Status is Determined, U.S. Census Bureau, 8 December 2022, <https://data.census.gov/table?q=poverty+in+philadelphia+in+2021&tid=ACSS15Y2021.S1701>

⁹² Steven Nadel, "Coming Electrification Will Require the Grid to Evolve," American Council for an Energy-Efficient Economy, 10 February 2023, <https://www.aceee.org/blog-post/2023/02/coming-electrification-will-require-grid-evolve>.

⁹³ Energy & Environmental Economics, Econsult Solutions Inc., Portfolio Associates, "Philadelphia Gas Works Business Diversification Study." December 2021, <https://www.phila.gov/media/20211207134817/PGW-Business-Diversification-Study-2021-12.pdf>

Workforce Considerations for Decarbonized Gas

Expert interviews and industry research demonstrated that the skill set required for the production and refinement of decarbonized gas varies depending on the type of fuel employed, but the workforce needed for its distribution and maintenance is expected to look similar to existing gas workers. Therefore, decarbonized gas would theoretically largely preserve a major portion of the current gas utility workforce – though some new training may be required.

There is also some evidence that certain types of decarbonized gas may create new employment opportunities. In order to adopt any form of decarbonized gas as an energy source, new pipelines would have to be built connecting the current gas system with the decarbonized gas generation site, and existing pipelines would continue to require maintenance.⁹⁴ The scope of these new pipe distribution systems depends on the chosen decarbonized gas. Because of this, pipefitters and gas workers with expertise in processing, pressurizing, and distributing gas will be equally valuable to a decarbonized gas utility.

Although jobs in decarbonized gas production and distribution are expected to offer higher-than-average wages, they will also likely require additional training.⁹⁵ For example, hydrogen has only recently become prevalent as a potential decarbonized energy source, thus the jobs and subsequent training resources surrounding those jobs are still in their infancy or do not fully exist.⁹⁶

However, when compared with existing electrification technologies, decarbonized gas faces a variety of barriers as a building energy source while offering limited decarbonization benefits in this application. Given this, our analysis did not include the adoption of decarbonized gas within its cost and employment assumptions.



⁹⁴Deloitte: The Center for Energy Workforce Development, “The Natural Gas Workforce in a Decarbonizing World,” Deloitte, 2022, <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-the-natural-gas-utility-workforce-in-a-decarbonizing-world.pdf>.

⁹⁵Joseph Majkut, Jane Nakano, and Mathias Zacarias, “Making Hydrogen Hubs a Success,” Center for Strategic & International Studies, July 2022, <https://www.csis.org/analysis/making-hydrogen-hubs-success>.

⁹⁶“Making Hydrogen Hubs a Success,” <https://www.csis.org/analysis/making-hydrogen-hubs-success>.

Foremost among these barriers is that the current types of decarbonized gas available are largely not “drop-in ready,” meaning that they cannot be directly used within the current gas mains and service pipe system. For example, the existing building gas infrastructure can only support a gas blend of between 7% and 20% hydrogen.⁹⁷ Most of these decarbonized gas types require further processing to make them safe and efficient enough to use in the current infrastructure built for gas, which would require the construction of processing centers and likely require additional reskilling for existing gas workers.^{98, 99}

Additionally, significant cost and supply constraints exist that limit the feasibility of decarbonized gas. According to the American Gas Association, the total potential supply of biofuels can only account for 6-13% of current total U.S. gas use.¹⁰⁰ The *PGW Business Diversification Study* relied heavily on assumptions around synthetic natural gas, but acknowledged this is not yet a commercially viable technology, with decades of research and development still needed.

⁹⁷Joseph Majkut, Jane Nakano, and Mathias Zacarias, “Making Hydrogen Hubs a Success,” Center for Strategic & International Studies, July 2022, <https://www.csis.org/analysis/making-hydrogen-hubs-success>.

⁹⁸“An Overview of Renewable Natural Gas from Biogas,” U.S. Environmental Protection Agency (EPA), EPA 456-R-21-001, January 2021, https://www.epa.gov/sites/default/files/2021-02/documents/lmop_rng_document.pdf.

⁹⁹Dan Aas, Amber Mahone, Zack Subin, Michael Mac Kinnon, Blake Lane, Snuller Price, Doug Allen, Charles Li, & Gabe Mantegna, “The Challenge of Retail Gas in California’s Low-Carbon Future: Technology Options, Customer Costs, and Public Health Benefits of Reducing Natural Gas Use,” California Energy Commission, CEC-500-2019-055-F, April 2020, <https://www.energy.ca.gov/sites/default/files/2021-06/CEC-500-2019-055-F.pdf>.

¹⁰⁰American Gas Association via Earthjustice, Rhetoric vs. Reality: The Myth of “Renewable Natural Gas” for Building Decarbonization. <https://s3.documentcloud.org/documents/6988834/Rhetoric-vs-Reality-The-Myth-of-Renewable.pdf>.



There is conflicting evidence on the potential GHG emission reductions from decarbonized gas since **the emissions involved in the separate capture, creation, processing, and transport of many decarbonized gasses may negate the building emission reduction achieved from their adoption.**^{101, 102, 103}

There is also increased concern that aged gas mains and non-weatherized or non-sufficiently sealed buildings could emit more methane with decarbonized gasses than they have been with natural gas.^{104, 105} For this reason, experts argue that decarbonized gas may be currently better suited for more hard-to-electrify sectors such as high-heat industrial production and heavy-duty vehicle, air, and maritime transportation to reduce overall emissions.^{106, 107, 108, 109}

Even the recent federal funding around hydrogen comes with restrictive stipulations that may make it somewhat unobtainable for widespread use.^{110, 111}

Decarbonized gas also remains more expensive than fossil gas and will likely remain so unless it can be mass produced and distributed.¹¹² While increased funding and incentives exist for some decarbonized gas technologies, and this may be appropriate for hard-to-electrify sectors, it is not a viable alternative to gas or electricity for the vast majority of Philadelphia's buildings.¹¹³

¹⁰¹ Yuanrong Zhou, Diana Swidler, Stephanie Searle, Chelsea Baldino. "Life-Cycle Greenhouse Gas Emissions of Biomethane and Hydrogen Pathways in the European Union." ICCT, October 2021, <https://theicct.org/sites/default/files/publications/lca-biomethane-hydrogen-eu-oct21.pdf>.

¹⁰² Emily Grubert, "At scale, renewable natural gas systems could be climate intensive: the influence of methane feedstock and leakage rates," Environmental Research Letters, 15(8), 11 August 2020, <https://iopscience.iop.org/article/10.1088/1748-9326/ab9335>.

¹⁰³ Emily Chung, "Renewable natural gas could help slow climate change, but by how much?" CBC News, 13 February 2022, <https://www.cbc.ca/news/science/renewable-natural-gas-1.6346783>.

¹⁰⁴ Maria Gallucci. "The investment boom in 'renewable natural gas' is sparking debate," Canary Media, 8 May 2023, <https://www.canarymedia.com/articles/food-and-farms/the-investment-boom-in-renewable-natural-gas-is-sparking-debate>.

¹⁰⁵ Kyle Murray, "Hydrogen shouldn't have a role in heating buildings," CommonWeath Magazine, 11 September 2022, <https://commonwealthmagazine.org/opinion/hydrogen-shouldnt-have-a-role-in-heating-buildings/>.

¹⁰⁶ Emily Chung, "Renewable natural gas could help slow climate change, but by how much?"

¹⁰⁷ "An Overview of Renewable Natural Gas from Biogas," U.S. Environmental Protection Agency (EPA), EPA 456-R-21-001, January 2021, https://www.epa.gov/sites/default/files/2021-02/documents/lmop_rng_document.pdf.

¹⁰⁸ Bentham Paulos, "Analysis: Why utilities aren't doing more with renewable natural gas," Energy News Network, 14 February 2019, <https://energynews.us/2019/02/14/analysis-why-utilities-arent-doing-more-with-renewable-natural-gas/>.

¹⁰⁹ Beth Burmahl, "Turning waste to energy: tracking renewable natural gas transportation projects," Argonne National Laboratory, 12 April 2022, <https://www.anl.gov/article/turning-waste-to-energy-tracking-renewable-natural-gas-transportation-projects>.

¹¹⁰ The IRA currently only recognizes hydrogen production systems as "clean" if the process emits less than 2 kilograms of CO₂ for every 1 kilogram of hydrogen produced. Currently, at the time of this report's writing, no hydrogen facility in the United States has a production system that meets this requirement.

¹¹¹ Joseph Majkut, Jane Nakano, and Mathias Zacarias, "Making Hydrogen Hubs a Success," Center for Strategic & International Studies, 29 July 2022, <https://www.csis.org/analysis/making-hydrogen-hubs-success>.

¹¹² ICF, "Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment," American Gas Foundation, December 2019, <https://www.gasfoundation.org/wp-content/uploads/2019/12/AGF-2019-RNG-Study-Full-Report-FINAL-12-18-19.pdf>.

¹¹³ Alan Krupnick and Aaron Bergman, "Incentives for Clean Hydrogen Production in the Inflation Reduction Act," Resources for the Future, 9 November 2022, <https://www.rff.org/publications/reports/incentives-for-clean-hydrogen-production-in-the-inflation-reduction-act/>.

Furthermore, in the Commonwealth of Pennsylvania, gas utilities are only permitted to offer their residential and commercial customers the cheapest form of gas for heating. Due to this legal requirement, public gas utilities in Pennsylvania could not offer customers decarbonized gas until its production becomes cost efficient or less than that of competing gas sources. Therefore, even though decarbonized gas may seem like the easiest transition of both the gas utility workforce and existing infrastructure, there are a number of barriers that prevent its widescale deployment.

Centering the Workforce in Philadelphia's Decarbonization Plans

Including the interests and voices of gas utility workers in the long-term transition planning will be critical for Philadelphia's success. Based on interviews with leaders of Gas Workers Employees Union Local 686, gas utility workers feel that decisions are being made for them without their involvement.

Gas utility workers are experts on Philadelphia's gas infrastructure, the types of skills and benefits associated with their jobs, and the common barriers and opportunities for their reskilling. As an example, initial conversations with Local 686 revealed how established or longer-serving PGW workers mentor and train newer employees in the daily skills, knowledge, and proficiencies of being a gas utility worker. This established method of internal training could be used to introduce new decarbonization technologies; a younger cohort of PGW workers could be formally trained and reskilled in a new technology that they could then pass on to the next cohort of future PGW workers. Increased engagement with gas utility workers may lead to other new insights regarding barriers and opportunities. Labor stakeholders have proven to be critical partners in other cities and states, and can be for Philadelphia as well, as the City works to realize a clean energy future with fair employment opportunities.



SUMMARY OF KEY FINDINGS

The goal of this report is to inform Philadelphia's transition toward clean energy in ways that will help retain and grow family-sustaining jobs and create new economic opportunities. This report does not set the blueprint for a decarbonization transition but finds that it is possible to decarbonize Philadelphia's buildings and protect gas workers throughout a multi-decade, planned transition away from fossil fuels. The findings demonstrate that with the right engagement, communication, and coordination, solving climate change does not have to come at the expense of creating and retaining good quality jobs.

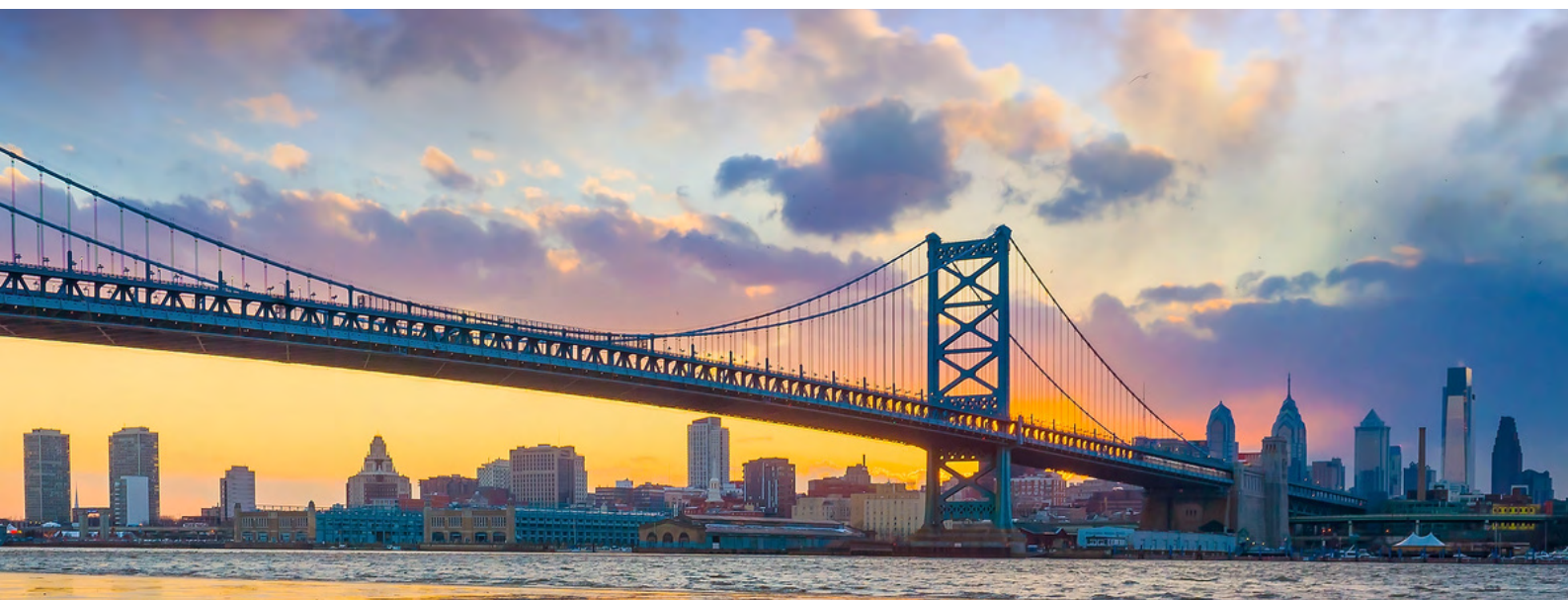
The key findings of this report are:

- **Philadelphia's decarbonization efforts will be a long-term process that will take decades.** There will be a long-term need to strategically maintain, repurpose, and decommission gas pipelines. Current gas utility workers do not need to fear that building decarbonization means they will lose their jobs overnight. Many current workers will reach retirement age before major changes occur. It will be critical to back this messaging up with funded opportunities for reskilling and training around decarbonization technologies.
- **Deploying multiple decarbonization technologies through a long-term planned transition would provide the greatest economic and workforce innovation opportunities for PGW and the City of Philadelphia.** A combination of building electrification and district energy networks powered by geothermal energy could require between 6,000 to 12,000 full-time jobs annually across the building retrofit and utility infrastructure sectors, with many jobs requiring similar skill sets from the current gas utility workforce.



- **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 offers the best chance of protecting and supporting current gas workers.** Private utilities and businesses are already investing in and deploying decarbonization technologies within Philadelphia’s building stock. It remains unclear if these private entities could provide the same pay and benefits currently offered to gas workers by PGW and the City. If state regulatory barriers are amended, PGW could expand its services into more decarbonization technologies, providing a solid foundation for retaining, reskilling, and expanding its existing workforce.
- **The construction, operations, and maintenance of large-scale district energy networks powered by geothermal or other renewable energy would provide significant job opportunities for current gas utility workers.** If 50% to 100% of Philadelphia’s buildings over 50,000 square feet pursued district energy networks powered by geothermal energy, this would require an estimated 3,000 to 8,000 full-time equivalent employees annually from 2025–2050. District energy networks require skill sets that are compatible with those of gas utility workers; experts suggest minimal reskilling is needed for most utility workers. For example, pipefitters would require little to no reskilling. These energy systems, however, face regulatory and infrastructure barriers that would require a coalition of partners to advocate for changing state legislation related to public gas utilities.
- **Full or hybrid building electrification would create thousands of building retrofit and electric infrastructure jobs, although there may be limited job transition opportunities for the current gas workforce.** If all buildings in Philadelphia fully or partially electrified, this would require up to 4,000 full-time building retrofit jobs annually through 2050. Workers with skills in the construction and building trades – like HVAC technicians, plumbers, and insulation workers – would likely see new employment opportunities with minimal reskilling under electrification. However, it is unclear if these workers could retain the same level of wages and benefits currently offered by PGW (particularly in the small residential sector) without significant changes to the current policy landscape. It is also unclear how PGW could provide services related to electricity distribution or usage, which is currently offered by other private utilities. Additionally, there is a risk that as electrifying customers leave PGW’s gas network, rates for the remaining customers would increase dramatically.

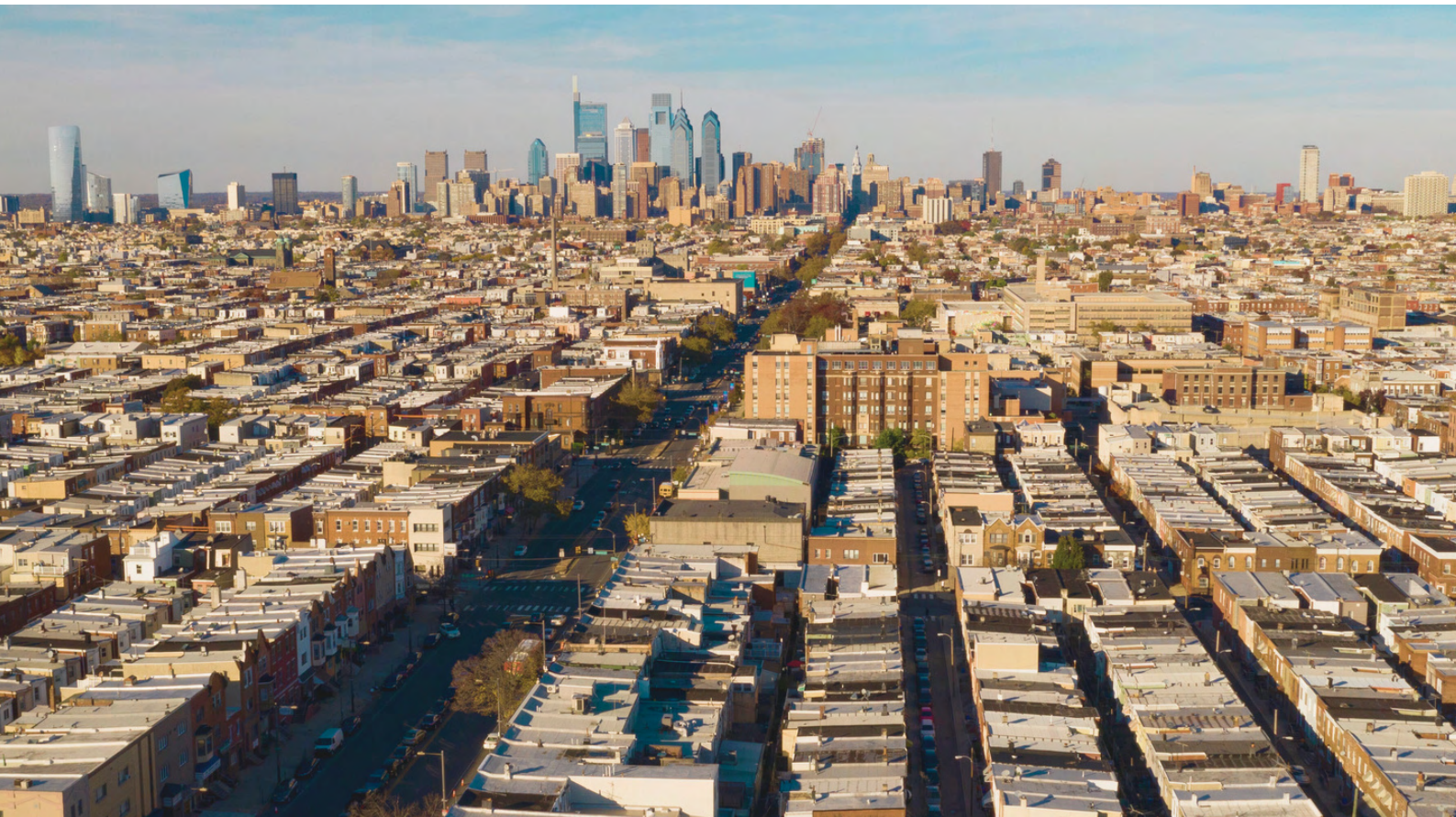
- **Decarbonized gas in buildings theoretically offers the simplest skill set transition for current gas workers, but significant cost and regulatory barriers exist, and it may result in limited job creation and minimal impacts on building emissions,** which make it an unlikely sole candidate for meeting the City’s building decarbonization goals. The use of decarbonized gas may be more fitting for hard-to-electrify industrial and transportation uses but is not appropriate for the city’s homes and businesses.
- **As part of a long-term planning process, there is an opportunity to look beyond building decarbonization strategies and make investments in other sectors to help mitigate potential job losses for gas workers.** For example, water infrastructure and sewer construction and maintenance require skill sets similar to those possessed by gas utility workers. It will be important to work closely with labor partners to identify positions in other infrastructure sectors, to ensure these jobs match the level of wages and benefits that gas utility workers currently receive.
- **The City of Philadelphia and PGW must engage and include the existing workforce, including current gas workers, throughout decarbonization planning efforts.** Interviews with current natural gas workers revealed that they feel excluded from current conversations about decarbonization. Since these workers will be the most impacted by changes to current energy systems, increased communication and engagement may alleviate misconceptions about decarbonization technologies and increase the willingness to collaborate on the best ways to introduce new decarbonization technologies and reskill members of the current workforce. Gas utility workers have a wealth of knowledge about the city’s energy infrastructure and delivery systems. Partnering with these workers around how the City can pilot and execute decarbonization technologies will help build trust and identify new strategies.



CONCLUSION

Philadelphia has the opportunity to create a fair, multi-decade transition strategy for its existing gas utility workforce, leading by example for the hundreds of communities across the country who are grappling with the accelerating impacts of climate change and a shared goal to protect existing workers. Realizing this opportunity will require continued communication and engagement between the City, PGW, and labor stakeholders.

A first step toward collaboration would be identifying common concerns and priorities, since it sets a foundation of shared interests. Key to any potential collaboration is elevating the expertise and experience of the existing workforce, including gas utility workers, and decarbonization utility experts who can refine skill set alignments and feasible strategies for investing in decarbonization technologies. The City, PGW, and gas utility workers can leverage their respective expertise, resources, and influence to implement and drive innovative solutions, reduce building emissions, create tens of thousands of jobs, and create a cleaner and healthier future for Philadelphia. By coming together, there will be increased opportunity to formulate balanced plans that equitably solve climate change, create good family-sustaining jobs, and prioritize and reward existing workers.



ACKNOWLEDGEMENTS

This report was developed in partnership by the Building Electrification Institute and the Economy League of Greater Philadelphia.

Many thanks to key partners for contributing ideas, critically reviewing, and providing feedback on this report:

- Inclusive Economics
- Lion Advisors
- Movement Economics
- Ponder Analytics
- Philadelphia Energy Authority
- The City of Philadelphia
- Upright Consulting

Thanks also to those who made time for interviews, which contributed greatly to the information included in the report:

- BlocPower
- Building Decarbonization Coalition
- Egg Geo
- Energy + Environmental Economics (E3)
- Energy Coordinating Agency
- Geothermal National & International Initiative (GEO-NII)
- Green Building United
- Home Energy Efficiency Team (HEET)
- International Ground Source Heat Pump Association
- Gas Works Employees' Union Local 686
- Los Angeles City Council
- Pennsylvania State Senate
- Philadelphia Energy Authority
- Philadelphia Water Department
- PIDC
- POWER Philadelphia
- RNG Coalition
- Solar States
- Unite Here! Local 30
- Vicinity



APPENDIX A - DETAILED SKILLS AND PROFICIENCIES OF UNIONED PGW EMPLOYEES

Table A1: Required Proficiencies of Unionized PGW Employees

REQUIRED EQUIPMENT PROFICIENCIES
Natural Gas Equipment: Compressors, Scrubbers, Evaporators, Refrigeration Equipment, etc.
Construction Equipment: Jackhammers, Excavation Hand Tools, Shovels, Bars, Rakes, Levels, etc.
Welding Tools: AC/DC Welders, Arc Welders, Welding Machines, etc.
Drafting Tools: CAD, Drafting Machines, Hand Compasses, Dividers, Protractors, etc.
REQUIRED VEHICLE PROFICIENCIES
Skilled Trade Vehicles: Excavators, Front End Loaders, Cranes, Towed Compressors, Forklifts, etc.
Trucks/Vans: Pick-ups, Commercial Motor Vehicles, Cargo Vans, etc.
Standard Passenger Vehicles: Coupes, Sedans, Light SUVs, Minivans, etc.
Bicycles

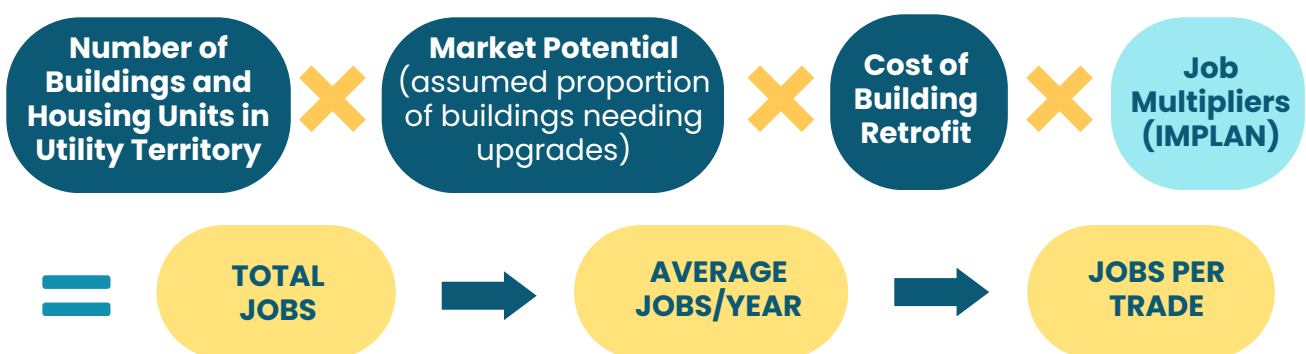
APPENDIX B - METHODOLOGY

This report incorporates a mixed methodological approach: it uses both a quantitative analysis to assess the employment and cost impact of the decarbonization pathways as well as interviews with key experts on the workforce skill sets and social, political, and financial logistics associated with introducing or pursuing certain decarbonization technologies. This dual approach provided a foundation of potential employment estimates across most of the decarbonization pathways and a ground-truthing component to understand how those job estimates and their skill sets relate to the skill sets of current gas utility workers.

Building Retrofit Job Estimates - Methodology

The project team used an economic input-output model developed by Inclusive Economics to assess the total jobs resulting from a total investment dollar amount needed to implement each building decarbonization pathway. In this model, building stock data is multiplied by the market potential across set retrofit types (or the percent of buildings that require each retrofit type), then multiplied by the cost of each retrofit type, which results in a total investment dollar needed (see **Figure B1**). The model then uses job multipliers sourced from IMPLAN economic data to estimate the total jobs across trades. IMPLAN is a regional economic analysis software designed to estimate the impact of a given economic activity within a specific geographic area through a built-in input-output model. This model largely focuses on employment created directly from the investments in existing buildings to replace gas with efficient, electric appliances as well as building efficiency upgrades.

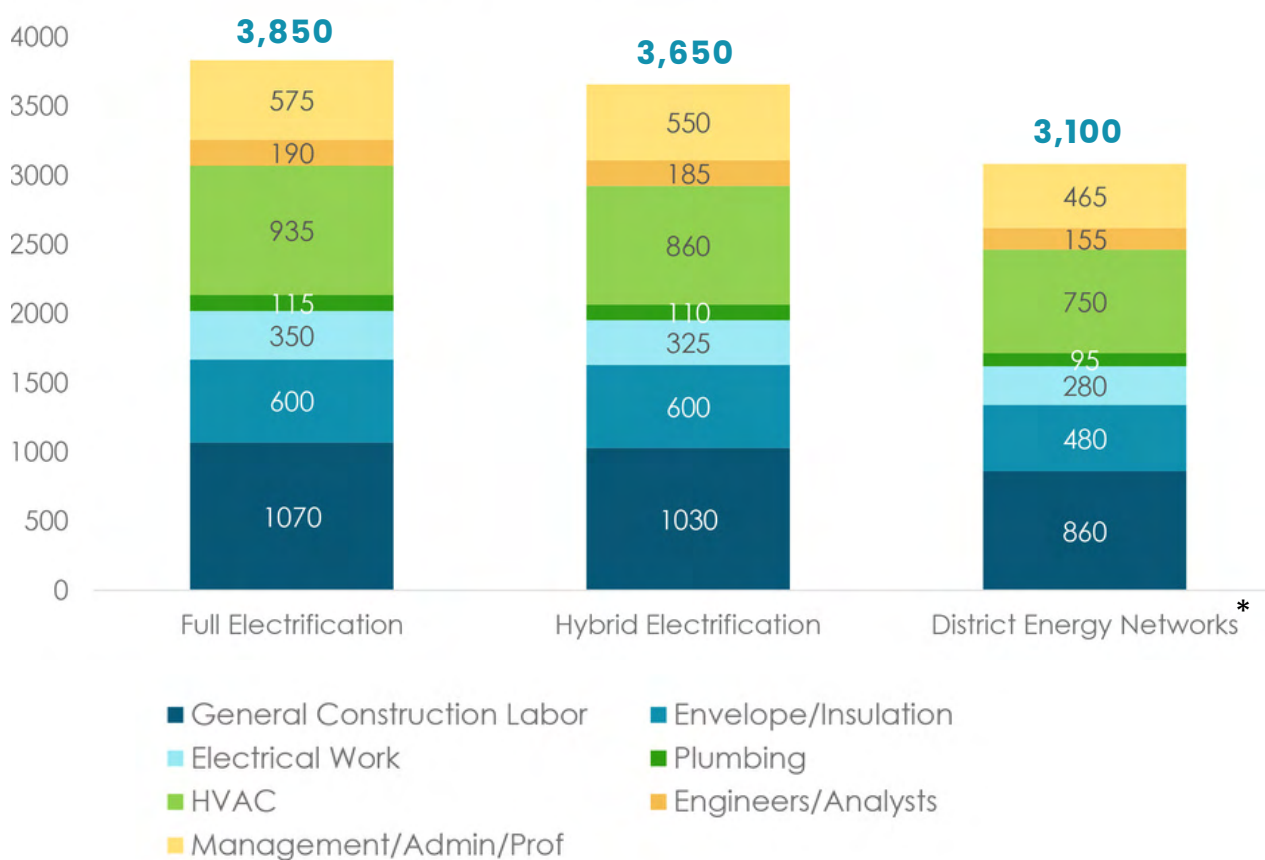
Figure B1: Inclusive Economics' Building Retrofit Job Modeling Methodology



Given there is a range of different costs across the three analyzed decarbonization pathways (full electrification, hybrid electrification, and district energy networks), this results in a range in the total investment costs, and therefore the total jobs, required for each decarbonization pathway. These resulting employment estimates are distributed by building type and the sum of all buildings. Jobs are calculated as the total number of job years (and equivalent work hours) and converted to average annual number of full-time jobs. The jobs are distributed by trade including construction labor, insulation, electrical, plumbing, HVAC, engineers/analysts, and management professionals. (See **Figure B2.**) This distribution also informs job quality, potential wages, and training needs. These estimates do not include ongoing operations and maintenance jobs, nor do they include any supply chain jobs or account for job loss. These estimates do not necessarily represent new jobs in the local economy. The best way to interpret these estimates is the full-time equivalent number of workers required to achieve each pathway within 100% of Philadelphia’s buildings.

FIGURE B2: Potential Building Retrofit Job Results

Annual Full-Time Employees, 2025–2050, rounded



*Figure B2 only shows building retrofit jobs (see page 25 for job definitions), therefore the District Energy Network figures do not include jobs associated with building, operating, and maintaining pipelines outside of the building.

Utility Infrastructure Job Estimates - Methodology

In addition to in-building retrofit job estimates, this analysis also assessed the potential utility-scale investments and job impacts required under the decarbonization pathways. This included:

- **District Energy Networks:** Based on case studies of other cities and regions with district energy networks, the analysis assessed the potential utility-scale job creation that could occur from investing in a new geothermal district energy network for all or part of Philadelphia.
- **Electric Grid Infrastructure:** Based on research from geographies with similar climates to Philadelphia's, the analysis assessed the potential utility-scale investments and job impacts from full electrification and hybrid electrification on Philadelphia's electric grid.

District Energy Network Jobs

To develop the estimates of potential district energy jobs, the following methodology and assumptions were used:

- For district energy construction jobs, the analysis used a district energy network job analysis for the City of Los Angeles to estimate average full-time equivalent employees per square foot of built area extrapolated to Philadelphia's total built square footage to estimate potential jobs impacts of a district energy network in Philadelphia.¹¹⁴
- For district energy maintenance jobs, the analysis estimated the number of jobs by scaling the total maintenance jobs from a district energy network case study from Norway by population size.¹¹⁵
- The potential costs of building out a new district energy network in Philadelphia was extrapolated based on the per square foot cost from the district energy network at Stanford University.¹¹⁶

Note that all assumptions above are based on extrapolating information from existing studies in cities or regions with dissimilar climates to Philadelphia's. As such, they should be used as ballpark estimates only, and more extensive research is required to develop more accurate job impacts for Philadelphia.

¹¹⁴ Los Angeles Building Decarbonization: Community Concerns, Employment Impacts, and Opportunities.

¹¹⁵ Estimated data from Norway provided in Betony Jones and Nikki Luke, "District Energy Decarbonization: Addendum to California Building Electrification Workforce Needs and Recommendations" (Luskin Center for Innovation [UCLA] and Inclusive Economics, November 2019), https://innovation.luskin.ucla.edu/wp-content/uploads/2019/11/California_Building_Decarbonization-Addendum.pdf

¹¹⁶ Los Angeles Building Decarbonization: Community Concerns, Employment Impacts, and Opportunities.

Electric Grid Infrastructure Jobs

To develop the estimates of potential electric grid infrastructure jobs, the following methodology and assumptions were used:

- To estimate the potential increase in electric grid jobs under full building electrification, the analysis assumed that half of the current electric grid would need to be updated, the current estimate for New York City.¹¹⁷ The analysis assumed that jobs would increase proportionally to the percentage of the electric grid updated.
- Under hybrid building electrification, in which all buildings installed heat pumps to meet roughly 80% of their heating needs, the analysis assumed that 40% of the electric grid would need to be updated.¹¹⁸
- The potential costs of electric grid upgrades were extrapolated by starting with the annual electric grid upgrade costs under full building electrification estimated for the state of Maryland and scaling to the population of Philadelphia, over an investment period of 25 years.¹¹⁹

Note that all assumptions above are based on extrapolating information from existing studies in cities or regions with similar climates to Philadelphia's. As such, they should be used as ballpark estimates only. More local research is needed to understand Philadelphia-specific workforce opportunities and the types of workers who might be employed.

Over the long term, major infrastructure investments will be needed to support a high degree of electrification, and this could lead to substantial job growth for highly skilled electrical and utility workers. The investments in electric grid infrastructure likely include:

- Transmission lines and towers that bring high voltage energy from power plants into a city,
- Transmission substations, which lower energy voltage for customer distribution,
- Distribution lines, which distribute lower voltage energy either directly to customers/buildings or to additional neighborhood-level transformers,
- In-city renewable energy and battery storage, which will likely be needed for peak capacity requirements and demand management, and
- Additional non-wires solutions and dispatchable technologies, both behind the meter and in front of the meter, to enable smart grid management.

¹¹⁷Urban Green Council, "Grid Ready: Powering NYC's All-Electric Buildings." 2021, <https://www.urbangreencouncil.org/grid-ready-powering-nycs-all-electric-buildings/>

¹¹⁸ibid.

¹¹⁹E3, "Maryland Building Decarbonization Study Final Report." October 2021, https://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Documents/MWG_Buildings%20Ad%20Hoc%20Group/E3%20Maryland%20Building%20Decarbonization%20Study%20-%20Final%20Report.pdf

Blended Scenario Job Estimates - Methodology

Inclusive Economics developed an additional analysis tool to assess the job impacts of three “blended scenarios” for the building decarbonization pathways. While the above estimates were used to estimate the total jobs needed if each pathway were applied to 100% of Philadelphia’s building stock, this blended scenario tool allows user input of a proportion of each pathway. For example, this allows us to assume 70% of single family houses are fully electrified, and 20% of single family houses only pursue hybrid electrification, and the remaining 10% pursue district energy. The methodology for the blended scenarios extrapolates these proportion of job estimates from the total results of the 100% pathway job results described above. These estimates are for initial discussions only and should be further researched and validated by local partners.

Table B1: Blended Scenario Building Inputs

Blended Scenario 1: Full Electrification for All Small Buildings / District Energy for All Large Buildings

	SFH	Small MF	Large MF	Small + Med Comm	Large Comm	Large Govt-Owned
Full Electrification	100%	100%	0%	100%	0%	0%
Hybrid Electrification	0%	0%	0%	0%	0%	0%
District Energy Networks	0%	0%	100%	0%	100%	100%

Blended Scenario 2: Full and Hybrid Electrification for All Small Buildings / Split Electrification and District Energy for All Large Buildings

	SFH	Small MF	Large MF	Small + Med Comm	Large Comm	Large Govt-Owned
Full Electrification	75%	50%	25%	50%	25%	25%
Hybrid Electrification	25%	50%	25%	50%	25%	25%
District Energy Networks	0%	0%	50%	0%	50%	50%

Blended Scenario 3: Full and Hybrid Electrification for All Buildings / No District Energy for Any Buildings

	SFH	Small MF	Large MF	Small + Med Comm	Large Comm	Large Govt-Owned
Full Electrification	90%	90%	80%	90%	80%	90%
Hybrid Electrification	10%	10%	20%	10%	20%	10%
District Energy Networks	0%	0%	0%	0%	0%	0%

NOTE: *Small buildings* refer to buildings under 50,000 square feet. *Large buildings* refer to buildings over 50,000 square feet.

Qualitative Research and Interviews - Methodology

The initial findings from the quantitative analysis and desktop research were then “ground-truthed” by expert interviews. This inductive approach allowed the research team to identify key themes and hypotheses to further discuss in expert interviews. Sampling interviews with a grounded theory approach often requires “snowball convenience sampling” where initial experts are identified by the investigators but new themes and interviewees’ insights lead to new themes and contacts.

A simple respondent framework was developed by the research team to identify key expertise on the workforce and skill sets needed to adopt and implement the associated decarbonization technologies. Both national experts and local experts reviewed and provided input on the workforce characteristics, skill sets, training, and transition opportunities across decarbonization technologies identified in the *2021 PGW Business Diversification Study*. In total, 20 interviews with national and regional experts were completed for this analysis (with cases of multiple respondents being affiliated with the same organization). See Acknowledgements (page 43) for the professional organizations affiliated with the national and regional expert respondents during the analysis.

Member validation is often used in qualitative research to evaluate, validate, and sometimes refute the insights and findings gathered from background research or expert interviews. Leadership of the Gas Workers Employees Union Local 686 participated in interviews and offered key insights underpinning this analysis. PGW’s leadership was informed of this report early on; however they did not participate in exploratory interviews. They reviewed a final report draft and offered comments, many of which the project team incorporated.

