Heat Forward

Lessons from Local Scottish & Dutch Building Decarbonization Strategies

Columbia | SIPA
School of International and Public Affairs

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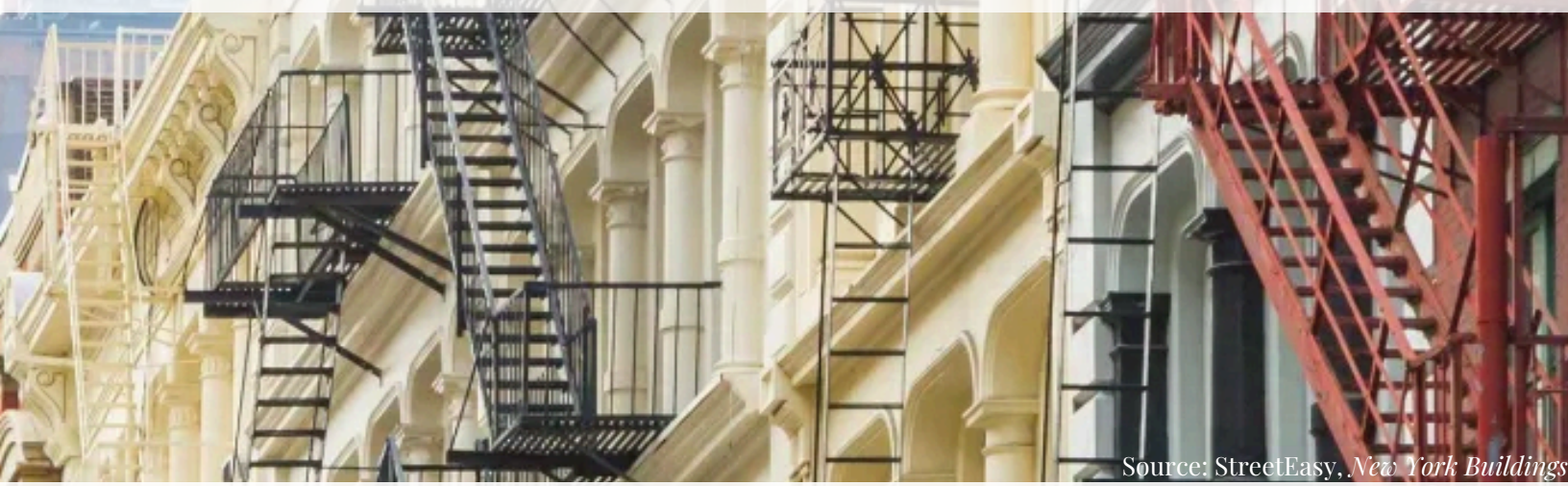
Table of Contents

Table of Contents

Glossary

Term	Abbreviation	Definition
District Heating		District heating is a system which generates heat in a central location (using either fossil fuels or sustainable energy sources) and distributes it to buildings in the surrounding area.
Energy Performance Certificate	EPC	Energy Performance Certificates (EPCs) are a rating scheme to summarize the energy efficiency of buildings or devices. Buildings are rated from A to G, with A being the most efficient and G being the least efficient. EPC ratings are based on an assessment called the Standard Assessment Procedure, which gets scored from 1-100. The aforementioned letter grades are then assigned to each numeric score.
Fuel Poverty		According to the Scottish government, a fuel poor household is one in which more than 10% (20% for extreme fuel poverty) of net income is required to pay for reasonable fuel needs after housing costs have been deducted, and where remaining income is not enough to maintain an adequate standard of living.
Greenhouse Gas	GHG	Greenhouse gasses are heat-trapping gasses that capture outgoing radiation from exiting the atmosphere and consequently warm the planet. Examples include carbon dioxide (CO_2), nitrous oxides (NOx), methane (CH_4), and others.
Heat Network Zone		Heat network zones are a decarbonization planning term meaning areas identified as potentially suitable for district heating development.
Local Authority		Local authorities or "council areas" are the subnational level of government in Scotland. There are thirty-two total local authorities.
Local Heat and Energy Efficiency Strategy	LHEES	Local Heat and Energy Efficiency Strategies (LHEES) are the term for locally-led building heat transition plans in Scotland.
Programma Aardgasvrij Wijken	PAW	Programma Aardgasvrij Wijken (PAW) is a Dutch natural gas-free districts grants program.
Regional Energy Masterplan	REM	The Regional Energy Masterplan (REM) is a combined LHEES and Delivery Plan covering the local authorities of Clackmannanshire and Stirling.
Heat Transition Vision / *Transitievisie Warmte*	TVW	*Transitievisie Warmte* (TVW) is a local "Heat Transition Vision" for Dutch municipalities' plans to transition heating systems in each district.

Executive Summary



Source: StreetEasy, *New York Buildings*

Nearly one-third of all greenhouse gas (GHG) emissions in New York State (NYS) originate from the building sector. To address emissions from this sector, NYS must advance its building decarbonization strategy from both an energy use and energy efficiency standpoint. This report, compiled and written by MPA in Environmental Science & Policy students at Columbia University, examines the building decarbonization approaches adopted by Scotland and the Netherlands. Each of these countries has made significant advances in their local heat transition planning and implementation. Through an analysis of seven case studies, the report delves into the unique challenges faced by each locality and the methods they are employing to overcome these obstacles.

To date, Scotland has embraced progressive climate policies. The Scottish Parliament committed the nation to net zero emissions by 2045, with an interim target of 75% emissions reduction by 2030.[1]

Addressing heat in buildings is critical to meet this goal, since building heating currently accounts for 30% of Scotland's total energy consumption.[2] While Scotland's ability to regulate energy is limited – as the U.K. parliament retains governance over traditional energy regulation – energy efficiency measures and heat planning are still within Scotland's jurisdiction. Following Scotland's 2021 Heat in Buildings Strategy that set targets for reducing emissions across the buildings sector, Scotland published its Local Heat and Energy Efficiency Strategies (LHEES) Order 2022. This legislation required each of Scotland's 32 local authorities to publish LHEES reports.[3]

This report analyzes four unique council-led approaches to developing the LHEES strategy in Scotland. Case studies include Glasgow, Fife, North Lanarkshire, and Clackmannanshire Councils.

1. "Scottish Government: Reducing Greenhouse Gas Emissions", Scottish Government, https://www.gov.scot/policies/climate-change/reducing-emissions/
2. "Heat in Buildings Strategy", Scottish Government, October 7, 2021, https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/pages/3/
3." Local Heat and Energy Efficiency Strategy Guidance", Scottish Government, October 20, 2022, https://www.gov.scot/publications/local-heat-energy-efficiency-strategies-delivery-plans-guidance/pages/8/

Findings from case studies in Scotland underscore 1) the importance of a data-driven approach that relies upon robust data for both domestic and non-domestic buildings; 2) the need for collaboration across council areas to ensure information and learnings are shared; 3) the importance of adopting an equity-driven approach that prioritizes the implementation of energy efficiency and heat planning strategies by assessing household energy burdens; 4) the need for public information campaigns to overcome public misconceptions about the energy transition.

The Netherlands began extracting its own natural gas in the 1960s, taking advantage of the vast natural gas reserves found in the province of Groningen. However, increasing earthquakes in the region caused widespread concern about the seismic potential of natural gas extraction; to address this, the Netherlands passed a mandate to halt natural gas extraction in 2018. Still, natural gas dominates the country's energy generation, and natural gas accounts for nearly 40% of energy generation as of 2022. In 2019, the Dutch government passed the National Dutch Climate Agreement or KlimaatAkkoord, which stated that seven million homes should be natural-gas free by 2050, and required that all Dutch homes that are not already natural gas free (10% of all homes) should phase out natural gas and switch to low-carbon heating by 2050. The agreement also set an interim goal that 1.5 million homes–or roughly 20% of all homes–should be made 'more sustainable' by 2030.[4] Finally, to address emissions from buildings, the agreement stipulated that all 345 Dutch municipalities must create a Heat Transition Vision or *Transitievisie Warmte* (TVW) by the end of 2021.

This report analyzes Heat Transition Visions from three municipalities in the Netherlands: Amsterdam, Pekela, and Tilburg. Each of these case studies illustrates unique challenges and opportunities to explore in the heat transition. Learnings from the Netherlands cases studies include the need to 1) prioritize enthusiastic neighborhoods when prioritizing pilot project areas; 2) work to engage stakeholders and employ 'energy coaches' (as illustrated in Pekela) to educate homeowners on the energy transition; 3) prepare for practical and financial challenges associated with district heating; 4) avoid over-relying on techno-economic modeling, and ensure that models reflect residential concerns about pricing.

The distinctive top-down and bottom-up approaches of Scotland and the Netherlands provide critical insights for state-level planning in New York. Contributions from policy experts, academics, and government officials from Scotland and the Netherlands helped to supplement any gaps left by textual policy analysis alone and bolstered findings from that analysis.

A common theme amongst both the Scottish and Dutch case studies was the importance of adopting a locally-led approach to decarbonization strategy. Given that different municipalities require unique approaches to decarbonization, NYSERDA should entrust local communities with leading their building decarbonization strategy; this responsibility, however, must be paired with local capacity-building and funding efforts.

The seven case studies we analyzed also underscored the importance of a data-driven approach.

4. "Climate Agreement: the Netherlands",The Hague , June 28, 2019, https://www.klimaatakkoord.nl/documenten/publicaties/2019/06/28/national-climate-agreement-the-netherlands

Supporting localities in developing and accessing detailed datasets on building stock, energy use, etc., can help to inform local decarbonization strategies. At the local level, heat decarbonization should be paired with utility engagement. A good example of this is illustrated in the Fife case study in Scotland, where Fife held regular meetings with the local utility (SP Energy Networks, or SPEN) in order to align strategy and goal-setting around building decarbonization. In particular, these regular meetings yielded collaboration on a five year price control mechanism which sets the outputs that district network operators must deliver, and stipulates the amount of revenue they're allowed to collect.[5] While the Netherlands focused less on equity considerations, fuel poverty (defined as whether cost to meet household energy needs exceeds 10% of the household's net income) was used as a metric to evaluate and prioritize implementation strategy for the LHEES in Scotland. Integrating equity considerations into heat planning is a critical recommendation for NYSERDA.

To maximize public engagement, public information campaigns and 'energy coaches' (as illustrated in the Pekela case study), are viable methods that can help mitigate misconceptions around the energy transition. Finally, collaboration across municipalities, illustrated in Clackmannanshire Council, is critical for sharing strategies and aligning information on successful decarbonization methodology.

These insights offer a valuable set of considerations for the New York State Energy Research and Development Authority (NYSERDA), and will help to support both their short-term and long-term policy development. Overall, the lessons learned from this research present a promising framework for crafting adaptable, equitable, and forward-thinking climate policies in New York State.

5. "Local Heat and Energy Efficiency Strategy", Fife Council, December 2023, https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf.

Introduction

New York State has a mandate to decarbonize and modernize its buildings sector, which is currently the largest source of greenhouse gas emissions (GHGs) in the state, accounting for nearly one-third of total annual emissions.[6] The State aims to reduce economy-wide GHG emissions by 40% below 1990 levels by 2030 and 85% below 1990 levels by 2050. State policymakers must embark on these goals while simultaneously ensuring equity, system reliability, and a just transition from fossil fuels to a robust clean energy economy.[7]

This report, prepared by a team of Graduate-level students at Columbia University, outlines locally-led heating decarbonization strategies in Scotland and the Netherlands. Heat transition planning refers to the process of implementing measures to transition from traditional fossil fuel-based heat sources to more low-carbon or carbon-free alternatives.

The goal of this report is to support NYSERDA in developing successful policies to decarbonize heating in New York State. Deploying decarbonization efforts at the local level allows for the development of targeted solutions: a "one size fits all" approach cannot adequately address the diverse climates, grids, and building stocks of New York State.

Scotland and the Netherlands can provide critical insight on useful strategies for heat transition planning at the state-level due to their bottom-up approaches, which grant significant power to local governments (bolstered by robust funding schemes and technical assistance). Like New York State, each country is dominated by natural gas-fueled heating infrastructure, an aging building stock, and a nascent electrification industry. With their heat transition plan implementation a few years underway as of this writing, recommendations have emerged which will allow New York to avoid the other countries' pitfalls and adopt their best practices.

6. New York's Carbon Neutral Buildings Roadmap. NYSERDA. 2022. https://www.nyserda.ny.gov/All-Programs/Carbon-Neutral-Buildings
7. New York State Climate Action Council Scoping Plan. New York State Climate Action Council. 2022. climate.ny.gov/ScopingPlan

METHODOLOGY

Before evaluating heat transition planning in Scotland and the Netherlands, the team began by familiarizing themselves with New York State's own decarbonization policies and targets. They then split up into two research groups, each covering one of the two countries. Given that Scotland and the Netherlands are impacted by supranational powers (the United Kingdom and the European Union, respectively), the team's first step was to map out regulatory contexts for each nation. By identifying which levels of government have jurisdiction over various energy and buildings-related issues, the team could draw direct parallels back to the New York State context.

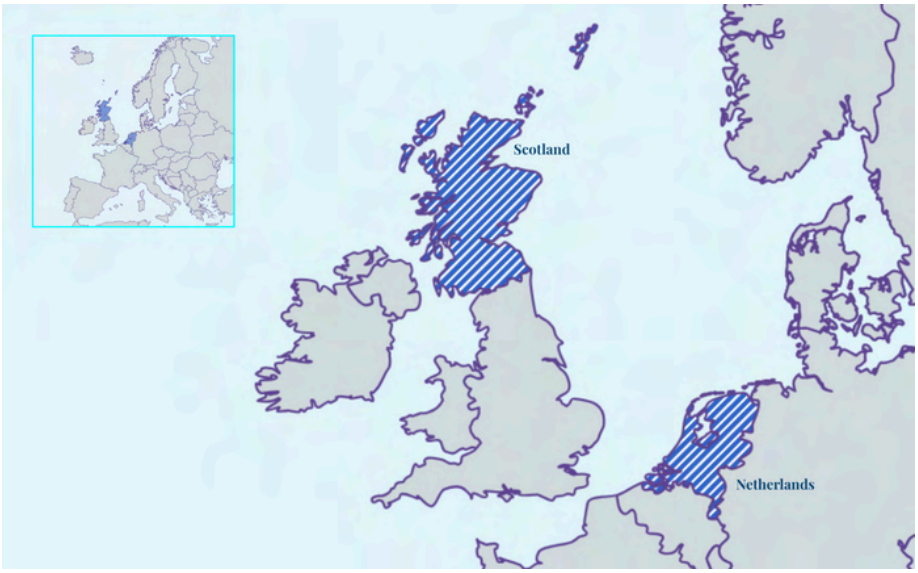
The next step was for each research group to select case study locations: they conducted preliminary literature reviews to seek out local entities in each country that had (1) made notable progress on their heat decarbonization plans, and (2) had robust publicly-available information on their transition plans. Each research group then selected three to four case studies that covered a diversity of urbanization levels, poverty levels, and unique challenges.

Ultimately, the teams selected four local authorities in Scotland and three municipalities in the Netherlands. Each research group then assigned specific students to conduct desktop research for each case study, examining transition plans, delivery plans, funding mechanisms, stakeholder outreach, community engagement, and data tools used. The groups also researched each national government's policies, technical and financial assistance offered to localities, and relevant independent partners and programs supporting heat transitions.

The research groups actively engaged with experts by conducting interviews with representatives from each case study location, national governments, and other key stakeholders. This approach allowed the teams to confirm identified barriers and solutions and dig deeper into unique approaches in each location.

Finally, the team formulated final recommendations by identifying common themes across case studies, aiming to provide applicable insights for New York State's heat transition journey.

Figure 1: Regional Map of the Study Area



National Policy Overview: Scotland

INTRODUCTION:
POLITICAL BACKGROUND & GOVERNANCE

The Scottish Parliament has demonstrated a strong commitment to addressing climate change: it has set ambitious targets and allocated the resources to meet them. Nationwide, 97% of electricity in 2020 was generated by renewables, with excess clean power being exported to the rest of the United Kingdom (U.K.).[8] Total renewable generation increased by nearly 30% from 2021 to 2022 alone, and is currently enough to meet one-quarter of the United Kingdom's total electricity demand. This rapid expansion of renewable energy is a large contributor to Scotland's overall success in decarbonizing: emissions are down 50% since 1990 baseline levels.[9]

In 2018, the Scottish Parliament committed the nation to net zero emissions by 2045 through the Scottish Climate Change Plan. This included an interim target of 75% emissions reductions by 2030. To reach that goal, the government is looking beyond clean electricity to other high emitting sectors such as transportation, agriculture, and buildings. Heating in buildings currently accounts for 20% of Scotland's annual greenhouse gas emissions, with three quarters of those emissions coming from the country's 2.7 million dwellings.[10]

Residential buildings also account for about 30% of the country's total energy consumption.[11] As of 2021, approximately 25% of energy consumed by residential buildings is from electricity with the remainder from natural gas.[12] Non-residential buildings had a hire share from electricity at 42%.[13] In October of 2021, the Scottish national government released the Heat in Buildings Strategy which set targets for reducing emissions across the buildings sector.

One important component of heat decarbonization is ensuring that electrification retrofits are coupled with energy efficiency measures to limit heat waste. Scotland has been committed to making such improvements for nearly a decade. As early as 2015, the Scottish National Party Minister declared that improving energy efficiency in buildings would be a national infrastructure priority. This has led to energy efficiency becoming fully embedded in Scotland's economic development strategy, including plans for workforce development, supply chain capacity building, and certifications for local businesses. An estimated 1,200 full-time jobs are created for every $106 million USD spent on energy efficiency improvements.[14]

8 "Energy Statistics for Scotland Q4 2020." Scottish Government. March 1, 2021. https://www.gov.scot/binaries/content/documents/govscot/publications/statistics/2018/10/quarterly-energy-statistics-bulletins/documents/energy-statistics-summary---march-2021/energy-statistics-summary---march-2021/govscot:document/Scotland+Energy+Statistics+Q4+2020.pdf.
9. "Scottish Greenhouse Gas Statistics 2021." Scottish Government. June 20, 2023. https://www.gov.scot/publications/scottish-greenhouse-gas-statistics-2021/.
10. "Households and Dwellings in Scotland, 2022." National Records of Scotland. June 22, 2023. https://www.nrscotland.gov.uk/files/statistics/household-estimates/2022/house-est-22-report.pdf.
11. "Heat in Buildings Strategy - Achieving Net Zero Emissions in Scotland's Buildings." Scottish Government. October 7, 2021. https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/pages/3/.
12. "Energy Statistics for Scotland - Q3 2022." Scottish Government. December 22, 2022. https://www.gov.scot/publications/energy-statistics-for-scotland-q3-2022/pages/energy-consumption/.
13. "Energy Statistics for Scotland - Q3 2022." Scottish Government. December 22, 2022. https://www.gov.scot/publications/energy-statistics-for-scotland-q3-2022/pages/energy-consumption/.
14. Scottish Government, Energy Efficient Scotland: Quality Assurance, https://www.gov.scot/policies/energy-efficiency/energy-efficient-scotland-qualityassurance/ 2019 (accessed 27 November 2019).

What is Fuel Poverty?

One key reason for energy efficiency improvements being popular politically is that they will help reduce the prevalence of fuel poverty in Scotland. A household is in fuel poverty if (1) the costs to maintain safe temperatures within the home exceed 10% of the household's net income, and (2) remaining income is not enough to maintain an adequate standard of living.[15] Further, a household is in extreme fuel poverty if the costs to maintain safe temperatures within the home exceed 20% of the household's net income. In a U.S. context, this is often described as an energy-burdened household. At present, 34% of households in Scotland (or about 850,000) are living in fuel poverty, while 23% qualify as living in extreme fuel poverty.

In 2019, the Scottish Parliament passed the Fuel Poverty Act, which set statutory targets for reducing fuel poverty. By the end of 2040, no more than 5% of Scottish households should be in fuel poverty, with no more than 1% falling into extreme fuel poverty. These targets must be achieved not just nationally, but within each of Scotland's 32 local authorities (similar to U.S. counties). Much of the work being undertaken in the Heat in Buildings Strategy will also help ameliorate fuel poverty. A number of grant programs discussed in later sections offer energy efficiency upgrades for low-income tenants and owner-occupants.

15."Fuel Poverty Act 2019." U.K. Legislation. July 18, 2019. https://www.legislation.gov.uk/asp/2019/10.

Decarbonizing the heating sector will help Scotland reach the targets outlined in the Scottish Climate Change Plan and the Fuel Poverty Act, and to do that, Scotland is taking a localized approach. Each of the country's thirty-two local authorities were tasked with developing and publishing Local Heat and Energy Efficiency Strategies (LHEES), which were all submitted on-time in December 2023. LHEES are heat transition plans that are place-based, locally-led, and tailored to a specific area. Per the national government's guidance, they are to include:

1. A review of national policies, including an analysis of how they intersect with local policies, targets, and strategies (particularly pertaining to fuel poverty, decarbonization, and energy efficiency), and mapping of relevant stakeholders
2. Development of a data and tools library that will be maintained and updated, with indication of which datasets are core to LHEES analysis and which are supplementary
3. An assessment of the current local building stock, called a "baseline," which uses best available data to map out the heat supply and energy efficiency for residential and non-residential properties
4. Identification of Strategic Zones to be used during analysis of which areas to prioritize in implementation (which can be unique or overlap with existing planning zones)
5. Prioritization of certain Delivery Areas with high-potential stock for the most immediate stages of implementation. Before finalizing Delivery Areas, a building-level pathway assessment should be conducted that indicates potential interventions, costs, and related carbon dioxide-equivalent reductions for residential and (where possible) non-residential buildings

The national government released a 53-page guidance document in October 2022 to assist local authorities with the production of their LHEES.[16] Local authorities also received $93,000 USD each for the development of their LHEES plans. As is illustrated in the case studies, many chose to use this funding to hire external consultants, who completed the majority of the data analysis and mapping required.

16. "Local Heat and Energy Efficiency Strategies and Delivery Plans: Guidance." Scottish Government. October 20, 2022. https://www.gov.scot/publications/local-heat-energy-efficiency-strategies-delivery-plans-guidance/documents/.

Three key datasets used for the development of local plans:

1. **Home Analytics** is a database of UK housing stock managed by Energy Savings Trust, a nonprofit organization heavily involved with energy efficiency and the clean energy transition. It is provided for free to the Scottish government and local authorities, and includes data down to the address-level.[17] The tool provides over 100 information fields on each residential property including energy efficiency potential and renewable energy potential, and allows local authorities to integrate their stock investment plans into the mapping tool to optimize retrofit planning and return on investment.
2. **Non-Domestic Analytics** is another dataset provided by Energy Savings Trust which provides data on the non-residential building stock by combining other publicly available data from sources such as EPC ratings and ordinance surveys.[18] Notably, the level of data is much less reliable than the domestic data in Home Analytics: for example, EPC ratings only cover about 15% of non-domestic buildings.[19] Other information like construction type, insulation level, and heating fuel source is not available for commercial and industrial buildings.
3. **The Scotland Heat Map** is an interactive geographic information system (GIS) map and reporting tool managed by the Scottish national government that maps out where and how much heat demand there is across the country.[20] It shows existing and planned heat networks, potential energy supply sources, and areas with high concentrations of socially-rented housing.

There are two versions of the map: one that is free and publicly-available, and another with more detail that is shared directly with local authorities.[21]

Another tool that can help local authorities plan their delivery strategies is the **Portfolio Energy Assessment Tool (PEAT)**, also created by Energy Savings Trust. This browser-based assessment tool converts Home Analytics data into an SAP-based calculation engine that uses known information about properties to determine the suitability of various energy efficiency measures, ranked by cost-effectiveness.[22] Users can model different scenarios by inputting parameters such as minimum spend per household or a desired energy efficiency score.

Finally, a tool that was not available during LHEES development but has since been created is Scottish utility SP Energy Network's (SPEN) new grid modeling tool.[23] This will allow Councils to model impacts of energy efficiency and heating decarbonization efforts on grid demand. The tool is not currently publicly available, but in interviews, council experts mentioned they will use this tool in further LHEES implementation phases.[24]

Aside from retrofitting the existing building stock through LHEES planning, the Scottish Parliament has also amended existing housing regulations to require all new buildings to install zero emission heating systems starting April 2024. The national government will also be using its procurement power to prioritize acquiring buildings that are energy efficient and run on low-carbon or renewable sources.

17. "Home Analytics." Energy Savings Trust. March 21, 2024. https://energysavingtrust.org.uk/service/home-analytics/.
18. "LHEES Capacity-Building Workshop: Non-Domestic Approach." Zero Waste Scotland. https://cdn.zerowastescotland.org.uk/managed-downloads/mf-mzzcjdbu-1710234023d.
19. "LHEES Capacity-Building Workshop: Non-Domestic Approach." Zero Waste Scotland. https://cdn.zerowastescotland.org.uk/managed-downloads/mf-mzzcjdbu-1710234023d.
20. "Scotland Heat Map Interactive." Scottish Government. https://heatmap.data.gov.scot/custom/heatmap/.
21. "Scotland Heat Map: Information." Scottish Government. March 25, 2024. https://www.gov.scot/publications/scotland-heat-map-documents/.
22. "Low Carbon Heating in Domestic Buildings - Technical Feasibility: Report." Scottish Government. December 22, 2022. https://www.gov.scot/publications/technical-feasibility-low-carbon-heating-domestic-buildings-report-scottish-governments-directorate-energy-climate-change/pages/7/.
23. Interview with Glasgow Sustainability team expert. 2024, Google Meet.
24. Interview with Glasgow Sustainability team expert. 2024, Google Meet.

OVERVIEW OF GOVERNING JURISDICTION

Given that Scotland is within the multinational state of the United Kingdom, their national government lacks authority over many aspects of traditional energy regulation. However, regulating heating in buildings is one area that they do have jurisdiction over. The table below offers more details on jurisdictional powers maintained by each level of government relating to the issues of decarbonization and energy efficiency.

United Kingdom (Supranational)

The United Kingdom retains authority over most traditional energy regulation. This includes managing competition, setting supplier energy efficiency obligations, consumer protection, and licensing for the generation and distribution of electricity, oil, and gas. The U.K. Parliament also oversees energy taxes and levies, which have significant consequences for the relative prices of electricity versus more carbon-intensive fuels. The U.K. Department of Business, Energy, and Industrial Strategy was established after the U.K.'s decision to leave the European Union in 2016, and has continued to prioritize three key policy areas in energy matters: security of supply, cost, and decarbonization.[25]

Scotland (National)

While the Scottish Parliament does not oversee most aspects of traditional electricity and energy markets, it does have impact within these sectors. Explicit authority includes overseeing economic development strategies and investments, onshore oil and gas licensing, environmental and climate change law, property law, housing policy, and building standards. Parliament can also promote renewable energy and energy efficiency through the creation of statutory targets and investments. Finally, the Scottish national government oversees social programs which includes ameliorating fuel poverty through winter fuel payments for low-income households.The Scottish national budget for 2023-24 is $74.34 billion USD, funded mainly through the UK government (known as the Scottish block grant) and Scottish tax revenues.[26]

Local Authorities

Scotland's thirty-two local authorities are local elected councils comparable to counties in the U.S., though as the smallest level of government, they also retain jurisdiction over many typically municipal-level issues here in the U.S. Councils can manage council-owned housing, oversee urban planning, and issue related building permits. The requirement for Local Authorities to develop LHEES plans was the first local statutory power over energy in Scotland since 1995. Council budgets are funded through Scottish government grants (~66%), Council taxes (19%), and non-residential rates on businesses (15%).[27]

25. "Electricity Regulation 2021." Milbank. September 1, 2020. https://www.milbank.com/a/web/140274/2021-Electricity-Regulation-United-Kingdom.pdf.
26. "Scottish Budget 2024 to 2025: Your Scotland, Your Finances." Scottish Government. March 5, 2024. https://www.gov.scot/publications/scottish-budget-guide/pages/scottish-budget-2023-to-2024-guide/.
27. "Local Government Facts and Figures: Scotland." LGiU. https://lgiu.org/local-government-facts-and-figures-scotland/.

Energy Performance Certificates (EPCs)

An Energy Performance Certificate (EPC) is an energy efficiency rating tool. This tool is used widely throughout the U.K. to score energy efficiency in buildings. The EPC ratings scale A through G, where A denotes high energy efficiency, and G denotes the lowest energy efficiency. Letter grades are based on the Standard Assessment Procedure (SAP), which gets scored from 1-100. These letter grades are then assigned to numeric score ranges. A 'C' band EPC score denotes mid-to-high level energy efficiency.[28] Ratings below C are considered poor. A schematic of a sample EPC scorecard can be found in Item I of the Appendix of this report.

Considerations of the Standard Assessment Procedure include Fabric Energy Efficiency (FEE), energy consumption per unit floor area, the energy cost rating (the SAP rating), the Environmental Impact rating based on CO2 emissions (the EI rating), the Dwelling Primary Energy Rate (DPER), and Dwelling CO2 Emission Rate (DER). Calculations are adjusted for floor area, and include energy cost considerations for space heating, water heating, ventilation and lighting, (minus cost savings from on-site energy generation technologies).[29]

EPCs in the U.K. are comparable to the Environmental Protection Agency's (EPA) Energy Star rating tool. Similar to the EPC rating, Energy Star ranks homes on a score from 1-100. To earn an Energy Star, homes must score a 75 or above on the rating scale. In New York City, letter grades are assigned to numeric scores, per stipulations from Local Law 95 of 2019.[30] Unlike the EPC rating, which is based primarily on energy cost analyses, Energy Star ratings are calculated based on the actual measured use of energy in a building, and consider different weather and operating conditions.

28. "Ultimate Guide to Energy Performance Certificate EPC Ratings." EDF. October 19, 2020. https://www.edfenergy.com/heating/advice/energy-performance-certificate-ratings.
29. "The Government's Standard Assessment Procedure for Energy Ratings of Dwellings." BRE Group. March 17, 2022. https://bregroup.com/documents/d/bre-group/sap-10-2-17-03-2022.
30. "Energy Grades." NYC Buildings. https://www.nyc.gov/site/buildings/property-or-business-owner/energy-grades.page.

FUNDING MECHANISMS

The Scottish Parliament has committed to invest at least $2.24 billion USD in building decarbonization during the current parliamentary term (2021-2026). These funds can be described in three categories: (1) grants and loans administered directly by the national government, (2) funding passed down to be administered by local authorities, and (3) investments by the national government into heat networks. The total cost of transitioning Scotland's heating sector to net zero by 2045 is estimated to be over $41 billion USD, so a significant portion of this funding will need to be provided by the private sector.[31]

Home Energy Scotland, the agency administering grants and loans on the national level, is funded by the Scottish government and managed by Energy Saving Trust, a nonprofit organization focused on addressing climate change through energy efficiency and renewables. Home Energy Scotland offers grants to owner-occupants and private sector housing tenants for insulation, energy efficiency improvements, and heat pumps. There are also grants available to companies for research and development, feasibility studies, and large capital projects relating to low-carbon heating systems. Private landlords can also apply for low-interest loans for energy efficiency, renewables, and district heating connections.

Area Based Schemes are another funding mechanism. Last year, $79.6 million USD was allocated to local authorities to develop and deliver energy efficiency programs targeting areas with high fuel poverty. Of the $56 million USD spent, most went toward solid wall insulation.

The national government is also investing in capital-ready heat networks. The Heat Network Fund will provide $373 million USD over four years for large-scale district heating networks and communal heating systems. This funding can be applied for by local authorities, universities, social landlords, community groups, charities, and energy service companies.

As for private financing, the Heat in Buildings Strategy established a Green Heat Finance Taskforce which effectively convened experts to address the $38.8 billion USD not being publically funded. Their first report was issued in November 2023, and included nine recommendations for the Scottish Parliament to consider. These included public engagement to spread awareness of green mortgages, researching blended finance opportunities, fiscal and tax incentives for property owners, and addressing split-incentives through green rental agreements.

31. "Green Heat Finance Taskforce Report Part I." Scottish Government. November 1, 2023. https://www.gov.scot/binaries/content/documents/govscot/publications/independent-report/2023/11/green-heat-finance-taskforce-report-part-1-november-2023/documents/green-heat-finance-taskforce-part-1-report/green-heat-finance-taskforce-part-1-report/govscot%3Adocument/green-heat-finance-taskforce-part-1-report.pdf.

Scotland Case Studies

Glasgow, Scotland

Source: BBC, *Glasgow*


Source: VisitScotland, *Glasgow*

Glasgow, Scotland

Population: 635,200	**Fuel Poverty:** 25%

Building Stock: Dense and mixed-use; almost 50% built before 1945.

Heating Decarbonization Goal: Net zero by 2030.

Current Heating Fuel Type Distribution:

- 82% of residential properties use gas
- 60% of non-residential properties use electricity
- Most energy demand in Glasgow comes from gas-using properties

Key Takeaways:

- Demand assurance and high capital costs pose challenges to utilizing heat networks.
- Areas where a high proportion of old and poorly insulated buildings, high levels of fuel poverty, and high electricity costs converge are particularly difficult to decarbonize and strategies should be developed to specifically address these three interacting dynamics.
- Public engagement and information campaigns can help resolve some of the risk that prevents investment.

Introduction

Glasgow has set an ambitious target to be net zero by 2030, and as of 2021, the city has already reduced carbon emissions by 42% compared to 2006 levels. To achieve their decarbonization goal, Glasgow, like all Scottish Councils, developed an LHEES strategy. Glasgow Council's Sustainability Team worked to draft the LHEES between May 2022 and November 2023, conducting extensive research and stakeholder engagement.[32] Glasgow's LHEES identifies four focus areas based on Glasgow's context: heat networks, energy efficiency, heat pumps, and identifying heating decarbonization solutions for pre-1919 tenements.[33]

Local Context

Scotland's largest city and council, Glasgow, is located in the lowlands along the River Clyde. Glasgow is the only city in the Glasgow Council area, and the Glasgow City and Council government are one. The council area dates back to the sixth century, and was one of Scotland and the United Kingdom's largest industrial centers. With the advent of the Industrial Revolution, Glasgow was home to coal mining, shipbuilding, iron and steelworks, and other heavy industry.[34] From the 1950s through the early 1970s, the council experienced a long period of industrial decline.[35]

The council has since transitioned to a service-based economy, although it is still dealing with the effects of deindustrialization and a shift in the proportion of manufacturing versus white-collar jobs.[36] Glasgow has a population of 635,200. Population demographics are summarized as follows: 88.3% White, 8.1% Asian, and 2.4% Black.[38] In 2021, 30% of households in Glasgow reported having a net income of less than $24,900 USD a year, and Glasgow's LHEES identifies fuel poverty as a challenge for the city.[39]

As of 2019, 25% of households in Glasgow were experiencing fuel poverty, and 13% of households were experiencing extreme fuel poverty.[40] For a household with a net income of $24,900 USD a year, this means that spending more than $206 USD or $414 USD a month on energy would mean experiencing fuel poverty or extreme fuel poverty, respectively. For reference, some estimates suggest that the current average monthly energy bill across Scotland is $215 USD a month.[41]

Figure 2: Map of Glasgow, Scotland[37]

32. "Local Heat and Energy Efficiency Strategy." 2023. https://www.glasgow.gov.uk/index.aspx?articleid=30339.
33. "Local Heat and Energy Efficiency Strategy." 2023. https://www.glasgow.gov.uk/index.aspx?articleid=30339.
34. "Glasgow | History, Facts, Map, & Points of Interest | Britannica." 2024. April 23, 2024. Glasgow | History, Facts, Map, & Points of Interest | Britannica. (2024, April 7). https://www.britannica.com/place/Glasgow-Scotland.
35. Pike, Andy. 2017. "Working Paper 8 Glasgow Case Study Report." Center for Urban and Regional Development Studies, New Castle University. https://www.cityevolutions.org.uk/wp-content/uploads/171211-Working-paper-8-Glasgow-case-study-report.pdf. .
36.Pike, Andy. 2017. "Working Paper 8 Glasgow Case Study Report." Center for Urban and Regional Development Studies, New Castle University. https://www.cityevolutions.org.uk/wp-content/uploads/171211-Working-paper-8-Glasgow-case-study-report.pdf. .
37. "File:Glasgow UK Blank Map.Svg - Wikipedia." 2010. July 17, 2010, https://commons.wikimedia.org/wiki/File:Glasgow_UK_blank_map.svg.,
38. "Briefing 12: 2021 Mid-Year Population Estimates." (2022), https://www.glasgow.gov.uk/index.aspx?articleid=29503; Glasgow Population 2024. (n.d.). Retrieved March 25, 2024, from https://worldpopulationreview.com/world-cities/glasgow-population
39. "Scottish Cities | The Glasgow Indicators Project." n.d. Accessed April 25, 2024. https://www.understandingglasgow.com/indicators/poverty/low_income_households/scottish_cities.
40. Glasgow City Council. (n.d.). "Glasgow LHEES 2023." Retrieved March 25, 2024, from https://www.glasgow.gov.uk/CHttpHandler.ashx?id=60506&p=0
41. "The Biggest Myth about Energy Bills in Scotland | Citizens Advice Scotland." n.d. Accessed April 25, 2024. The biggest myth about energy bills in Scotland. (n.d.). Citizens Advice Scotland. Retrieved April 12, 2024, from https://www.cas.org.uk/news/biggest-myth-about-energy-bills-scotland

Building Stock

Despite being heavily bombed in World War II due to its industrial activity, almost half of all of Glasgow's buildings were built before 1945. Among Glasgow's 330,000 residential properties, approximately 40% are pre-war. More than 52% of these buildings are apartment buildings (referred to in the LHEES as "tenement flats"); 93% of tenement flats in Glasgow were built before 1919.[42] Properties built before 1919 and between 1950 and1983 are the most prevalent in Glasgow, representing 25% and 30% of residential building stock, respectively. Gas is the main fuel type for 82% of properties. Glasgow recognizes three types of residential properties based on ownership structure: owner-occupied, privately-rented, and social landlords (nonprofit housing associations that now own Glasgow's public or "social" housing).[43] The majority of properties in the City of Glasgow are apartments (approximately 73%); lower-density properties are primarily located in the outskirts of the city.[44] Half of Glasgow's housing stock is occupied by renters.

Major categories of non-residential properties include retail (40.2%), office (27.6%), manufacturing/industry (6.7%) and cafes, pubs, restaurants (5.5%). Among non-residential properties, the two major building age categories are pre-1919 and post-1983, with 46.8% of properties constructed pre-1919, and 27.5% constructed post-1983. Interestingly, heat demand from post-1983 properties is higher than pre-1919 at 38.7% of total heat demand compared to pre-1919 buildings at 31.4%.

Most non-residential properties (60.3%) use electricity as their main heating source. Heat source contrasts with heat demand, which is a measure of the amount of energy required to heat a building. In Glasgow, gas accounts for 53.8% of heat demand from non-residential properties, while electricity only represents 37.8% of the total heat demand. As Glasgow's LHEES outlines, this indicates that while most non-residential buildings use electricity for heating, many of these electrically-heated buildings are of smaller size with a correspondingly lower heat demand. Conversely, larger buildings with larger heat needs use natural gas. The majority of demand for heat in the non-residential building sector comes from offices.[45] Despite Glasgow's cold winters (where temperatures average 37.5 degrees Fahrenheit), 41% of residential properties in Glasgow do not have wall insulation.

42. Tenement refers to a building subdivided "into two or more separate but related flats separated horizontally", according to the Glasgow City Council.
43. "Shelter Legal Scotland - What Is a Registered Social Landlord?" n.d. Shelter Scotland. Accessed April 25, 2024. Shelter Legal Scotland—What is a registered social landlord? (n.d.). Shelter Scotland. Retrieved April 9, 2024, from https://scotland.shelter.org.uk/professional_resources/legal/accessing_accommodation/registered_social_landlords/definition.
44. Glasgow City Council. 2017. "Glasgow's Housing Strategy 2017-2022." February 2017. Glasgow City Council. (2017, February). Glasgow's Housing Strategy 2017-2022.pdf. https://www.glasgow.gov.uk/CHttpHandler.ashx?id=55878&p=0.
45. Glasgow City Council. (n.d.). "Glasgow LHEES 2023." Retrieved March 25, 2024, from https://www.glasgow.gov.uk/CHttpHandler.ashx?id=60506&p=0

Strategy for Planning the Heat Transition

The heating decarbonization strategy outlined in Glasgow's LHEES is framed by its decarbonization goals. The Council also aims to reduce fuel poverty to 5% and extreme fuel poverty to 1% by 2040.[46] These dual goals shape the LHEES and therefore its emphasis on heat networks, energy efficiency, heat pumps, and identifying heating decarbonization solutions for pre-1919 tenements.[47] Glasgow's LHEES was also created to align with local and national targets outlined in Appendix 1.

To create its LHEES, Glasgow conducted a review of the city's building stock, did stakeholder engagement, and reviewed existing Council policies. Glasgow's Sustainability team is made up of 17 team members, and the team developed their entire LHEES in-house. The LHEES includes extensive information on city building stock, data which was gathered from the Energy Saving Trust's "Home Analytics" dataset. The Council also conducted strategic mapping to understand spatial patterns across four categories: heat demand/density, poor energy efficiency as a driver of fuel poverty, individual/communal heat pump suitability, and concentrations of pre-1919 properties (see Appendix 2). Based on this mapping, the Council identified "indicative zones," which are high-priority areas for implementing heat networks, energy efficiency measures, or heat pumps as the LHEES moves from the strategic to implementation phase. Identifying these indicative zones is one of the most crucial contributions of this stage of the LHEES. The LHEES identifies 9 indicative zones for heat network delivery and 36 indicative zones for heat pumps.

For addressing poor energy efficiency and fuel poverty, the LHEES did not finalize indicative zones; however, the mapping conducted and data gathered on areas with high fuel poverty and single-wall insulation will inform the Glasgow Council's parallel efforts to develop a retrofit strategy. The retrofit strategy will also focus on more residential-level data in addition to spatial mapping, according to a Glasgow council official.

Community and stakeholder engagement

The LHEES outlines the Sustainability Office's stakeholder engagement process, which began in 2018. The Sustainability Office conducted initial internal workshops to determine the scope of Glasgow's LHEES. Throughout the development of the 2023 report , the Office conducted ongoing engagement with Glasgow Council Housing and Planning officers as well as the Scottish Futures Trust, Energy Saving Trust, and Zero Waste Scotland. The Council engaged with other local authorities in Scotland and the Scottish Government. They hosted a stakeholder engagement event for internal partners with the Council, strategic partners, and city stakeholders such as social housing associations. They conducted further targeted engagement with city stakeholders and conducted a full public consultation to inform the initial draft of the LHEES. Where appropriate and feasible, the LHEES was updated according to consultation feedback. Key lessons learned from stakeholder engagement, as described by the Glasgow Sustainability Office expert we interviewed, include recognizing that homeowners and property owners have uncertainty and both a lack of and incorrect information regarding heating decarbonization potential.

46. As per Glasgow LHEES, a household will be considered under fuel poverty status if the fuel costs for reasonable conduction of heat is above 10% of household adjusted net income.; "Glasgow & Clyde Valley | The Glasgow Indicators Project." n.d. Accessed April 25, 2024. Glasgow & Clyde Valley | The Glasgow Indicators Project. (n.d.). Retrieved April 2, 2024, from https://www.understandingglasgow.com/indicators/environment/fuel_poverty/glasgow_clyde_valley.

47. As per Glasgow LHEES, a household will be considered under fuel poverty status if the fuel costs for reasonable conduction of heat is above 10% of household adjusted net income.; "Glasgow & Clyde Valley | The Glasgow Indicators Project." n.d. Accessed April 25, 2024. Glasgow & Clyde Valley | The Glasgow Indicators Project. (n.d.). Retrieved April 2, 2024, from https://www.understandingglasgow.com/indicators/environment/fuel_poverty/glasgow_clyde_valley.

They said, we "...haven't matched up well enough the potential benefits of district heating and heat pumps and energy security", adding that doing so will require a massive push to ensure district heating gets off the ground.

The Council also focused specifically on stakeholder engagement related to fuel poverty by engaging stakeholders from housing associations. They found that many housing associations were looking to local authorities for guidance on heating decarbonization while prioritizing affordability, suggesting that the Council needs to be proactive. More specific recommendations and approaches for pursuing heating decarbonization in high fuel poverty areas where electricity costs are already burdensome and stand to be increased by retrofit efforts will need to be worked out at a granular level through the Glasgow Council's retrofit strategy.

Finally, although the LHEES does not require utility engagement, Glasgow Council engaged SGN and SPEN, who provide gas and electricity (respectively) to the city. The LHEES was developed using their datasets to model which locations are most suitable for heat retrofits based on grid characteristics and confirm assumptions. This data included publicly-available data on substation locations.[48] While not available during LHEES development, SPEN has since developed a tool allowing local authorities to model the impacts of decarbonization actions on local grid capacity requirements.[49]

Strategy for Implementing the Heat Transition

Glasgow's LHEES is a strategy, not exclusively an implementation plan. An expert on the Sustainability Team at the Glasgow Council stressed that the LHEES represents the beginning of a journey, and is intended to "highlight the scale of the investment opportunity" and the political will and commitment to heating decarbonization. As such, they acknowledged that the LHEES is "suitably high-level and future-proof" to serve as an effective plan even as environments change. This makes LHEES a powerful foundation to direct the decarbonization of Glasgow's heating sector. The LHEES also includes an extensive action plan outlining 25 discrete steps to move forward on implementation.

Since completing the LHEES in November 2023, the Glasgow Sustainability Office has moved into Phase I of their identified implementation steps. In Phase I, they are working to develop heat network delivery plans that can attract investment capital. This includes exploring an energy partnership, which would involve a company contracting with the city to provide heat network services. Ownership models and more operational specifics will be explored in Phase I. This phase is slated to run from 2024-2029.

A significant focus of Phase I will involve actualizing heat network planning. Glasgow's indicative heat networks were developed by mapping heat demand, then using spatial analysis to identify areas with both high density and high heat demand which would be most suitable for heat networks as a heating decarbonization strategy.

48. Interview with Glasgow Sustainability team expert. 2024 Google Meet.
49. Interview with Glasgow Sustainability team expert. 2024 Google Meet.

The lowest demand/density for inclusion as a potential heat network indicative zone was 4,000 kw/m/yr; the Council also identified indicative zones with heat densities of 8,000, 16,000, and 32,000 kw/m/yr. These indicative zones covered 6,200; 3,300; 1,580; and 642 hectares respectively. Zones were categorized into either primary or secondary categories, with primary being priority for development due to existing heat network efforts or infrastructure. In Phase I, the Glasgow Sustainability Office will conduct more detailed modeling on the number of buildings, and existing and necessary infrastructure. Based on this, the Office will upgrade certain "indicative zones" to "designated" heat network delivery zones, and will work to secure investment funding to establish heat networks in those designated zones.

The project will then move into Phase II: Initial Project Delivery. Phase II will involve the first heat networks going into operation in the designated heat network delivery zones. This phase will run over the same time period as Phase I from 2024-2029, as soon as heat network delivery plans that can attract investment capital are created and investment is secured.

Phase III focuses on expanding the heat networks sector in Glasgow. Phase III will seek to combine heat network efforts with fuel poverty reduction, with the hope that heat networks will become cheaper and more cost-effective by this point. Phase III will run from 2029-2034.

Challenges

Glasgow's LHEES highlights a variety of potential challenges to implementation. Barriers unique to Glasgow, or barriers that were emphasized in our interview with a Council expert include the following, grouped by category.

Where the Council has identified a solution, potential solutions are included:

Availability and Cost of Capital and Consumer Impacts

1) **Demand Assurance:** Glasgow's heating decarbonization plan depends, in part, on developing large-scale heat networks. However, without assurance that customers will connect to the heat network, the high upfront initial investment may be perceived as too risky to potential investors. This perceived risk drives up the cost of capital, and thus the potential cost for customers, disincentivizing customers to sign up for heat network heating provision.

2) **High Upfront Capital Costs:** As is the case for many energy efficiency and decarbonization projects, high upfront costs, and the potential that large heat network projects may operate at a loss in the early phases of the project presents a challenge to implementing the LHEES.

3) **Rate Structure:** The rate structure for heat networks is such that heat networks are not cost competitive compared to utility-provided rates.[50] Glasgow's LHEES highlights that a 90% subsidy for renewable energy-powered heat networks is available via the Scottish government until 2024.

4) **Operating Costs:** Glasgow's LHEES suggests that gas prices are low enough so as to be cost-competitive with heat networks, presenting a barrier to incentivizing customers to switch to heat networks.

5) **Connection Suitability:** Due to low building energy efficiency, many properties are not good candidates for individual heat pumps due to the cost of electricity.

6) **Funding:** Uncertainty remains regarding how to fund residential heat pump installation.

50. Glasgow LHEES, 2023. Glasgow City Council. (n.d.). "Glasgow LHEES 2023." Retrieved March 25, 2024, from https://www.glasgow.gov.uk/CHttpHandler.ashx?id=60506&p=0

Stakeholder Engagement

1) **Consumer Confidence:** As mentioned above in the context of demand assurance, heat networks are generally not understood amongst customers and customers may have inaccurate perceptions of the benefits and drawbacks of heat networks. The Glasgow LHEES identifies stakeholder engagement and public information campaigns as crucial to removing this barrier (and likewise addressing demand assurance).

Capacity

1) **Procurement:** Procurement processes required for public buildings to connect to heat networks can result in lengthy delays. The LHEES identifies a lack of funding available at the municipal level and skill gaps among local authorities as being key components of procurement process delays.

2) **Heat Network Design:** As heat networks are designed, there is uncertainty that must be resolved between projected and actual heat demand. Building heat networks that are larger than necessary ensures there will be enough capacity, but increases project costs. Building heat networks that are smaller than necessary reduces cost, but runs the risk of providing too little capacity, which is then difficult to amend.

3) **Balancing Energy Efficiency & Decarbonization:** Both energy efficiency and decarbonization efforts should be pursued together; however, the LHEES notes that this requires the capacity to synchronize efforts, ensure both goals are supporting each other, and coordinate projects.

4) **Supply Chain & Workforce Development:** The LHEES notes a gap between materials required for the heating decarbonization transition and those available. There is also a gap in contractors with skills to build, install, and repair decarbonized heating technologies.

5) **Data Confidence:** The LHEES identifies a need for more accurate data regarding heat demand, noting that concerns regarding privacy are sometimes a barrier to accessing accurate data in this sector.

Building characteristics and ownership structure:

1) **Pre-1919 Tenemental Buildings:** The large proportion of pre-1919 tenements in Glasgow have low energy efficiency due to their age, material, and construction. Often, they have mixed-tenure, meaning that some units may be owner-occupied and some may be rented or have other ownership structures within the same building. Traditional retrofit approaches focusing on increasing insulation may be prohibitively expensive and particularly difficult due to the characteristics. This is made more complicated by many pre-1919 buildings being included in historical preservation regulations.

2) **Mixed Tenure:** As is the case for many pre-1919 buildings, many apartment buildings are mixed tenure. This causes split-incentive issues and challenges relating to getting approval from multiple owners when retrofits must happen at the building level. Given that 74% of Glasgow's homes are apartments, solutions that address multi-tenure ownership and incentive challenges are particularly important.

3) **Owner Occupied Dwellings:** There is a lack of incentive for owners to retrofit their homes to decarbonized heating technology, particularly if the cost savings from heat pumps are unsubstantial. Once "low-hanging-fruit" energy efficiency upgrades are made, the value proposition of investing in expensive decarbonized heating systems is weak for owner-occupied properties.

4) **Private Rented Dwellings:** The lack of funding available to private landlords may present a challenge for incentivizing building retrofits.

5) **Non-Residential Properties:** Many non-residential properties require large amounts of heat. Questions remain around the order in which energy efficiency and decarbonization programs should occur within the non-residential sector.

Proposed Solutions & Recommendations

Overall, Glasgow's LHEES illustrates the benefits of local heat planning, including granular analysis and planning responsive to local contexts. At the same time, Glasgow's LHEES demonstrates that significant questions remain that must be resolved to enable heating decarbonization, especially around funding and investment risk reduction.

The LHEES notes that the Scottish national government is discussing mandatory gas disconnection that would incentivize households to connect to district heating, which may be proposed in the Heat in Buildings legislation.[51] Negotiations and consultations to inform the Heat and Buildings legislation are ongoing this year. The Glasgow Council supports legislation that would require this, with the caveat that there be extensive stakeholder engagement to support affected property owners. In interviews, an expert source within the Glasgow Sustainability team spoke to the impact of stakeholder engagement on the success or failure of district heating as a heat decarbonization strategy. They described that stakeholder engagement that provides information to property owners about district heating and why it might be a good decision could be the difference between district heating only serving large anchor loads (e.g. large municipal buildings, including hospitals) and district heating meeting the ambition of the LHEES. The LHEES suggests that legislation, alongside potential government subsidy, may offset the high capital costs and reduce risk enough to make district heating projects feasible.

While the LHEES does not mention it, Scotland's Green Heat Finance Taskforce is a national team of experts developing creative financing strategies and funding recommendations for the national government in order to address many of the funding-related barriers to heat decarbonization.

The Taskforce's first report highlights potential avenues to explore in order to fund residential heat decarbonization, including tax incentives and low-interest loans.[52] The Taskforce is focusing their second report on potential financing strategies for capital-intensive projects such as district heating networks, due to be released in the second half of 2024. Recommendations by the Taskforce may address challenges related to risk, affordability, and capital availability.

Because utility rates are not within the jurisdiction of the Scottish national government, Glasgow has limited control over utility rate reform or reduction. However, rate structures for both electricity and district heating must be re-evaluated to incentivize electrification, heat network development, and reduce the impact of the high cost of heat network equipment on rates. The LHEES suggests the upcoming Heat in Buildings legislation may also offer solutions by requiring decarbonization of buildings by a certain date.

51. "Delivering Net Zero for Scotland's Buildings - Heat in Buildings Bill: Consultation." n.d. Accessed April 25, 2024. Delivering net zero for Scotland's buildings - Heat in Buildings Bill: Consultation. (n.d.). Retrieved April 21, 2024, from http://www.gov.scot/publications/delivering-net-zero-scotlands-buildings-consultation-proposals-heat-buildings-bill/.
52. "Annex 2 – Potential Finance Mechanisms." n.d. Accessed April 25, 2024. Annex 2 – Potential Finance Mechanisms. (n.d.). Retrieved April 12, 2024, from http://www.gov.scot/publications/green-heat-finance-taskforce-report-part-1-november-2023/pages/10/.

Glasgow offers a model of heating decarbonization in a relatively high-density city with a large stock of multifamily apartment buildings and a high proportion of renters.[53] The challenges faced by Glasgow related to mixed-tenure buildings and split incentives, old building stock, and fuel poverty may be particularly similar to NYC, especially given that almost 50% of New York's residential building stock was built pre-1940.[54] Glasgow's approach moving forward to decarbonizing heating in pre-1919 and apartment (tenement) buildings more generally will be instructive in decarbonizing similarly old buildings in NYC that may deal with low energy efficiency and cost barriers to deep retrofits. Many solutions are in progress — as Glasgow continues to troubleshoot the challenges highlighted earlier, their approaches will be a resource for understanding how to address similar challenges in New York.

Takeaways from Glasgow's LHEES development process include that the council's emphasis on spatial mapping and identifying "indicative zones" is an effective way to create a path for implementation. Furthermore, the Council's emphasis on stakeholder engagement, and on checking their assumptions with stakeholders as they moved through the process, is a model for developing a heating decarbonization plan. The LHEES focus on heat network development might also be of use to NYC, given its steam heating network and existing heat infrastructure. Glasgow's focus on tackling fuel poverty and decarbonization through both energy efficiency and decarbonization retrofits provides a useful framework for decarbonization priorities. Finally, Glasgow's LHEES speaks to the need for policy at the national level to support heat decarbonization, and for utility regulation and engagement.

53. "Tenant Protection Cabinet." n.d. Tenant Protection Cabinet. Accessed April 25, 2024. Tenant Protection Cabinet. (n.d.). Tenant Protection Cabinet. Retrieved April 9, 2024, from https://www1.nyc.gov/content/tenantprotection/pages/.
54. "Cherre Blog - Most Buildings in NYC Were Built Prior to WWII." n.d. Accessed April 25, 2024. Cherre blog—Most buildings in NYC were built prior to WWII. (n.d.). Retrieved April 12, 2024, from https://blog.cherre.com/2019/01/23/most-buildings-in-nyc-were-built-prior-to-wwii/.

Fife, Scotland

Source: LovefromScotland, *Fife*

Source: Expedia, *Fife*

Fife, Scotland

Population: 374,730	**Fuel Poverty:** 24%

Building Stock: 92% of the buildings are residential buildings, with 65% of them privately owned.

Heating Decarbonization Goal: Net-Zero by 2045.

Current Heating Fuel Type Distribution:

- Residential: 90% of residential properties use gas, 9% use either electricity, oil, LPG, biomass or solid fuel, and the remaining 1 % lack data or use a different type of fuel.
- Non-residential: 53% use electricity, 32% use main gas, 13% use oil and 2% lack data or use a different fuel type.

Key Takeaways:

- Fife Council has taken a data-driven approach for identification of measures that can substantially reduce the heating emissions
- The Council is engaging with utilities to develop a price control program to manage the rising cost of electricity
- Public education programs and community trust are key to increase adoption of energy efficiency technologies such as heat pumps

INTRODUCTION

In 2019, Fife declared a climate emergency and committed to reaching net-zero by 2045. The Climate Fife: Sustainable Energy and Climate Action Plan was released in 2020, and "provides a long-term, flexible strategy, and iterative delivery plan, to decarbonize heat and improve energy efficiency, considering wider priorities and targets."[55] In line with the Scottish Government's Local Heat and Energy Efficiency Strategy (LHEES) order, Fife published its LHEES on December 13, 2023. Fife's strategy focuses on engaging with multiple stakeholders, including utilities, to decarbonize not just heating systems but also electricity systems. Fife's LHEES goes beyond statutory LHEES requirements, outlining policy recommendations at the national level to support successful implementation of LHEES in Fife and throughout Scotland.

Figure 3: Map of Fife, Scotland [60]

Local Context

Fife has a population of 374,730, making it the third largest local authority in Scotland.[56] It is located in east central Scotland and covers a larger geographical area than the other Council areas included in this report.[57] Historically, the area had an industrial-based economy that was supported by a robust coal mining industry dating back to the thirteenth century, but the last coal mine closed in 1988.[58] Some of these former mining areas still have yet to economically rebound. Fishing and shipbuilding are two other local industries in the coastal areas that have gradually declined. Today, the Council area's economy is supported by tourism, whisky and gin distilleries, and a growing manufacturing sector.[59]

Building Stock

Fife's population is distributed across urban and rural landscapes, with 64.1% residing in urban areas and the remainder in rural areas.[61] The region has over 180,234 residential buildings, with 83% constructed before 1983.[62] Unlike Glasgow, 65% of Fife's residences are owner-occupied and only 13% are rented by private landlords.[63] An estimated 165,000 domestic buildings are connected to the gas grid for heating. 16,200 are dependent on other sources such as oil, liquified petroleum gas, biomass, electricity, solid fuel, or have no fuels.[64]

55. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
56. "Fife council area profile." National Records of Scotland, Accessed March 21, 2023. https://www.nrscotland.gov.uk/files/statistics/council-area-data-sheets/fife-council-profile.html
57. "Fife." Encyclopædia Britannica, March 27, 2024. https://www.britannica.com/place/Fife-council-area-Scotland.
58. "Fife's Demographic and Economic Context – Fife Coastal Zone." Fife Coastal Zone, Accessed April 23, 2024.
59. "Fife." Fife | Tay Cities Deal, Accessed April 23, 2024. https://www.taycities.co.uk/about-us/fife.
60. "File:Fife UK Ward Map (Blank).Svg." Wikipedia, Accessed April 23, 2024. https://en.wikipedia.org/wiki/File:Fife_UK_ward_map_%28blank%29.svg.
61. "Scottish Government Urban Rural Classification 2020." Scottish Government, October 10, 2022. https://www.gov.scot/publications/scottish-government-urban-rural-classification-2020/pages/5/.
62. "Local Heat and Energy Efficiency Strategy." Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
63. "Local Heat and Energy Efficiency Strategy." Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
64. "Local Heat and Energy Efficiency Strategy." Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf

In Fife, 93% of residential buildings are categorized as low-energy efficiency buildings (which means their Energy Performance Certificate (EPC) ratings are below band B) according to Scotland's EPC system. [65]

Fife also has approximately 15,000 commercial buildings; of those, two-thirds were constructed before 1983. At least half of the commercial buildings use electricity as the source of heat, while only 13% depend on oil for heating needs.[67] Many commercial buildings in Fife are located in a Victorian-era shopping district, and thus lack proper insulation. Commercial buildings without proper insulation are numerous, and total 9,300.[68] The majority of these non-residential buildings are located in more dense urban areas that house retail shops, office spaces, and light manufacturing companies. [69]

Strategies for Planning the Heat Transition

Fife's LHEES strategy aims to abide by the national 2045 net-zero target. Additional priorities mentioned include tackling fuel poverty, improving environmental health, ensuring a just transition and an inclusive economy, and ensuring that adequate skill-building is achieved to carry out the heat transition with locally-sourced labor.[70] The Council conducted a public engagement survey where organizations such as the Fife Communities Climate Action Network, Saline Environment Group, Sustainable Cupar, and Tayport Community Trust partcipated to inform local strategies.[71]

In order to complete the required building stock assessment, the Council utilized the Home Analytics data set, created by Energy Saving Trust, to identify the distribution of residential buildings and their fuel type.[72] The Non-Domestic Analytics data from Energy Savings Trust was used to prepare the commercial and industrial stock. The Council then produced maps with external support from Arup, a London-based architectural and engineering consultant firm, which include spatial detail on some of their planning priorities. For example, maps in the LHEES divide the local authority into data zones and display the average fuel poverty per zone as well as average EPC band.

Thirty-five baseline and eleven stringent heat network zones were identified based on anchor load thresholds of 876 and 308 GWh/year of heat demand, respectively. Most of these anchor loads are industrial estates. After identifying potential baseline zones with at least three anchor loads, each was assessed by its proximity to social housing, potential to address fuel poverty, availability of heat source, and proximity to local development sites.[73] A second level of analysis was then conducted for the four zones which were deemed most viable for further development.

Strategies for Implementing the Heat Transition

To implement the LHEES, Fife is collaborating with Scottish Power Energy Networks, or SPEN to develop optimal building and home decarbonization plans. [74]

65. "Local Heat and Energy Efficiency Strategy." Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
66. "Local Heat and Energy Efficiency Strategy." Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
67. "Local Heat and Energy Efficiency Strategy." Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
68. "Local Heat and Energy Efficiency Strategy." Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
69. "Local Heat and Energy Efficiency Strategy." Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
70. "Local Heat and Energy Efficiency Strategy." Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
71. "Empowering Communities: FCCAN's Collaborative Response to Fife's Local Heat and Energy Efficiency Strategy." Fife Climate Hub, November 15, 2023. https://fccan.org.uk/empowering-communities-fccans-collaborative-response-to-fifes-local-heat-and-energy-efficiency-strategy/.
72. "Home Analytics." Energy Savings Trust. March 21, 2024. https://energysavingtrust.org.uk/service/home-analytics/.
73. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
74. "Making a Difference Part Two: Stakeholder engagement outcomes and impacts." Scottish Power Energy Network. 2023. https://www.spenergynetworks.co.uk/userfiles/file/39998_SPEN_Ofgem-DIST23_PART-TWO_AW-Online.pdf.

While the five year delivery plan (2025-2030) for the LHEES has not yet been developed, the existing tentative plan includes seven key focus areas: 1) transitioning individual buildings through retrofits and heat source upgrades; 2) expansion and delivery model analysis for heat networks; 3) upgrading grid capacity to meet new demand needs; 4) capacity building and jobs training; 5) exploiting existing funding sources and investigating alternative funding sources; 6) Raising public knowledge and awareness of heat decarbonization measures; 7) improve modeling and and data analytics. Generally, the delivery plan aims to prioritize targeted interventions with low regret measures. In essence, any 'low-hanging fruit' upgrades will be addressed first.

For their 5 year delivery plan, Fife is conducting pilot projects to identify strategic zones, potential heat networks and delivery areas. There are three existing heating networks in Scotland, which services the communities of Glenrothes, North Dunfermline, and St. Andrews University.[75] In Glenrothes North and Dunfermline North, the council is evaluating the feasibility of expanding the existing district heating network. In two other communities, Rosyth waterfront and Kirkcaldy, the council is exploring the development of new district heating networks, as both of these areas have low suitability for installation of heat pumps.[76]

Figure 4: Potential Heat Networks Zone [77]

In exploring alternative fuels for heat decarbonization, a total of $39 million dollars have been invested in Energy Park Fife in Levenmouth to replace natural gas with green hydrogen. This hydrogen to homes or H100 project has been executed with support from Scotia Gas Network (SGN) and the Scottish Government.[78] The project is still in the construction phase and will be operable by summer of 2025. The project is powered by a 7MW wind turbine, which is already running in the energy park.[79] For backup power, the project is also connected to the electricity grid. SGN claims that they will provide free hydrogen consultation to the first 300 consumers along with free hydrogen appliances and free maintenance over the length of the project to get more consumers to be a part of this project. [80]

75. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
76. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
77. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
78. "A world-first green hydrogen project from SGN: H100 Fife." Accessed April 24, 2024. https://www.h100fife.co.uk/.
79. H100 fife - a hydrogen world-first on Scotland's East Coast." Accessed April 24, 2024. https://businessevents.visitscotland.com/why-scotland/journey-to-change/sgn-h100-fife/.
80."H100 Fife." Fife Council, November 7, 2023. https://www.fife.gov.uk/kb/docs/articles/environment2/climate-change-carbon-and-energy/h100-fife-hydrogen-heating-network.

Fife Council's collaboration with the distribution network operator SPEN includes their joint development of a price control mechanism. The price-control mechanism follows the formula Revenue = Incentives + Innovation + Outputs - Electricity Distribution 2, otherwise referred to as RIIO-ED2. [82] This formula sets the outputs that Distribution Network Operators should deliver, and stipulates the revenues they're allowed to collect. In this way, revenues collected hinge on the outputs delivered.

Challenges

Prioritizing Fuel Poverty Amidst Cost Concerns

Fuel poverty is a significant challenge identified in Fife's LHEES, with 24% of households being formally recognized as fuel poor.[83] Rising fuel prices and nationwide inflation cause local leaders to expect this number to rise if left unaddressed. Across the Council, fuel poverty disproportionately affects renters, women, ethnic minorities, and people with disabilities.[84] Poor energy efficiency measures can also contribute significantly to higher fuel poverty due to higher utility energy bills. However, the lack of granular data to identify the fuel poor households inhibits the Council from understanding where poor energy efficiency measures are a driver of fuel poverty. Uncertainties with the performance of heat pumps, and the potential for higher future energy costs, exacerbate issues with identifying suitable measures for heat transitioning in fuel poor households.[85]

Heat Transition Measures May Increase Strain on the Grid

With 90% of residential buildings connected to the gas grid (a system of connections of pipelines that supply natural gas from production units to end users including residential, commercial and industrial) in Fife, a major concern tied to transitioning these buildings to electrified heating is the potential strain on the electricity grid.[86] Installation of heat pumps can also generate higher energy demand. To this end, Scotland's energy system would need to be upgraded. However, the United Kingdom oversees energy governance in Scotland. This limits the actions Scotland can take to increase its grid capacity to meet the rising energy demand.

Public Skepticism May Prevent Residential Engagement

Despite the political momentum present locally and nationally for energy efficiency and heat decarbonization, educating consumers is still critically needed. Fife's LHEES recognizes that more certainty and transparency around these new technologies will need to be established to build public trust.[87] Given concerns surrounding potential energy cost increases with the adoption of heat transition measures, addressing public skepticism is crucial.

Skill Gaps Exist in the Workforce

Implementation of heat decarbonizing technologies can create green jobs and enable new technologies. However, this requires a skilled and trained workforce that can install energy and heat efficiency technologies. There is a huge skill gap to meet the existing demand, which is expected to grow.[88]

81. "SPEN LHEES Portal User Guide." Scottish Power Energy Networks, April 27, 2020. https://www.spenergynetworks.co.uk/userfiles/file/SPEN_LHEES_Portal_User_Guide.pd.
82. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
83. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
84. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
85. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
86. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
87. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
88. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf

Poor installation of energy efficiency measures can lead to more problems for the household in future including reduced system efficiency or increase the risk of dampness in the buildings. The delay in the installation of heat pumps due to a lack of skilled workforce can further delay the heat delivery plans. Within Fife, there is also a lack of data on local skills and current workforce gaps.[89]

Poor Energy Efficiency of Buildings

Improving energy efficiency in buildings can result in lower energy costs. However, only 7% of the residential buildings in Fife have a rating of A or B, per Scotland's EPC system.[90] Given the need for rapid decarbonization, retrofitting more than 93% homes in Fife for higher energy efficiency is a challenge for the council.[91] The lack of poor energy efficiency is not just a challenge in domestic buildings, but also in commercial buildings. Since 62% of the commercial buildings lack insulation, the local leadership would need to provide additional support to commercial buildings to support the heat transition. These challenges are exacerbated by issues with retrofitting buildings, as owners may not perceive retrofitting as financially viable. Moreover, pre-1919 buildings are particularly challenging due to their stone brick/bridge wall construction.

Proposed Solutions & Recommendations

Alongside its planned building-level analysis, the Council will conduct research to identify the best areas for heat network development and develop options for heat network delivery models. This data will inform the development of specific delivery areas, which, in combination with stakeholder engagement, will form the basis of a detailed delivery plan.

The Council will conduct energy system planning to understand electrical grid capacity requirements to meet heat decarbonization needs and identify measures to expand energy systems. Additional sectors support the successful implementation of the LHEES. These include skills and jobs development, including training existing providers and workforce and supply chain development. From a funding perspective, the Council will promote existing funding sources and explore alternative funding sources, and conduct public education campaigns regarding improved building energy efficiency and decarbonized heat resources. Finally, the Council will publish a detailed delivery plan, review methodology to inform future programs, and collect data for future iterations of the LHEES.

The Fife LHEES includes several unique characteristics. These include 1) the opportunities latent in LHEES implementation, not just the challenges; 2) the proactive identification of requests for support from the Scottish government; 3) the emphasis on a just transition, and 4) utility engagement and the joint development of a price control mechanism. NYS can gather insights from the Fife approach to their LHEES to inform NYS strategy.

The LHEES identifies the potential for green jobs, stakeholder connections, and better use of waste heat as opportunities throughout the heat decarbonization process. The LHEES includes 17 "asks" for the Scottish government, ranging from requests for additional funding and support with public information campaigns to requests surrounding data privacy.[92] Specifically, in Fife's LHEES and in conversations with a Sustainability Team expert, the issue of allowing anonymized building-level energy use data to be shared came up as a priority.

89. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
90. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
91. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf
92. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf

The LHEES also proposes specific policy changes related to grid capacity, including policy changes to allow channeling surplus energy from private grids/renewables to power local buildings.[93] Fife prioritizes a just transition as part of their strategic guiding goals, and ties a just transition to both indoor air quality and fuel poverty, recognizing that the burdens of both are borne unequally throughout the Fife Council area. The Fife LHEES recognizes the opportunity that heating decarbonization presents to tackle both issues, and the responsibility of the LHEES to only pursue heating decarbonization where it does not adversely affect fuel poverty. Given existing equity issues in NYS, the state can adopt a similar approach to advancing the heat transition.

Finally, Fife Council's work with SPEN both to develop the 5-year price control mechanism (ending in 2028), as well as the 'Local Heat and Energy Efficiency Portal', presents a salient example of how utility engagement can help advance local heat planning in NYS. In combination with the portal – which gives insight into grid capacity as a function of local heat planning efforts – the utility will be well-prepared to handle changes to heat demand and expand the grid accordingly. Engagement with SPEN will continue in order to set new price controls, further develop implementation strategy, and inform grid reinforcement strategy in the future.

As NYS develops its heat in building decarbonization strategy, it can draw insights from Fife's approach. Fife's data-driven strategy in identifying areas conducive to heat networks offers valuable lessons for NYS.

Adopting a similar approach can help NYS identify areas with high potential for success, enabling the development of proof-of-concept projects to gather public support. Moreover, it is imperative for NYS to establish a robust data collection strategy. This approach can play a pivotal role in identifying areas within the state where residents face significant energy burdens; spatial mapping can also help identify areas optimal for heat network siting. By leveraging data and tools like spatial mapping, NYS can strategically target its heat decarbonization efforts, ensuring maximum impact and efficiency.

Stressing the importance of public trust, discussions with Fife Council also highlighted the significance of stakeholder engagement in NYS's journey toward heat decarbonization. Prioritizing stakeholder involvement facilitates the identification of actionable measures aligned with stakeholder needs and preferences. Moreover, NYS can learn from Fife's approach by analyzing future capacity needs for the electricity grid; this can assist with the installation of heat pumps, among other heat transition efforts.

93. "Local Heat and Energy Efficiency Strategy". Fife Council, December 13 2023. https://www.fife.gov.uk/__data/assets/pdf_file/0033/515859/Local-Heat-and-Energy-Efficiency-Strategy-Fife-Council-2023.pdf

North Lanarkshire, Scotland

Source: HomeInstead, *Airdrie, North Lanarkshire*

Source: Wikipedia, *Coatbridge, North Lanarkshire*

North Lanarkshire, Scotland

Population: 340,180	**Fuel Poverty:** 19.7%

Building Stock: 95% of the building stock is residential buildings, with 26% of those being council-owned.

Heating Decarbonization Goal: Net Zero by 2045, 75% reduction by 2030.

Current Heating Fuel Type Distribution:

- Residential: 60% use electricity as a main fuel source, 31% use gas, 6% use oil, and 3% lack data or use a different fuel type.
- Non-residential: 49% use electricity, 35% use gas, 15% use oil, and 1% lack data or use a different fuel type.

Key Takeaways:

- The Council is prioritizing council-owned housing for the first stage of implementation, though many of these residences have already received the most inexpensive energy efficiency upgrades through prior publicly-funded programs.
- A very small portion of residences (just 6%) are within identified potential heat network zones, leaving nearly all transition decisions on the individual household level.
- A lack of adequate data on non-residential properties' fuel type caused their current fuel type inventories to be estimated. Public outreach processes will need to include more accurate stock-taking.

INTRODUCTION

Located in the suburbs of Glasgow, the North Lanarkshire council area covers a range of residential housing with varying fuel mechanisms and ownership types. As of December 2023, North Lanarkshire has developed an LHEES strategy that outlines their targeted decarbonization plan. This strategy includes a set of considerations such as community engagement, technologies to advance heat decarbonization, heat pump suitability analyses, heat network zonation analyses, and energy efficiency upgrade analyses for different building types. It is estimated that 41% of homes require an intervention to improve their energy efficiency performance.[94] Only six percent of the current stock is in areas identified as potential district heating networks, meaning the vast majority of homes will need to undergo retrofitting on an individual basis. The Council is prioritizing council-owned homes for their pilot projects, many of which have already received "low hanging fruit" energy efficiency upgrades.

Local Context

North Lanarkshire is in the central valley of Scotland. It is a mid-sized council area, with a population of 340,180 as of 2018. In North Lanarkshire, 15% of the people (or 50,897 people) are categorized as being income-deprived.[95] The map below shows North Lanarkshire and its towns. North Lanarkshire is a part of the central lowlands of Scotland, and many of the towns in this council area are considered suburbs of Glasgow. After the collapse of the coal mining industry in the late 20th century, some towns in North Lanarkshire fell into poverty.[96] These towns include Motherwell, Wishaw, and Coatbridge, which experienced notable economic hardship in the aftermath of this collapse. Most businesses in North Lanarkshire are small businesses, and construction is the largest economic sector.[97] The weather in North Lanarkshire is relatively temperate year-round. Average temperatures hover around 32 degrees Fahrenheit in the winter and 65 degrees during the summer. Due to this, peak heating demands are typically expected during the winter months.

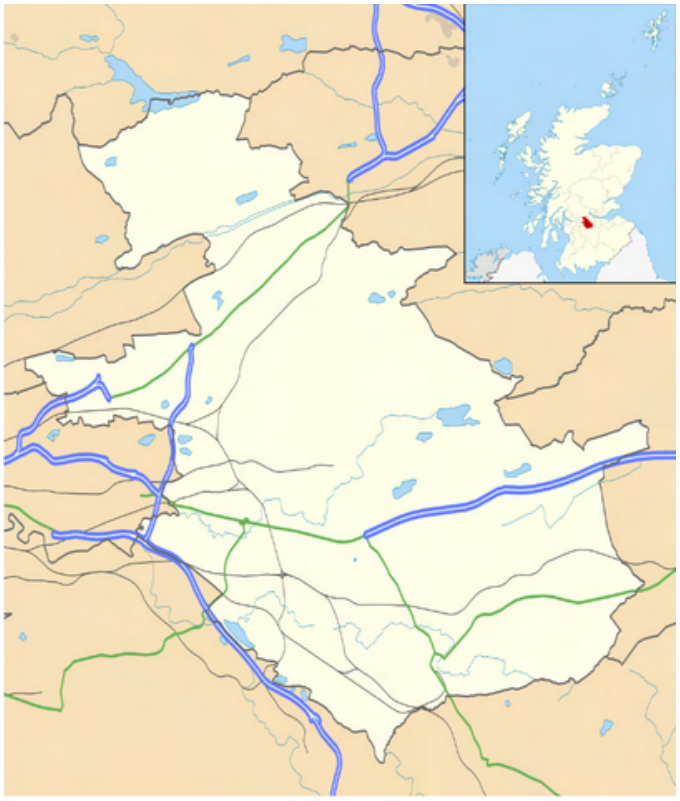


Figure 5 : Map of North Lanarkshire, Scotland[98]

94. "Local Heat and Energy Efficiency Strategy," North Lanarkshire, December 15, 2023, https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf.
95. "Local Child Poverty Action Report 2022-2023," North Lanarkshire, https://www.northlanarkshire.gov.uk/sites/default/files/2023-11/LOCAL%20CHILD%20POVERTY%20ACTION%20REPORT%202023.pdf.
96. "North Lanarkshire." Britannica. March 9, 2024, https://www.britannica.com/place/North-Lanarkshire.
97. "Jobs and Sector Growth Signal Strength in North Lanarkshire's Economy, " North Lanarkshire, December 22, 2023. https://www.northlanarkshire.gov.uk/news/jobs-and-sector-growth-signal-strength-north-lanarkshires-economy#:~:text=The%20biggest%20shift%20in%20the,business%20numbers%20(currently%201%2C540).
98. North Lanarkshire, Scotland, UK Map https://en.m.wikipedia.org/wiki/File:North_Lanarkshire_UK_location_map.svg

Building Stock

The North Lanarkshire building stock can be categorized into residential and non-residential buildings. The building stock consists of just over 161,000 residential buildings and 7,509 non-residential buildings.[99] Of the residential building stock, 26% of homes are owned by the Council and 6% are owned by housing associations—the remaining 68% are privately-owned. Building ages range from pre-1919 to present, but most buildings in North Lanarkshire were built between 1950 and 1983. Over 70% of buildings in North Lanarkshire have an EPC rating (Energy Performance Certificate) of C or D. That said, 41% of properties in North Lanarkshire require an intervention to raise their EPC to a grade of C or better.[100]

Of those homes that do not require an intervention, more (59%) of them are owned by the council, compared to privately-owned buildings (47%), where energy efficiency upgrades require individual homeowner impetus. Almost all homes in North Lanarkshire have double or triple-glazed windows—this means that other structural efforts to enhance energy efficiency are likely to be more expensive, given the windows are already up-to-date. These buildings have an estimated total heat demand of 396,280 MWh/year; however, data limitations prevent more detailed analysis of the non-residential building stock and its energy use.

Strategy for Planning the Heat Transition

North Lanarkshire's LHEES was completed by an external consulting firm, Ricardo Group, and was formulated largely following the methodology provided by the Scottish Government. The plan begins with a policy review, an overview of available building stock data, and an outline of selected strategic zones.[101] Delivery areas are then selected and incorporated into the overall strategy and related Delivery Plan.[102]

The Council's baseline buildings summary was formed using the Homes Analytics dataset, which has robust data on age, EPC ratings, and fuel type for all 161,000 residential properties in North Lanarkshire. The tool covers all residential properties in the United Kingdom and has been developed over the past few decades as energy efficiency and alleviating fuel poverty have become national priorities.[103] For non-residential buildings, the Non-Domestic Baseline Tool was used, which estimates the non-residential stock's energy source and energy demand. This is a newer dataset that was established by Energy Savings Trust as a stopgap for the lack of data on commercial and industrial properties.[104] Data gaps were identified as a major planning barrier which is discussed in more detail in subsequent sections.

To identify potential heat network zones, heat density was mapped out and cross-referenced with the presence of one or more "anchor loads." This involved comparing the Scottish Heat Map to the Council estate's fuel consumption data.[105]

99. "Local Heat and Energy Efficiency Strategy," North Lanarkshire, December 15, 2023, https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf.
100. "Local Heat and Energy Efficiency Strategy," North Lanarkshire, December 15, 2023, https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf
101. "Local Heat and Energy Efficiency Strategy," North Lanarkshire, December 15, 2023, https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf
102. "Local Heat and Energy Efficiency Strategy," North Lanarkshire, December 15, 2023, https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf
103. "Home Analytics," Energy Savings Trust, https://energysavingtrust.org.uk/service/home-analytics/.
104. "LHEES Capacity Building Workshop," Zero Waste Scotland, https://cdn.zerowastescotland.org.uk/managed-downloads/mf-mzzcjdbu-1710234023d.
105. "Local Heat and Energy Efficiency Strategy," North Lanarkshire, December 15, 2023. Page 36, https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf.

Resulting maps identified viable areas, which underwent further analysis to confirm the presence of anchor loads and remove erroneous loads such as those which may have been misjudged or double-counted. Given that North Lanarkshire does not have any substantially urbanized areas, very few potential networks were identified. Local solutions like communal heating and individual heating were then explored for the remaining housing stock, with the Home Analytics Tool used to predict viability for heat pumps.[106]

Finally, the area boundaries from the 2022 North Lanarkshire Local Development Plan were selected as the most appropriate strategic zones, as they capture fundamental geographical differences and use existing policy boundaries, an important consideration for integrating LHEES into existing planning work and service delivery.

Strategy for Implementing the Heat Transition

While the LHEES's development was outsourced to consultants, implementation of the Delivery Plan will be carried out by the Local Authority's staff. As of the writing of this report, there are three employees on the council area's Asset Team who are responsible for implementing the LHEES on top of their existing duties: an energy efficiency project manager, an energy coordinator, and a climate coordinator.[107] In recognizing that these existing employees do not have adequate capacity to carry out the Delivery Plan alone, an LHEES Officer post has recently opened and is expected to be filled by Summer 2024.[108] This individual will be ultimately responsible for ensuring each action item outlined in the LHEES priority list is followed through on.[109]

The Local Authority is also going to be hiring an external consultant to review potential pathways to net zero and revise interim dates as outlined in their climate plan.[110] Part of this work will involve an analysis of their building stock and how much it will cost to transition it to zero emissions technologies.[111] This will be key for the Council, as they currently have no such estimate.

Finally, the Local Authority's planners will also be ensuring that the next update to their local plan reflects their climate change and adaptation priorities, including the heating in buildings transition.[112]

106. "Local Heat and Energy Efficiency Strategy," North Lanarkshire, December 15, 2023, Page 57, https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf.
107. Lynda Stevenson (North Lanarkshire Council) and Margaret Kelly (North Lanarkshire Council) in discussion with the author, April 2024.
108. Lynda Stevenson (North Lanarkshire Council) and Margaret Kelly (North Lanarkshire Council) in discussion with the author, April 2024
109. Lynda Stevenson (North Lanarkshire Council) and Margaret Kelly (North Lanarkshire Council) in discussion with the author, April 2024
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112. Lynda Stevenson (North Lanarkshire Council) and Margaret Kelly (North Lanarkshire Council) in discussion with the author, April 2024

Challenges

Some Public Housing & Easy Energy Efficiency Measures have Already Been Addressed

Given that 26% of the homes in North Lanarkshire are owned by the Council, addressing energy efficiency and decarbonization measures in these homes is a natural first step. However, 59% of publicly owned homes already have an EPC rating of C or better.[113] While this suggests there is still more work to be done to reach 100%, many immediate improvements to enhance energy efficiency have already been undertaken. Further, since North Lanarkshire's residential building stock consists almost entirely of homes with double or triple-glazed windows, easier energy efficiency upgrades like glazing windows aren't as relevant; the low volume of homes requiring low-cost energy efficiency interventions means the impact of such upgrades is marginal. The Council may also face barriers with pilot projects where they own less than half of the units in a building.

Need for Data Sourcing for Non-Residential Buildings

While Scotland's historic focus on energy efficiency in homes has led to robust public datasets for residential buildings, very little data is available for the non-residential building stock in North Lanarkshire. For this reason, much of the non-residential data in the LHEES is sourced from the Non-Residential Analytics dataset, which is mostly formulated by estimates and therefore largely unreliable.[114] For example, a building's footprint on a map and its presumed number of levels (based on height) would be used to estimate its total square footage and associated energy demand.[115]

Further, energy sources are also estimated, and of the top ten gas-consuming sites in North Lanarkshire's building portfolio, only three were correctly identified as using gas as their main fuel type. Thus, the analysis of non-residential buildings in the North Lanarkshire LHEES is less rigorous than the residential properties analysis.. In order to better plan the transition of non-residential buildings, including predicting cost projections for the entire transition, more accurate data is needed.

Heat Network Zones are Not Widely Scalable

Another limitation of the LHEES strategy has to do with heat network adoption. The North Lanarkshire LHEES includes a holistic analysis of viability zones for heat networks. These zones are dubbed 'Heat Network Zones,' and are visualized in the map below. Heat network zones are determined by analyzing heat density and assessing the presence of "anchor loads," or energy loads that are large, stable, and likely to connect.

A linear heat density method was used where circles were drawn around each anchor building with diameters proportional to the heat load of the property.[116] The analysis included a baseline scenario using 4,000 kWh/m and a stringent scenario using 8,000 kWh/m.[117] Areas were then filtered based on whether a continuous area could be formed where circles overlapped, with the most promising locations identified as those with heat loads exceeding 15,000 MWhs.

113. Lynda Stevenson (North Lanarkshire Council) and Margaret Kelly (North Lanarkshire Council) in discussion with the author, April 2024.
114. Lynda Stevenson (North Lanarkshire Council) and Margaret Kelly (North Lanarkshire Council) in discussion with the author, April 2024
115. "Local Heat and Energy Efficiency Strategy," North Lanarkshire. December 15, 2023, Page 23. https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf.
116. "Local Heat and Energy Efficiency Strategy," North Lanarkshire. December 15, 2023, Page 23. https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf.
117. "Local Heat and Energy Efficiency Strategy," North Lanarkshire. December 15, 2023, Page 23. https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf.

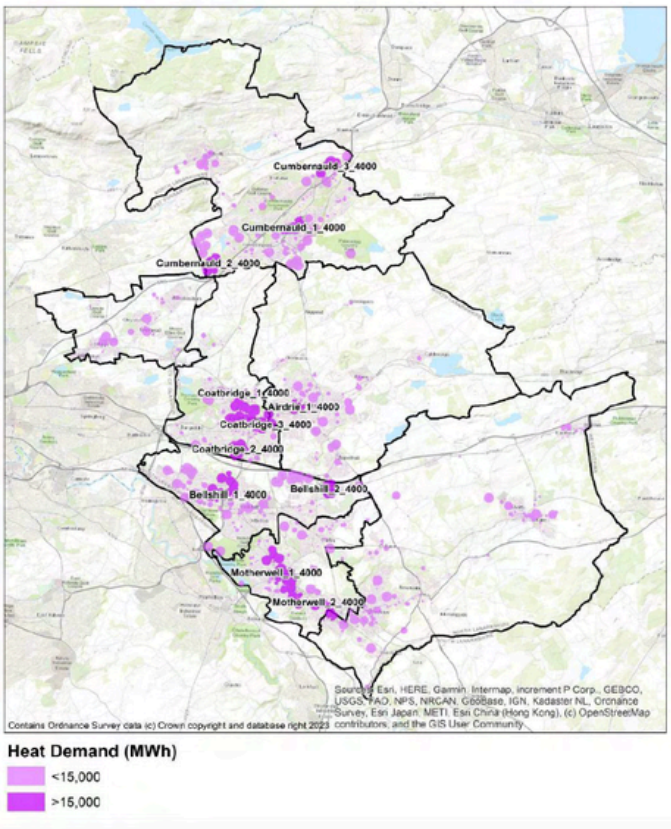
As the maps below demonstrate, there are very few viable heat network zones. The current baseline zones capture 6% of residential and 11% of non-residential buildings. Notably, some large industrial buildings that would be technically feasible anchor loads are not viable because they are warehouses owned by major corporations.[118] Heat network zones are determined by the existing building stock, but it is important to note that future developments would lend themselves better to heat networks since the installation cost and disruption of existing heat networks would be more minimal if completed at the building construction stage.

Suitability Barriers with Heat Pumps and District Heating

Generally, heat pumps should operate 2.8 times more efficiently than direct electrical heating and 3.3 times more efficient than gas boilers.

An estimate of North Lanarkshire home suitability for heat pumps is included in the LHEES, although a more detailed analysis at the individual home level would be necessary to accurately assess the real viability. Suitable properties are those that have a predicted heat demand per square meter of property of less than 160 kWh/m2/year, which equates to approximately 75 W/m2 during peak heat demand. [119]

Of the total 161,150 residential properties in North Lanarkshire, 70,172 (43.5%) were identified as being suitable for heat pump installation (without any fabric/ insulation interventions).[120] That figure increases to 99,435 (61.7%) when cost effective energy efficiency interventions are included into the viability analysis, and 117,094 (72.7%) if more costly measures are taken.[121] Even at its best, heat pump installation will not be viable for all homes in North Lanarkshire.



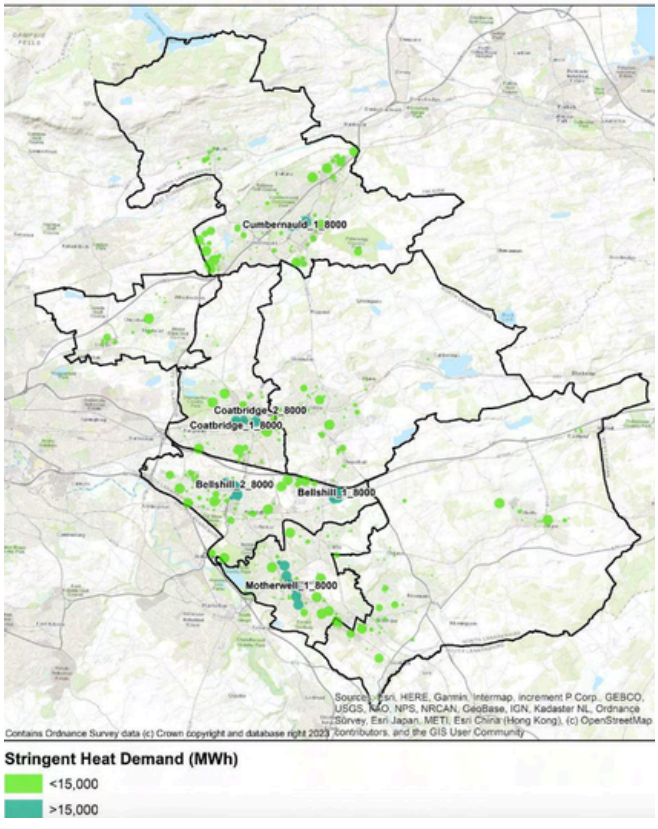


Figure 6: Baseline Heat Network Zones & Stringent Heat Network Zones in North Lanarkshire, Scotland[121]

118. Lynda Stevenson (North Lanarkshire Council) and Margaret Kelly (North Lanarkshire Council) in discussion with the author, April 2024.
119. "Local Heat and Energy Efficiency Strategy," North Lanarkshire, December 15, 2023, https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf.
120. "Local Heat and Energy Efficiency Strategy," North Lanarkshire. December 15, 2023, Page 23. https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf.
121. "Local Heat and Energy Efficiency Strategy," North Lanarkshire. December 15, 2023, Page 23. https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf.

Conservation Areas & Historical Homes

Around 3,000 buildings, or 2% of North Lanarkshire's total building stock, are considered conservation areas. These buildings are often excluded from certain permitted development rights, and may therefore require extra permissions for energy efficiency upgrades and low-carbon heating implementation. Upgrades can also be more time consuming and costly in these traditional properties due to certain structural barriers—sometimes these upgrades are not even possible to install.

Stakeholder Alignment in Mixed-Tenure and Mixed-Used Properties

Mixed-tenure buildings are those which have multiple properties of the same use (an apartment complex with multiple condos), whereas mixed-use buildings will have many properties in the same building that have different use profiles and are not all residential, such as a shop with a flat above. Around 1,700 residential properties are recorded as flats in mixed-use buildings. Wall insulation is a key area of concern for this array of buildings, and yet 858 of the 1,100 flats with uninsulated walls have solid stone walls, which are not easily knocked down/manipulated to install wall insulation.[122] There are 22,554 mixed-tenure buildings in North Lanarkshire. Mixed-tenure and mixed use buildings will require specialized engagement, funding and delivery strategies in order to implement the necessary energy efficiency measures. There are likely to be challenges with aligning the goals of each of the multiple stakeholders in this subsect of the North Lanarkshire building stock.

Proposed Solutions & Recommendations

In order to address some of the challenges outlined above, North Lanarkshire has developed a delivery plan, with outlined next-steps. These can be broken into four categories: (1) moving forward with identified district heat networks, (2) using Council-owned housing upgrades to create case studies for shared learning, (3) encouraging early adoption of decarbonization technologies, and (4) addressing existing knowledge gaps through collaboration and stakeholder engagement. Considering both the challenges and unique solutions that North Lanarkshire is employing can help to inform NYS strategy. Learnings from North Lanarkshire's approach include the importance of developing a holistic array of datasets to enable more precise planning and performance measurements; prioritizing stakeholder engagement; using fuel poverty statistics to prioritize publicly-funded improvements; and using publicly-owned housing as a site for pilot projects.

North Lanarkshire Council's highest priority action is to move forward with stakeholder engagement in potential heat network zones.[123] By 2028, the Council plans to have conducted feasibility studies for prospective zones and business cases developed for those that are deemed feasible[124] Similar strategic zoning and stakeholder engagement in an NYS context can ensure that communities that can easily implement a heat network zone are identified and prioritized. Strategy for heat transitions may differ depending on the feasibility of certain technology types, the density of buildings, the age of buildings, and other factors; zoning can help to identify these differences.

122. "Local Heat and Energy Efficiency Strategy," North Lanarkshire, December 15, 2023, https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Strategy%20Report_0.pdf.
123. "Local Heat and Energy Efficiency Delivery Plan," North Lanarkshire. December 15, 2023, https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Delivery%20Plan.pdf.
124. "Local Heat and Energy Efficiency Delivery Plan," North Lanarkshire. December 15, 2023, https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Delivery%20Plan.pdf.

However, without stakeholder engagement at the community level, fear or uncertainty surrounding unfamiliar technologies and pricing/rate changes for utility bills may hinder communities from engaging with the heat transition. Council staff may also reassess heat network zones that were previously deemed infeasible: technologies have developed in the past few years, enabling heat to be transported further distances.[125]

As mentioned in the last section, the Council will prioritize the top third of areas where energy efficiency measures will have the greatest impact on reducing fuel poverty. NYS could also focus publicly-funded improvements on those currently enrolled in the federal Low-Income Home Energy Assistance Program (LIHEAP) considering that those New Yorkers are the most likely to have high energy burdens. Prioritizing energy efficiency upgrades and decarbonization measures for these households can help alleviate the burden of energy costs on vulnerable populations while advancing broader sustainability goals.

When administering energy efficiency measures, the Council will prioritize authority-owned homes given the Council's existing jurisdiction over their maintenance. NYS may benefit from piloting clean heat improvements in public housing properties, where private ownership is not a barrier to entry. These interventions could overlap with existing maintenance plans.

For non-Council-owned housing within these priority zones and homes in other zones, the Council hopes to encourage early adoption of decarbonizing technology by setting up a means to share educational materials on technologies and funding opportunities by 2026. Given that these decisions are so complex and specific to each case, the Council will work with other local authorities, the national government, and universities to develop and collect the best available material for stakeholders.[126] In an NYS context, information dispersal and collaboration with other states advancing heat transition plans can help to facilitate smoother roll-out and implementation, while ensuring that mistakes made in one locality are not duplicated in another.

North Lanarkshire's LHEES integrates a data-driven approach, but also underscores the need for a comprehensive array of datasets that are fully developed. As NYS develops its heat in building decarbonization strategy, it is critical that they consider potential biases in their data, and ensure it represents all communities, building stock types, etc. This way, the specific issues associated with different building types can be more clearly illuminated. In North Lanarkshire, the shortcomings of the Non-Domestic Baseline Tool are prompting the national government to improve the quality of existing data for their next updated report (due December 2028). Similar attention to the rigor of datasets and data collection should be employed in NYS.

125. Lynda Stevenson (North Lanarkshire Council) and Margaret Kelly (North Lanarkshire Council) in discussion with the author, April 2024.
126. "Local Heat and Energy Efficiency Delivery Plan." North Lanarkshire. December 15, 2023. https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Delivery%20Plan.pdf.

Clackmannanshire, Scotland

Source: Alamy, Thescottishsun

Source: Wikipedia, *Clackmannan*

Clackmannanshire, Scotland

Population: 51,540	**Fuel Poverty:** 27%
Building Stock: 24,000 dwellings.	
Heating Decarbonization Goal: Corporate net zero by 2040; Eliminate fossil fuels by 2045.	
Current Heating Fuel Type Distribution: Either utilize boilers or electric heat sources. • Residential properties: 89% natural gas, 6% electricity, ~2% LPG, ~1% biomass, ~1% oil. • Non-residential properties: Data unavailable.	
Key Takeaways: • Dual-council approach to LHEES enables information sharing and collaboration. • Four-part work-stream plan promotes flexibility and adaptability. • Stakeholder engagement anticipates unique challenges.	

INTRODUCTION

Clackmannanshire's LHEES approach is unique due to its adaptable, collaborative-nature. The Regional Energy Masterplan (REM) was developed through a partnership formed between Clackmannanshire Council and neighboring Stirling Council, and prioritizes regional projects that will reduce fuel poverty, reduce emissions, and improve the resilience of the local energy supply. The plan explores multiple heat management strategies, enabling flexibility in implementation should delays arise. The thorough stakeholder engagement carried out before the REM's development enabled the identification of comprehensive solutions, categorized by which actors need to implement them.

Local Context

Inland and North of Glasgow, Clackmannanshire sits near the mouth of the River Forth. As of 2021, it had a population of 51,540 people, making it the smallest council area in Scotland. The main town is Alloa, with a population of 20,730. The geography is dominated by hilly terrain, lowland plains and the River Devon. [127] While its economy was once centered around coal mining, brewing, and textile industries, today it is mainly supported by agricultural and brewing industries.[128]

Clackmannanshire's Local Development Plan (LDP) was adopted in 2015 and sets out strategic objectives for future development, focusing on sustainable economic growth, environmental protection, and the transition to a low-carbon economy. It emphasizes high-quality design and layout in development, town center regeneration, energy efficiency, and the use of renewable energy sources and district heating.[130] The specific building standards integrate green standards through energy efficiency programs, renewable energy initiatives, and a climate action scorecard.[131]

In response to Scotland's statutory order mandating councils develop a Local Heat and Energy Efficiency Strategy (LHEES) and Delivery Plan, Clackmannanshire Council decided to partner with neighboring Stirling Council to develop a Regional Energy Master Plan (REM). Heat electrification will be achieved through heat pumps, direct electric/electric storage heating, and bioenergy.[132] The REM is broken down into 4 work-streams: energy efficiency, heat management, renewable generation, and sequestration, each with measurable Key Performance Indicators (KPIs), action items, and five-year phases from 2023-2045.[133]

Building Stock

There were an estimated 24,377 dwellings in Clackmannanshire as of 2017, with the majority located in Alloa.[134] As of 2011, 21% of properties were owned by Clackmannanshire Council, 66% owner-occupied, 5% private rented, and 8% social rented. Although the population is in decline, the number of households is increasing: 125 homes were completed in the last year alone. By 2037, it's estimated that 75% of all households will be either single-person

126. "Local Heat and Energy Efficiency Delivery Plan." North Lanarkshire. December 15, 2023. https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Delivery%20Plan.pdf.
127. "Local Heat and Energy Efficiency Delivery Plan." North Lanarkshire. December 15, 2023. https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Delivery%20Plan.pdf.
128. "Local Heat and Energy Efficiency Delivery Plan." North Lanarkshire. December 15, 2023. https://www.northlanarkshire.gov.uk/sites/default/files/2023-12/LHEES%20Delivery%20Plan.pdf.
129. "Clackmannanshire UK blank map," File:Clackmannanshire UK blank map.svg - Wikipedia
130. Planning and Building Standards, "Local Development Plan," Clackmannanshire Council, (2015). https://www.clacks.gov.uk/property/ldpadopted/
131. Planning and Building Standards, "Building Standards," Clackmannanshire Council, (2024). https://www.clacks.gov.uk/property/
132. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 70 https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf
133. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 70 https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf
134. Council and Government, "Households and Dwellings," Clackmannanshire Council (2024). https://www.clacks.gov.uk/council/householdestimatesinscotland/

occupied or a couple.[135] Buildings in the region are primarily heated by boilers and electric heating systems – non-residential buildings have a more even split between the two, while residential is primarily boilers.[136] Clackmannanshire spends approximately $830,000 per year on energy, which is roughly one percent of the Council's overall budget.[137] Total energy consumption is about 26,508,286 kWh per year, with 6,972,871 fueled by electricity and 19,535,415 from gas.[138]

Socioeconomic Status & Fuel Poverty

Major equity concerns have arisen in the Council's heat transition given the high proportion of households struggling to afford their energy needs. As of 2018, 27% of households in Clackmannanshire were in fuel poverty, slightly higher than the national average of 25%. Extreme fuel poverty affected 11% of households. The groups most affected include single pensioner income households, social housing tenants with long-term illnesses or disabilities, and families with children, highlighting significant need to address energy access and affordability.[139]

Funding Mechanisms

Over the past fourteen years, the Council's Energy and Sustainability team has secured over $23 million in government funding to improve the energy efficiency in homes resulting in an estimated emissions reduction of over 13,000 tonnes of CO_2e in annual savings or over 334,000 tonnes of CO_2e in estimated lifetime savings.[140]

REM was created as part of the Stirling and Clackmannanshire City Region Deal, a commitment between the two councils, Scottish Government, UK Government and University of Stirling to deliver a £214 million investment over ten years to support the economic development of the Stirling and Clackmannanshire city region. REM identifies a total of 18 funding sources available to help fund heat transition measures. Programs include funding for local authorities, companies, investors, homeowners, and community organizations to help fund low-carbon heating systems, some renewables and storage, energy efficiency improvements, development plans and professional advice, zero-carbon heating, energy infrastructure and controls upgrades, expert advice from consultants on available options for heat decarbonisation across a community, and District Heating Networks, including heat sources, pipes and connectors.

Strategy for Planning the Heat Transition

Digital Twin Model

To create the regional energy masterplan and provide projections for energy demands and carbon emissions for buildings and networks under different scenarios, the City Region Deal partners turned to Integrated Environmental Solutions (IES), a design and analysis

135. "Strategic Housing Investment Plan 2018- 2023" Clackmannanshire Council, https://www.clacks.gov.uk/document/5747.pdf
136. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 17. https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf
137. Housing and Council Tax, "Home Energy Efficiency Programs," Clackmannanshire Council, (2024). https://www.clacks.gov.uk/housing/homeenergyefficiency/
138. Andy Lee and Mark Hobbins, "Energy Management and Opportunities for Clackmannanshire Council," Mabbett & Associates Ltd, 2004. https://www.clacks.gov.uk/document/779.pdf
139. Housing and Council Tax, "Fuel Poverty," Clackmannanshire Council, (2024). https://www.clacks.gov.uk/housing/fuelpoverty/
140. Environment and Waste, "Climate Change," Clackmannanshire Council, (2024). https://www.clacks.gov.uk/environment/climatechange/

software company. Utilizing data from the local councils and the Energy Saving Trust, IES's digital twin model creates 3D models for every building in the region, including information on building fabrics, heating system, fuel type and primate use. The model is based on five steps: 1) behavioral & operational changes, 2) physics-enabled simulation to support decision-making, 3) interactive 3D baseline model & investment road mapping, 4) local energy sharing and demand management, and 5) virtually test onsite renewables and low carbon technology. This enables predictions on building performance and simulation of proposed action plans to identify and target potential shortfalls. This model will be an ongoing resource, continually updated by the councils, information which will soon be available for public use. [141]

Stakeholder Engagement

The REM included stakeholder engagement through the services of Ricardo Energy, which contacted key stakeholders (residential, non-residential, public sector and third sector, and individual large-scale energy users) on the REM's objectives, KPIs, and modeling work. Engagement efforts identified the biggest challenges and barriers for energy decarbonization through workshops and individual sessions. One-on-one interviews were also conducted with large energy users as well as the DNOs that supply electricity to buildings in the region: Scottish Power Energy Networks (SPEN) and Scottish and Southern Electricity Networks (SSEN), which are responsible for grid improvements. While the REM is implemented, communication with DNOs will continue so all parties are aware of projects and actions they need to take.[142] All stakeholders expressed intentions to decarbonize due to either increasing energy costs, ending user/consumer pressure, or company goals/targets. Most stakeholders expressed experiencing barriers while implementing decarbonizing technology, and were knowledgeable about the opportunities to replace their equipment with low carbon technologies.[143]

Strategy for Implementing the Heat Transition

REM Four-Part Work-Stream Approach:

1. *Energy Efficiency*

To meet the energy efficiency targets outlined in the REM's KPIs, the Council will encourage weatherization directly and indirectly. In intermediate zones identified as target areas based on fuel poverty risk, the Council will directly fund upgrades.[144] The Council will also encourage consumers to adopt energy efficient technologies and upgrades through education and outreach. For non-residential commercial buildings, small businesses will likely need help funding improvements. An estimated 41% of non-residential buildings in the region require retrofit, and are typically harder to address because of varying construction types and mixed use. Per the REM, off-gas grid properties are the top priority, and both councils plan to develop district heating networks to help decarbonize alongside energy efficiency

141. Ewan Prentice (Stirling Council Strategic Energy Coordinator) in discussion with the author, April 2024.
142. "Stirling and Clackmannanshire Regional Energy Masterplan," Engage Stirling, (2023). https://engage.stirling.gov.uk/en-GB/projects/regional-energy-masterplan
143. "Stirling and Clackmannanshire Regional Energy Masterplan," Engage Stirling, (2023). https://engage.stirling.gov.uk/en-GB/projects/regional-energy-masterplan
144. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 46 https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf

improvements. Both council areas will engage with smaller businesses and charities to raise awareness of Scottish Government energy efficiency policies surrounding non-residential buildings, funding and financial support available, and to help them to identify skilled and trusted installers.[145]

2. *Heat Management*

Clackmannanshire Council has prioritized off-gas areas and is actively offering solutions to tenants. Due to limited supply of biofuels/biomass in the future, the majority of buildings in the region will be heated by electricity (via heat pumps) or hydrogen (via conversion of the existing mains gas grid). Buildings in areas of high heat demand will be heated by heat networks, which will similarly use either electricity or hydrogen.[146] To help ensure the grid can handle an increase in demand, the councils will coordinate with Distributed Network Operators (DNOs) that supply electricity to buildings in the region.

The Scottish Government's Heat Network Support Unit helps local authorities and the public sector plan, develop, and fund the construction and commissioning of new heat networks, with funding available through the Heat Network Fund.[147] As part of the 2022 First National Assessment of Potential Heat Network Zones, the Scottish Government determined 16 potential district heating network sites in Clackmannanshire and Stirling, based on high heat demand across several buildings in a relatively small area and viability for construction in the short term. These were narrowed down to nine sites based on the number of public non-domestic buildings, carbon emissions, fuel poverty, financial cost, local economic impact, local environmental impact, social factors, and resilience.[148]

Of the nine recommended sites, three are located in Clackmannanshire. The Alloa Forthbank Network would initially include 12 industrial, education, childcare, library, office, and warehouse buildings, as well as an estimated 100 socially rented domestic buildings located next to Alloa Academy. Of these buildings, 5 run on electricity, 4 on natural gas, and 3 on oil. The Alloa Healthcare and Business Centre Network would initially consist of 10 office, warehouse, and healthcare buildings. Half run on natural gas, and half on electricity. Additionally, an estimated 50 socially rented buildings South of Alloa Business Park could also be connected to the network when it is initially constructed. The Alva Network would consist of 13 buildings, including a secondary school, primary school, office buildings, industrial, and warehouse. All but two run on natural gas, with the two school buildings running on electricity. Additionally, 25 socially rented properties could be connected initially.[149] Action items include raising awareness of options to decarbonize heat, how to identify best solutions, optimum use of technologies, and financial support available, as well as addressing the skills gap for supply and installation of low carbon technologies.

145. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 46 https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf
146. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 56 https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf
147. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 78 https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf
148. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 80https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf
149. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 62 https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf

3. Energy Generation

Scotland's energy grid is already highly decarbonized, with 97% of electrical demand met by renewables. More renewable installations are necessary to meet increasing demand from green hydrogen and electrification of heat and transport. Large-scale renewable development typically falls under the jurisdiction of the Scottish Government and energy companies; however, mid-sized installations can be developed on council-owned land. The REM includes local, small and medium-scale generation projects as a means to support electrification of heating; both individual heat pumps and district heat network heat pumps. The REM suggests Smart Local Energy Systems (SLES) to play a role in grid-constrained and off-gas grid areas to enable smarter operation, lower bills, and improve resilience. Both councils will be assessing the potential of SLES projects in implementation. Additionally, following the publication of the Scottish Government's National Planning framework, new council planning policy will enable projects and communication with DNOs on electricity grid constraints. Action items include raising awareness of financial support available and supporting communication and collaboration.[150]

4. Sequestration

Sequestration is viewed as a last resort in the REM to address the realities of difficult-to-decarbonize sectors. Recommended solutions include tree-planting, woodland restoration, peatland restoration, and land management changes. It is estimated that between 67 and 180 ktCO2e will need to be sequestered in the region to account for residual energy-related emissions by 2045 in order to reach the net-zero target. Stirling Council's "Alive with Nature Plan and Forestry and Woodland Strategy" and Clackmannanshire Council's "Biodiversity Action Plan" will help to reduce emissions from farming and land use. Action items for immediate implementation include determining the carbon sequestration of the regions' peatland and rewilded landscapes and supporting land management change.[151]

Figure 7 below illustrates the current carbon emissions attributed to the energy use of the region's residential and non-residential buildings. The expected emissions reduction is shown for each 5-year phase. The sliver of remaining residual carbon in 2045 will be addressed through sequestration.

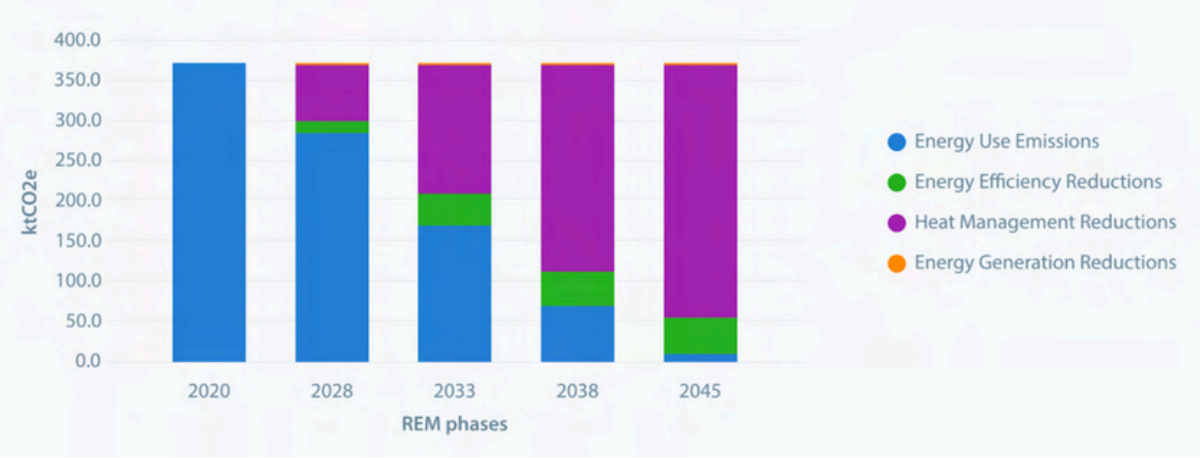


Figure 7: Projected Regional Building Carbon Emission Reductions [152]

150. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 93 https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf
151. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 105https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf

Challenges

Lack of Public Awareness of Technologies and Funding Opportunities

The REM outlines current and expected challenges for the four work-streams, as well as required actions by the Scottish government, local authorities, and partner organizations to address these challenges. One challenge present across work-streams is a lack of public awareness. Specifically, lack of citizen awareness of how heat networks operate, mandatory targets and funding measures available for energy efficiency and heat decarbonization, as well as awareness of certain technologies. Small and mid-sized businesses are less likely to have decarbonization plans than larger businesses, or be aware of funding available to help with required measures.

High Capital Costs of Decarbonization Projects

Another challenge is the high capital costs for some retrofit workers and decarbonization projects, including district heating networks. There are limited funds to achieve expensive energy efficiency measures with very long pay back times. When it comes to the possible development of a hydrogen conversion pathway, there are technical feasibility challenges around costs, gas pipeline placement, safety concerns, and amount of green hydrogen available. Additionally, the two councils have established shorter deadlines to reach net zero (Stirling: 2035 and Clackmannanshire: 2040) and are doing so with limited funds.

Limitations in Data Collection and Availability

The LHEES process is also challenged by limits in data availability. EPC data is used to determine energy efficiency; however, it is not well suited to this because the metric is also based on cost. There is also a non-residential building data gap, with a lack of information available on aspects including building fabrics.

Grid Capacity

Lastly, there are also concerns over grid capacity. Specifically that the current grid capacity constraints in certain areas will not be able to support increased electrical demand from heating. Additionally, homeowners and private businesses can be reluctant to connect to heat networks, partially due to the lack of currently operational heat networks nation-wide. [153]

Proposed Solutions & Recommendations

The REM calls for an increased awareness of available funding resources and support for homeowners and private landlords, which is currently carried out through Home Energy Scotland and Energy Saving Trust by both the Scottish Government and local authorities. It also seeks to address this challenge through open dialogue with Small and Midsize Enterprises and third sector organizations to help with their decarbonization plans, and raise awareness of available financial support for retrofit works. This action would be carried out by the Scottish

152. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 18https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf
153. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023), p. 93 https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf

Government, as well as local authorities through open forum in partnership with others. It also charges the Scottish government and local authorities with working to increase public awareness of how heat networks operate and the benefits that they can bring.

To address high costs, the REM tasks local authorities with investigating the use of proceeds from renewable energy projects to fund energy efficiency improvements for homeowners who cannot afford it and establish public-private partnerships. Local authorities are also responsible for considering the Asset Rationalisation Strategy and identifying assets that may be sold off and used more efficiently by others, or replaced with more efficient buildings. They will also utilize funding from the Scottish Government, obtain detailed feasibility studies and business cases for highest ranked potential sites, and begin construction and commissioning if successful. The REM also calls for the use of the developed open forum between businesses, DNOs, industry, and community groups to identify where potential renewable generation projects may be able to create green hydrogen from their excess generation, potentially avoiding grid constraints limiting capacity.

The REM states that local authorities and the Scottish government should investigate best solutions for matching homeowners and landlords with trustworthy, skilled installers, as well as the possibility of signposting retrofit guidance in partnership with Scottish Government guidance. They should also outline a standard process of retrofit for homeowners and landlords and take action to increase the number of skilled, accredited installers of low carbon heat technologies/heat pumps in the region. It is also recommended that local authorities investigate the viability of joint procurement projects where either council may facilitate procurement and installation of energy improvements on multiple non-residential buildings in an area and use proceeds as payback.

To remedy delays in planning permissions, the REM calls for planning authorities to support retrofit and renewable proposals that make a positive contribution to the climate and nature crises in appropriate situations, having regard to the facts and circumstances of each case in line with the adopted national spatial strategy and any Local Development Plan for the area.

The REM tasks the Scottish government with reforming the EPC to align metrics used with industry standard metrics, such as kWh/m2/yr space heating demand. Local authorities must update the digital twin model to address the data gap and obtain information on the fabrics used in each non-residential building in the region through the Scottish government's Energy Saving Trust. Lastly, local authorities are tasked with facilitating communication between DNOs, Scottish Gas Network, council officers and planners, community groups, and larger industrial and commercial sites through the creation of an open forum to share heat decarbonisation strategies to share knowledge and expertise, the identification of potential joint projects, the discussion of waste heat opportunities for district heating, and inform DNOs

of required grid improvements.

DNOs, in partnership with community groups and local authorities, are tasked with creating an open forum to facilitate conversation between the region's DNOs and large consumers so grid upgrades and reinforcements required for future plans are in motion and actions are tracked. These groups in partnership must also determine required grid upgrades in the rural off-gas grid areas which will electrify their heat demand by 2032. DNOs and local authorities are also tasked with identifying areas where grid reinforcement will be required, improving grid capacity, and working with other partners to determine heating electrification plans.[154]

The REM was completed in 2023 and approved in March 2024. Each council will determine governance boards, which will sit under the Joint REM Board and Climate Portfolio Board, to oversee plan delivery and monitor KPIs and progress. A governance board for this plan will be determined by each council. This will consist of key individuals to oversee the delivery of the plan and ensure actions are underway, KPIs are monitored, and progress is being made, with subgroups to oversee each work-stream. The REM will be updated every 5 years so new opportunities or projects can be identified in the face of potential policy changes or technology advances. This will allow for changes to be made if a KPI is anticipated to be missed/behind.

Phase 1 (2023-2028) includes two actions with hard deadlines within this time period to ensure all social houses and privately rented houses meet the required EPC rating improvements, and are at the top of the energy efficiency section. There are ongoing actions with later phase deadlines which will be started as soon as possible. Work will also begin on the highest ranked potential district heating and energy generation projects in this phase. This phase also includes discussions with potential industrial partners for the development of district heating networks.[155]

NYS municipalities can learn from Clackmannanshire's cooperation with neighboring localities in smaller regions, utilization of external resources and funding, and engagement efforts. The REM was created in partnership between Clackmannanshire and Stirling Councils, combining the resources and expertise of two smaller council areas into a larger-scale joint plan. The plan's exploration of multiple heat management strategies keeps the plan adaptable, flexible, and resilient. Including energy efficiency (retrofits), heat management (heat supply/residual emissions), energy generation (microgeneration, individual heat pumps and district heating networks, renewable energy), and sequestration projects creates an "energy hierarchy" which helps identify interdependencies between workstreams. The Scottish Government's prioritization of LHEES and provision of resources to help councils develop these plans has enabled the REM

154. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023). https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf
155. "Regional Energy Masterplan," Clackmannanshire and Stirling Councils, (December, 2023). https://www.clacks.gov.uk/document/meeting/1/1202/7738.pdf

to develop its plan which utilizes resources and funding made available from the national level.

The REM successfully identifies constraints and challenges the plan may face based on thorough community and stakeholder engagement. The plan's identification of actions needed to address these items and the inclusion of what groups are responsible helps those implementing the plan anticipate needs and take a proactive approach. The REM's engagement strategy has provided the councils with ample information for identifying public information gaps, and where public education efforts are most needed. The 18 identified sources funding resources for local authorities/homeowners/property owners/business owners help integrate the plan across the residential and non-residential spheres, with informational resources tailored for specific audiences. For instance, Clackmannanshire Council's Home Energy Advice Team gives support for low-income houses in fuel poverty by providing energy efficiency improvements, consolidating energy debt and accessing funding to help to alleviate increased costs. In addition to these services, the team also holds community events to engage residents. These efforts can serve as a guide to successfully learn from and assist communities in NYS.

SUMMARY TABLE

COUNCIL AREA	KEY TAKEAWAYS	RECOMMENDATIONS FOR NYS
Glasgow	• Demand assurance and high capital costs pose challenges to utilizing heat networks • Areas where three dynamics converge - a high proportion of old and poorly insulated buildings, high levels of fuel poverty, and high electricity costs - are particularly difficult to decarbonize and strategies should be developed to specifically address these three interacting dynamics • Distinguishing buildings by age can help to enhance understanding about zonation pathways for district heating networks • Public engagement & information campaigns can help resolve some of the risk that prevents investment	• There may be a role for the public sector at the state level to play in ensuring demand for heat networks and decreasing perceived investment risk • Work on public engagement and information campaigns to ensure public participation, and circumvent potential misunderstandings regarding the heat transition • Pursuing energy efficiency and decarbonization together can help address fuel poverty issues
Fife	• Fife council has taken a data-driven approach for identification of measures that can substantially reduce the heating emissions • The council is engaging with utilities to develop a price control program to manage the rising cost of electricity • Public education programs and community trust are key to increase adoption of energy efficiency technologies such as heat pumps	• Explore existing funding sources and identify new and innovative ways to garner funds • Engage with the utilities sector by scheduling regular meets; ensure numerous parties have a seat at the table, and a voice in the conversation • Pilot public engagement and education campaigns to build community trust
North Lanarkshire	• North Lanarkshire Council is navigating challenges related to stakeholder engagement in potential heat network zones • In North Lanarkshire, council sharing of educational and funding opportunities can encourage decarbonization in non-council owned home • Thorough datasets that provide insight into both residential and non-residential homes are critical to ensure effective energy efficiency and decarbonization tactics are implemented across the council	• Need to develop a holistic array of datasets to enable more precise planning and performance measurements • Focus on prioritizing stakeholder engagement • Use fuel poverty statistics to prioritize publicly-funded improvements • Use publicly-owned housing as a site for pilot projects
Clackmannanshire	• Dual-council approach to LHEES enables information sharing and collaboration • Four-part work-stream plan promotes flexibility and adaptability • Stakeholder engagement anticipates unique challenges	• Cooperation with neighboring states or localities on the heat transition can help to avoid duplicating mistakes, and promote information sharing • Public-private partnerships to help finance energy efficiency improvements

National Policy Overview: The Netherlands

INTRODUCTION:
Political Background & Governance

While most European countries rely on imports for natural gas, the Netherlands began extracting its own gas in the 1960s, capitalizing on abundant natural gas stores in the province of Groningen. Residential buildings in the Netherlands quickly came to rely on this accessible and cheap energy source for heating. Nearly 90% of Dutch homes had natural gas-fired central heating systems as of 2019, the highest share among European countries and much higher than the EU average of 27% in the same year.[156] Natural gas dominated the country's energy generation in 2022, accounting for 40% of Dutch energy generation, followed by wind (18%), solar (15%), coal (14%), biomass (7%), and other sources such as nuclear and petroleum products (7%).[157] However, concerns about the seismic potential of natural gas extraction emerged among the Dutch population at the turn of the century as earthquakes in Groningen began to increase in frequency and intensity.[158] In 2018, the Dutch government responded by halting natural gas extraction.[159]

In 2019, recognizing the need for alternative energy sources that also aligned with the European Union's (EU) growing focus on sustainability, the Dutch parliament established ambitious goals to reduce their greenhouse gas emissions. They first passed the Netherlands Climate Act in May 2019,[160] which set specific targets for 2030 and 2050, including 49% reduction in greenhouse gas emissions by 2030 compared to 1990 levels and 95% reduction by 2050. [161]

They then released the National Dutch Climate Agreement or *KlimaatAkkoord* in June 2019, which created targets and governance frameworks for emissions-intensive sectors and stated that 7 million homes should be natural-gas free by 2050. The agreement focuses on five sectors: electricity, industry, the built environment, traffic and transport, and agriculture.[162] By 2050, all Dutch homes – excluding the 10% of homes that are already natural gas-free – should have switched to low-carbon heating, with natural gas completely phased out. As an interim goal, 1.5 million homes–or roughly 20% of all homes–should be made 'more sustainable' by 2030.[163] The agreement is based on the principle that reducing carbon emissions must be feasible and affordable for everyone and is designed to impose "annual additional costs" on the country of less than 0.5% of GDP in 2030.[164]

The agreement also stipulates that municipalities should play a central role in the heat transition, given the local nature of decision-making, municipal governments' closer knowledge of the local landscape, and their relationships with stakeholders. It designates all 345 Dutch municipalities as the directors of the heat transition in the built environment and directs them to work with property owners, residents, grid operators and stakeholders to draft a Heat Transition Vision or Transitievisie Warmte (TVW) by the end of 2021. The TVW is a roadmap or plan that outlines how each district (i.e., neighborhood) in the municipality will transition to sustainable heating and when it will happen. Districts are not a level of governance, and they do not have formal decision-making bodies.

156. OECD, "Decarbonising Homes in Cities in the Netherlands: A Neighbourhood Approach," OECD Regional Development Papers, no. 42 (Paris: OECD Publishing, 2023), https://doi.org/10.1787/b94727de-en.
157. US International Trade Administration, "Netherlands Energy," 2024, https://www.trade.gov/country-commercial-guides/netherlands-energy?_gl=1*.
158. "History of Earthquakes and Natural Gas in Groningen," Northern Times, April 3, 2024, https://northerntimes.nl/history-of-earthquakes-in-groningen.
159.Government of the Netherlands, "Definitief Einde Gaswinning Groningen Wettelijk Geregeld," November 24, 2020, https://www.rijksoverheid.nl/actueel/nieuws/2020/11/24/definitief-einde-gaswinning-groningen-wettelijk-geregeld.
160. "'Klimaatwet," Wetten.nl, accessed April 24, 2024, https://wetten.overheid.nl/BWBR0042394/2020-01-01.
161. David Roberts, "The Netherlands Just Passed a Radical Climate Law. Here's What It Does.," Vox, July 6, 2018, https://www.vox.com/energy-and-environment/2018/7/6/17535720/netherlands-dutch-climate-law-paris-targets?_gl=1*wt2jsv*_gcl_au*MjA4MTg3NjA4Mi4xNzAyMzI5NTAy
162. Government of the Netherlands, "Climate Policy," accessed April 24, 2024, https://www.government.nl/topics/climate-change/climate-policy?_gl=1*a0x0ql*_gcl_au*NTc0MDE2MTY2LjE3MDg1NTQxMzA.
163. "National Climate Agreement The Netherlands," Klimaatakkoord.nl, June 28, 2019, https://www.klimaatakkoord.nl/documenten/publicaties/2019/06/28/national-climate-agreement-the-netherlands
164. Government of the Netherlands, "Climate Policy."

Rather, they are a unit in which a city can divide itself to facilitate more granular heat transition planning and implementation. This strategy seeks to ensure that the Dutch heating transition is tailored not just to the country's municipalities but to each of its 14,000 districts, which contain 500 homes each on average. The Dutch government also sent a letter to municipalities with more detailed guidance on what each TVW should include, highlighting two main requirements:

1. Each TVW must include a clear timeframe for transitioning, specifying the number of homes in each district that would be supplied with sustainable heating solutions between 2022 and 2030.
2. Districts must indicate their chosen approach to sustainable heating, prioritizing methods with the lowest social and end-user costs (e.g. all-electric or district heating). The plan should also specify which districts would begin their heat transitions before 2030 and which would start after.

The national government has provided key resources to support municipal efforts to develop their TVWs, including an open-source modeling tool which estimates the costs and feasibility of various heating solutions at the district-level, and a Heating Expertise Centre (HEC) for information and guidance.[165] Municipalities may also leverage information from the country's regional energy strategies (RES), which locate heat sources, map out heat supply and demand, and identify opportunities for heat infrastructure in thirty regions of the Netherlands. Various stakeholders (i.e., government officials, businesses, community groups, and energy network operators) collaborated to develop each RES to meet electricity and built environment targets. Almost all municipalities responded to the directive before the deadline, barring some that did so in early 2022.

Municipalities are now responsible for developing district-level plans for implementing the recommendations in their TVWs.[166]

The Dutch government also created two dedicated programs to further support municipalities' heat transition efforts, one of which invests money into heat transition pilot projects and another which synthesizes and shares learning from those pilot projects to other districts and municipalities. Municipalities may also leverage another existing national program to bolster their capacity for planning and implementing their heating transition plans. Each of these three programs is detailed below, along with three proposed policies whose passage would significantly impact the pace of the Dutch heating transition.

Natural Gas-Free Neighborhood / Programma Aardgasvrije Wijken (PAW)

In 2018, the Dutch national government created the Natural Gas-Free Neighborhoods Program or Programma Aardgasvrije Wijken (PAW), in collaboration with the Association of Dutch Municipalities (VNG), the Interprovincial Consultation Committee (IPO) and the Union of Water Boards (UvW).[167] PAW offers multi-million euro grants for municipalities to pilot heating transition projects in key districts. While the national government lacks the funds to finance every district's heat transition, the PAW pilots have offered key lessons that will facilitate the scale-up of the heat transition across the country.

This program invited all 345 municipalities to submit grant proposals and received 193 applications across

165. Michiel Hekkenberg et al., "Decarbonizing the Dutch Built Environment: Challenges and Opportunities," Energy Policy 224 (2023): 113298, https://www.sciencedirect.com/science/article/pii/S2210422424000091#sec0007.
166. Florian Kern et al., "Governing the Transition to a Climate-Neutral Built Environment in the Netherlands: Challenges and Opportunities," Energy Policy 234 (2023): 113298, https://www.sciencedirect.com/science/article/pii/S0301421524000478#:~:text=The%20Netherlands'%20342%20municipalities%20were,by%20the%20end%20of%202021.
167. Greta, "Natural Gas-Free Living," accessed April 24, 2024.
168."Dutch Municipalities Are Tasked to Lead the Heat Transition to Quit Gas. Do They Have the Right Tools for the Job?," Going Dutch, accessed April 24, 2024, https://www.going-dutch.org/news-1/dutch-municipalities-are-tasked-to-lead-the-heat-transition-to-quit-gas-do-they-have-the-right-tools-for-the-job.
169. KWINK Groep, "Evaluatie Programma Aardgasvrije Wijken," October 14, 2022, https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2022/10/14/evaluatie-programma-aardgasvrije-wijken/evaluatie-paw.pdf.

the three rounds of grants.[168] Ultimately, they selected 66 districts across 59 municipalities which collectively represented the diversity of challenges and opportunities in the Dutch Heat Transition.[169]

They tasked each district with identifying key challenges in deploying their chosen technologies and best practices for addressing a range of issues, including resident involvement and cost-efficiency. Figure 8 illustrates the program initiatives for the PAW grant provided to the districts and their distribution across 9 grant recipients.

National Programme for Local Heat Transition or Nationaal Programma Lokale Warmtetransitie (NPLW)

The NPLW is a Dutch intergovernmental program which supports municipalities in achieving their built environment decarbonization targets and translates knowledge from the PAW pilots into tangible lessons. This program absorbed the HEC in January 2023, becoming the single point of contact for municipalities seeking support in implementing their TVW.[171] The NPLW offers guidance to municipalities on both individual and collective heating solutions.[172] It also continues to monitor their progress to identify lessons and best practices for other municipalities.[173]

The director of the program manages a staff team and a communications team, with additional support from the Netherlands Enterprise Agency (RVO), a public organization that supports entrepreneurship, innovation, and sustainable development. [174]

Each of the 30 staff team members serve as the point of contact for 15-20 municipalities, working with stakeholders on the ground to gather, synthesize, and/or disseminate learnings from the PAW pilot projects.[175]

Temporary Capacity Regulation of Decentralized Authorities for Climate and Energy Policy (CDOKE)

The CDOKE scheme was designed to bolster municipalities' capacity for climate and energy policy implementation. Between 2023 and 2025, the government has allocated €1.04 billion, equivalent to approximately $1.16 billion USD, to assist municipalities and provinces in hiring additional staff and external experts. This temporary arrangement, known as the Capacity of Decentralized Authorities for Climate and Energy (CDOKE) scheme, aims to facilitate the establishment of internal organizations dedicated to climate and energy tasks within local authorities.

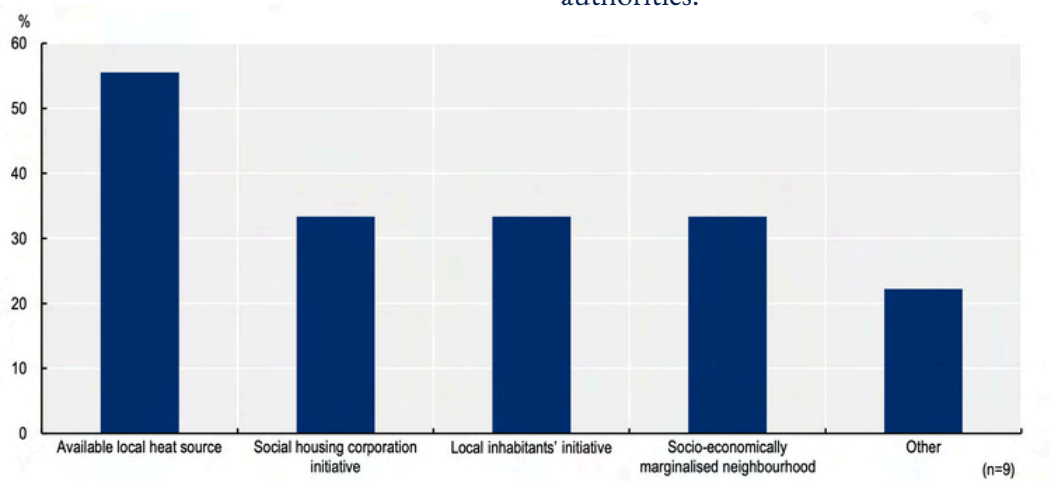


Figure 8: Distribution Across Grant Recipient Types for PAW Grant Funding[170]

170. OECD, "Survey on Decarbonising Buildings in Cities and Regions in the Netherlands," Programma Aardgasvrije Wijken (PAW), 2022.
171. "Verhaal Lokale Warmtetransitie," NPLW, accessed April 24, 2024, https://www.nplw.nl/strategieuitvoering/verhaal-lokale-warmtetransitie/default.aspx.
172."Nationaal Programma Lokale Warmtetransitie (NPLW)," Warmtenetwerk, accessed April 24, 2024, https://warmtenetwerk.nl/leden/item/nationaal-programma-lokale-warmtetransitie-nplw/.
173. "Verhaal Lokale Warmtetransitie," NPLW.
174. "Home," RVO, accessed April 24, 2024, https://www.rvo.nl/en.
175. Maureen Van Eijk, Director of NPLW, interviewed by the author, March 2024.

The temporary nature of the CDOKE scheme presented a challenge in financing permanent appointments. However, in consultation with relevant ministries and provinces, provincial supervisors have agreed to allow municipalities to include the received climate and energy funds as a structural benefit in their 2024 budget for the years 2024 to 2027. This enables municipalities to make permanent staff hires, providing stability and continuity to their climate initiatives. Furthermore, an additional CDOKE benefit is available for specific plans in 2024 and 2025. Municipalities can claim this for specific projects such as zero-emission zones, solar meadow and wind farm construction, and transitioning buildings to natural gas-free alternatives.[176]

Additional Policies Under Consideration

The interviews highlighted three policies under the Dutch legislature's consideration which will greatly accelerate the heating transition if they pass. The first is the Collective Heat Supply Act (Wcw), which would address public backlash against the privatization of district heating networks by requiring local or national governments to own over 50% of each network.[177] The law aims to facilitate the build out of sustainable district heating networks, emphasizing the role of municipal governments and end-users in managing the system and setting energy prices. Skeptics of the Wcw argue that it could raise the fixed costs of some district heating systems,[178] and that tariff regulations would be a more effective mechanism for ensuring the affordability of those systems.[179]

Another policy is the Municipal Heat Transition Instruments Act (Wgiw), which would force cities to transition their heating systems by halting their supply of natural gas at the end of a specified period (i.e., 8-12 years) after the law passes. Finally, the Dutch government is considering a law requiring building owners to install hybrid heat pumps instead of natural gas boilers beginning in 2026.[180] The proposed law also includes provisions to encourage manufacturing of low-carbon heating equipment and subsidize adoption of heat pumps.[181]

Recent elections in the Netherlands have decreased the likelihood that these laws will pass,[182] including the long-standing Wcw which once seemed very likely to pass. However, any one of these laws could fundamentally change incentive structures underpinning the heating transition, making low-carbon heating solutions a potentially more favorable and attractive option compared to gas-powered heat. Municipalities have found it challenging to navigate uncertainty around the passage of these laws in their heat transition planning.[183]

176. "Uitvoeringsmiddelen voor Gemeenten CDOKE," NPLW, accessed April 24, 2024, https://www.nplw.nl/financiering/subsidies+en+regelingen/2587513.aspx?t=Uitvoeringsmiddelen-voor-gemeenten-CDOKE .
177. Christiaan Verburg and Dario Garcea, "Wet Collectieve Warmtevoorziening (Wcw) en Warmtetransitie: Regierol voor Gemeente," June 1, 2023.
178. Amsterdam civil servant in discussion with the author, March 2024.
179. Robert Harmsen (Assistant Professor, Utrecht University) in discussion with the author, March 2024.
180. "Netherlands to Ban Fossil Heating by 2026, Make Heat Pumps Mandatory," EURACTIV, accessed April 24, 2024, https://www.euractiv.com/section/energy-environment/news/netherlands-to-ban-fossil-heating-by-2026-make-heat-pumps-mandatory/
181. "Netherlands to Ban Gas Boiler Installations from 2026," Homebuilding, accessed April 24, 2024, https://www.homebuilding.co.uk/news/netherlands-to-ban-gas-boiler-installations-from-2026.
182. Ajit Niranjan, "Geert Wilders' Far-Right PVV Vows to Scrap Dutch Climate Policy," The Guardian, November 26, 2023, https://www.theguardian.com/world/2023/nov/26/geert-wilders-far-right-pvv-dutch-climate-policy.
183. Amsterdam civil servant in discussion with the author, March 2024.

OVERVIEW OF GOVERNING JURISDICTION & REGULATORY CONTEXT

As a member state of the European Union (EU), the Netherlands shares sovereignty and policy-making responsibilities with other EU countries in certain areas. While the EU cannot directly regulate building heating in its member states, it does have energy efficiency directives and regulations that influence member states' approaches to decarbonization in this sector. Generally, the Dutch Climate Act and Climate Agreement go even further than EU directives require. The table below offers more details on jurisdictional powers maintained by each level of government relating to the issues of decarbonization and energy efficiency.

European Union (Supranational): The European Union's (EU) governance largely influences energy regulation in the Netherlands. The EU's responsibilities include declaring priorities, managing competition, consumer protection, and ensuring a functioning internal energy market.[184] They are also responsible for the licensing and regulation of cross-border energy infrastructure, especially since the country has seven cross-border interconnections and are planning to expand this number.[185] Energy taxation in the Netherlands is influenced by EU directives, with taxes levied on electricity and natural gas, impacting consumer prices and investment patterns.[186]

The Netherlands (National): The Netherlands sets its own national climate and energy policies, marked by distinct approaches of policy coordination, expert involvement, strategic planning, consensus building, and mutual self-commitments.[187] They are responsible for national-level environmental protection and climate change legislation, and have created the Dutch Climate Agreement to outline their targets and sector-specific regulations.[188] In coordination with setting the domestic targets, addressing fuel poverty is also factored into the plan.

Provincial Authorities: Provinces are responsible for translating the national energy and climate policies, through the Ministry of Infrastructure and the Environment, into the context of their respective provinces. Implementation and enforcement of national energy and climate policies at provincial level.[189] This incorporated spatial planning and land use policies, as more context-specific challenges are targeted here. Provincial authorities also coordinate and support local authorities in developing energy plans. They work closely with municipalities to ensure the necessary checks and balances in governance.[190] All the Provincial level work is facilitated through a provincial executive and council, chaired by a King's commissioner, who represents the central government in the province.[191]

Local Authorities (Municipalities): Municipalities are responsible for urban planning and building regulations, which includes the development and execution of local energy plans.[192] Municipalities also manage municipal-owned buildings, aiming to improve their energy efficiency and reduce carbon emissions. Local authorities have the responsibility of addressing energy poverty, by implementing social welfare policies and are often the first to recognize and respond to the needs of vulnerable groups.[193]

184. "Energy Policy: General Principles". European Parliament. (europarl.europa.eu/factsheets/en/sheet/68/energy-policy-general-principles).
185. "Energy System of The Netherlands". International Energy Agency. (iea.org/countries/the-netherlands).
186. "Netherlands Profile". Odysee-Mure. (odyssee-mure.eu/publications/efficiency-trends-policies-profiles/netherlands).
187. Musch, E. "Handbook of Energy Governance in Europe." Springer, Cham. (doi.org/10.1007/978-3-030-43250-8_20) , pg. 3.
188. "Energy System of The Netherlands". International Energy Agency.(iea.org/countries/the-netherlands)
189. "Provinces, municipalities and water authorities". Government of Netherlands (government.nl/topics/public-administration/provinces-municipalities-and-water-authorities)
190. "Provinces, municipalities and water authorities". Government of Netherlands (government.nl/topics/public-administration/provinces-municipalities-and-water-authorities)
191. "Provinces, municipalities and water authorities". Government of Netherlands (government.nl/topics/public-administration/provinces-municipalities-and-water-authorities)
192. "Building on local climate and energy experience in Energy Union Governance", Council of European Municipalities and Regions.
193. "Building on local climate and energy experience in Energy Union Governance". Council of European Municipalities and Regions.

Utility Sector

The Netherlands has a single electricity market that was liberalized (or deregulated) in 1998.[194] Utility companies in the Netherlands are governed by two regional companies that are responsible for the transportation of energy: the high-voltage electricity network is managed by TenneT, and the national gas transmission network is managed by N.V. Nederlandse Gasunie (Gasunie).[195] The distribution network that they govern operates under six electricity and gas distribution system operators (DSO) in the Netherlands, which include Cogas Infra & Beheer, Enexis, Liander, Rendo, Stedin, and Westland Infra.[196]

Federal Governance

- Electricity (TenneT): TenneT is controlled and owned by the Dutch government.[197] It's responsibilities include:
  - Providing electricity transmission services and facilitating the energy market.
  - Managing the transmission grid, connecting electricity producers to the grid, and transporting electricity to almost 43 million people in the areas it serves.[198]
- Natural Gas (Gasunie): The Netherlands, through their Ministry of Finance, is the sole shareholder of Gasunie.[199] It's responsibilities include:
  - Managing and maintaining the infrastructure for large-scale transport and storage of gas.

Regional Governance

The DSOs in the Netherlands are responsible for preparing the energy infrastructure in their respective operating regions based on the proposed changes in the Regional Energy Strategies (RES). RES's are identified by local governments, the federal network operators (TeneT and Gasunie), the private sector, and social organizations. [200] The Dutch government provides technical and financial assistance for the development and execution of the RES.

194. Electricity DSO market share in the Netherlands. Statista. 2023 (statista.com/statistics/878534).
195. Home utilities in the Netherlands. I Am Expat. (iamexpat.nl/housing/dutch-housing-market/home-utilities).
196. Electricity DSO market share in the Netherlands.
197. Dutch Ancillary Services, TeneT. TeneT. (tennet.eu/markets/dutch-ancillary-services).
198. Dutch Ancillary Services, TeneT. TeneT. (tennet.eu/markets/dutch-ancillary-services).
199. Organization, Gasunie. Gasunie. (gasunie.nl/en/organisation)
200. The Netherlands 2020: Energy Policy Review. IEA. 2020. (https://www.iea.org/reports/the-netherlands-2020).

FUNDING MECHANISMS

National, provincial, and municipal governments in the Netherlands offer a range of incentives (e.g., subsidies, tax schemes, loans, mortgages) to advance sustainability measures. Many of these incentives apply to the heating transition. This section summarizes key mechanisms at each level of governance, and Item IV in the Appendix lists specific funding mechanisms in more detail.

National Level: The National Green Fund supports various sustainability initiatives. The Specific Benefit (SpUk) program supports regional collaboration around sustainability, while the CDOKE program builds municipal governments' capacity for implementing sustainability initiatives. In addition, green banks have been created to access low-interest financing for clean energy projects through the Green Projects Regulations.

- **Tax Schemes:** The Dutch government has created tax schemes that allow businesses and residents to allow for greater savings when investing in clean energy technology. This applies on a national level, serving all Dutch residents. The following are examples of how these are used:
  - Environmental investment deduction (MIA) and Arbitrary depreciation of environmental investments (Vamil) tax scheme allows entrepreneurs to invest in environmentally friendly assets and technologies with tax benefits.
  - The Energy Investment Allowance (EIA) tax scheme enables entrepreneurs to deduct investment costs for implementing energy-efficient solutions.
  - A reduced value added tax (VAT) rate of 9% is offered for insulating, painting, plastering, and wallpapering homes older than two years.[201]
- **Loans & Mortgages:** The Dutch government offers various loans and mortgages to encourage homeowners to invest in sustainability measures.
  - For example, one program offers a loan based on the surplus value of the home, while another loan serves owners without enough borrowing space.[202]
- **Subsidies:** Subsidies are available from various sources, including types nationwide for business initiators, social real estate owners, and contractors for insulation improvements. The government plans to provide $2.13 billion USD to $4.34 billion USD in subsidies.[203]

201. Netherlands Enterprise Agency, accessed April 24, 2024, https://english.rvo.nl/subsidies-financing/mia-vamil/entrepreneurs.
202. European Investment Bank, "EIB Supports Energy Efficiency Loans to Homeowners in the Netherlands," August 20, 2020, https://www.eib.org/en/press/all/2020-082-eib-supports-energy-efficiency-loans-to-homeowners-in-the-netherlands.
203. "Renewable Subsidies: Balancing Economy and the Environment in the Netherlands and Beyond," Power Technology, accessed April 24, 2024, https://www.power-technology.com/features/renewable-subsidies-balancing-economy-and-the-environment-in-the-netherlands-and-beyond/.

Funding Mechanisms

Provincial Level: Provincial initiatives complement national policies and contribute to the national goals. Provincial subsidies encourage the deployment of heat pumps, geothermal energy, and other low-carbon heating technologies. They are typically open to individuals, businesses, community organizations, and local governments.[204] Some notable funding examples include:

- The province of Overijssel has implemented a subsidy mechanism for local low-carbon energy initiatives, with a total budget of $1.33 million USD.[205] This subsidizes high-risk commercial projects in different development phases to allow them to access funds during development.
- The provincial government of Fryslân has supported local low-carbon energy initiatives (LLCEIs) by creating a subsidy scheme with a budget of just over $2,600 USD for start-up capital per project to benefit around 40 LLCEIs.[206]

Municipal Level: Certain well-resourced municipalities provide their own subsidies for the heating transition. Unlike provincial governments, which operate at a larger scale and focus on regional priorities, municipal governments have the capacity and authority to ensure that funding is impactful on the ground and addresses community needs, such as working with local companies and citizens to develop and support on-the-ground subsidy administration and program development for energy efficiency technology upgrades.

204. Government of Netherlands, accessed April 24, 2024, https://www.government.nl/.
205. US International Trade Agency, "Netherlands Energy," accessed April 24, 2024, https://www.trade.gov/country-commercial-guides/netherlands-energy?_gl=1*v6wg8v*_gcl_au*MTExNjM0MDQyOS4xNzA5NjEzMDcx.
206. US International Trade Agency, "Netherlands Energy," accessed April 24, 2024, https://www.trade.gov/country-commercial-guides/netherlands-energy?_gl=1*v6wg8v*_gcl_au*MTExNjM0MDQyOS4xNzA5NjEzMDcx .

The Netherlands Case Studies

Amsterdam, The Netherlands

Source: Gettyimages, *Amsterdam*

Amsterdam, The Netherlands

Population: 873,338 (2021)	**Level of Urbanization:** High
Buildings: Dense; Mixed Age/Use	**Households in Poverty:** 20%[207]
Heating Decarbonization Goal: Natural-gas-free by 2040	
Heating Fuel Type Distribution: 74% natural gas, 16% district heating, 6% block heating, 1% all-electric, 3% unknown (2020)	

Key Takeaways:

- Hired an external consultant to lead a top-down planning process, leveraging modeling with some stakeholder input
- Slow progress in implementing the heating transition plan due to: (1) lack of legal and funding authority; (2) stakeholder resistance
- City's main implementation strategies are to coordinate "enthusiastic" stakeholders and provide them technical assistance
- Transition plan overemphasizes district heating, failing to anticipate major practical and financial challenges

207. "Policy: Income," City of Amsterdam, accessed April 11, 2024, Link to downloaded report

INTRODUCTION

Aside from its urbanization and population density, Amsterdam's climate ambition sets it apart from other Dutch municipalities. In 2017, the city set a goal to be natural-gas-free by 2040, which is ten years earlier than the national target. Amsterdam's municipal government has established a heat transition team of about 50 employees to lead the city's heat transition. The team has two major responsibilities: 1) overseeing the development and updating of the city's heating transition plan; and (2) engaging with major heat transition stakeholders to implement that plan.

Pursuant to its climate targets and the Dutch Climate Agreement, the heat transition team hired a consultant in to create a Heating Transition Vision (TVW) by 2020. The plan makes non-binding recommendations around the optimal heating solution and deployment timeframe for each of Amsterdam's 481 districts, including that Amsterdam decarbonize and significantly expand its district heating network. It also recommends local heating networks, all-electric solutions, or low-carbon gas for the 44% of buildings that would not be connected to district heating.

The city also published its first Amsterdam Climate Neutral 2050 roadmap in 2020,[208] which is monitored annually and proposes near- and long-term municipal decarbonization initiatives across four sectors: the built environment, mobility, electricity, and industry (including ports). It released its TVW the same year, which elaborates on the "built environment" section of the roadmap.

Updates to the initial roadmap indicate that progress in the built environment has been slower than anticipated (e.g., language around the timeframes and impacts of key initiatives has been gradually pared back), as later sections will explore.

Local Context

Amsterdam is the Netherlands' nominal capital and largest city,[209] with a population of over 870,000 as of 2021.[210] It is a flat and low-lying city off of the country's Northwestern coast, with man-made canals that facilitate its role as a major trading hub.[211] It has the seventh largest gross domestic product out of all European cities, due not only to its role in international trade but also its large consulting, information, medical, banking, and insurance industries.

Building Stock

Amsterdam has a mix of old, historic buildings (mostly constructed after World War II) and newer buildings across over 480 districts, or neighborhoods.[212] Its older buildings are concentrated in the center of the city, while the newer ones are more widely dispersed outside of the "ring road," a large circular motorway that divides the city.[213] The city has around 650,000 "housing equivalents,"[214] of which around 450,000 are residential dwellings.[215] Most residential buildings are multi-family homes, given the city's density. Private homeowners own 29% of the city's homes, private landlords own and rent out 31%, and housing corporations own the remaining 40%. Most housing corporations are social housing corporations, meaning that they serve low-income residents.

208. City of Amsterdam, New Amsterdam Climate: Roadmap Amsterdam Climate Neutral 2050, 2020. Link to downloaded report (accessed February 20, 2024).
209. Michael J. Wintle, Evert Werkmen, and Paul F. Vincent, "Amsterdam," last modified April 7, 2024, link to download
210. Going Dutch?, Amsterdam, University of Sussex, n.d. Link to downloaded report (accessed February 4, 2024).
211. Michael J Wintle, Evert Werkmen, and Paul F. Vincent, "Amsterdam," last modified April 7, 2024, link to download
212. Going Dutch?, Amsterdam, University of Sussex, n.d. Link to downloaded report (accessed February 4, 2024).
213. Kroes, E., Daly, A., Gunn, H. et al. The opening of the Amsterdam Ring Road. Transportation 23, 71–82 (1996). https://doi.org/10.1007/BF00166220
214. City of Amsterdam, Heat Transition Vision, 2020. Link to downloaded report (accessed February 8, 2024).
215. Going Dutch?, Amsterdam, University of Sussex, n.d. Link to downloaded report (accessed February 4, 2024).

When Amsterdam was drafting its Heat Transition Vision (TVW) in 2020, nearly three quarters of the city's buildings were reliant on natural gas.[216] Due to "decisions taken in the past," the city also has a large, privately owned district heating network which served 16% of the city's buildings in 2020.[217][218], Vattenfall, the Swedish company that operates the district heating network, was powering the network's Western region with a waste incineration plant and Eastern region with waste heat from a natural gas power plant. Later sections of this case study will explore the major role that this network could play in Amsterdam's heat transition and barriers to that. Local, small-scale heating networks serve six percent of buildings, one percent of buildings are all-electric, and three percent of buildings have unknown heating sources.

Strategy for Planning the Heat Transition

Given their lack of in-house modeling expertise, Amsterdam's local government hired a consultant, Over Morgen, to lead the development of the TVW. Over Morgen implemented both top-down and bottom-up planning strategies, using techno-economic modeling to identify one solution for each neighborhood with the "lowest social costs" as per the Climate Agreement's requirements, and engaging with key stakeholders to help design the model and ground-truth its results.[219] In addition to its modeling expertise, Over Morgen had proprietary data which they claimed was more accurate and granular than national data.

Techno-economic modeling

Throughout the second half of 2019, Over Morgen developed a model that could use data on the availability and costs of heating technologies to identify an "optimal" alternative to the dominant technology in each neighborhood, defining "optimal" based on results from their initial stakeholder engagement efforts.[220] Over Morgen started with their own proprietary model and combined it with another consultant's model and the Dutch government's open-source model. They relied on data such as: in-house knowledge of investment operating costs for alternative technologies; public data on neighborhoods (e.g., territorial boundaries), buildings (e.g., density, ownership, age, function), energy prices, and energy taxes; and energy network operators' data on energy consumption and prices.

Their model prioritized solutions with the "lowest social costs," defined in terms of their economic costs rather than the social costs of greenhouse gas (GHG).[221] It also considered the local availability of alternative heat sources, the GHG impact of solutions, existing and planned infrastructure in the district, and "nuisance" or disruptions that the solution might cause to residents. Finally, it planned district-level heat transition timelines around "natural moments" where heating solutions could be deployed as part of broader building upgrades (e.g. when natural gas boilers retire).

216. City of Amsterdam, Heat Transition Vision, 2020. Link to downloaded report (accessed February 8, 2024).
217. Amsterdam civil servant in discussion with the author, March 2024.
218. City of Amsterdam, Heat Transition Vision, 2020. Link to downloaded report (accessed February 8, 2024).
219. Going Dutch?, Amsterdam, University of Sussex, n.d. Link to downloaded report (accessed February 4, 2024).
220. Going Dutch?, Amsterdam, University of Sussex, n.d. Link to downloaded report (accessed February 4, 2024).
221. Going Dutch?, Amsterdam, University of Sussex, n.d. Link to downloaded report (accessed February 4, 2024).

Stakeholder engagement

To engage major businesses and coalitions involved in the heat transition, Over Morgen convened a working group that would provide input throughout the process.[222] The working group included: (1) Liander, the gas and electricity network operator; (2) the Amsterdam federation of housing corporations; (3) Ymere, a large housing corporation; (4) Vattenfall, the district heating network's operator; (5) Westpoort Warmte, which manages upstream inputs and energy distribution for the district heating network; (6) Waternet, a water company; and (7) !WOON, a citywide association of tenants and homeowners. They also conducted one-on-one interviews with other stakeholders, including housing corporations, large private landlords, and representatives of different municipality departments.

Over Morgen also took many steps to engage the public.[223]In June 2019, they distributed a survey via social media asking the city's residents to provide input on the principles behind the model and on how they wished to be involved. Around 3700 residents responded, most of whom cited affordability as the main principle they would like the model to prioritize. They then held a meeting with a "representative" set of residents to discuss and debate the results of the survey. Over Morgen held two more community meetings in January 2020 after developing and running their financial-technical model — one initial larger one and one smaller follow-up — which assessed residents' responses to the results of the modeling and how easy the results were to understand. That same month, they also sent out another online survey to ask residents how they wanted to be involved in the TVW's implementation.

Results

The TVW combines the results of the model with insights from later stakeholder engagement efforts and recommends an optimal solution for each district, which building owners can adopt (but are not obligated to).[224] It primarily focuses on collective heating, which the model perceived to be more efficient and affordable than upgrading each home separately. The TVW recommends expanding the city's district heating network to serve 56% of the city's residents while switching its heat sources to more sustainable sources like data center waste heat, geothermal energy, and aqua-thermal energy. For densely packed neighborhoods with local heat sources and few building owners (e.g., industrial parks), the plan recommends small-scale "block" heating networks. Finally, the TVW recommends that newer homes become all-electric while older, historical homes (i.e., more expensive to upgrade without disrupting building facades) remain on the gas network, which may eventually switch to renewable gas in the long term.

222. Going Dutch?, Amsterdam, University of Sussex, n.d. Link to downloaded report (accessed February 4, 2024).
223. Going Dutch?, Amsterdam, University of Sussex, n.d. Link to downloaded report (accessed February 4, 2024).
224. Going Dutch?, Amsterdam, University of Sussex, n.d. Link to downloaded report (accessed February 4, 2024).

Strategy for Implementing The Heat Transition

Given that the city does not have the legal or political authority to require building owners to transition their heating infrastructure, progress in implementing the TVW has not kept pace with the city's goal to phase out natural gas in 650,000 home equivalents by 2040. In recent weeks, some elected officials have called for the city to reconsider this goal. Only around 6,000 homes decarbonized their heating systems between 2020 and 2023,[225] and around 35,000 homes took energy saving measures between 2022 and 2023.[226] Around 19,000 housing equivalents (three percent of Amsterdam's building stock) connected to the district heating network between 2019 and 2023, falling behind the TVW's recommendation to connect an additional 40% of the building stock to district heating.

To persuade building owners to transition in the absence of standards, the TVW recommends "affordable" heating solutions that homeowners can deploy at "natural moments."[227] However, affordability is difficult to assess in the planning stage. Techno-economic models may not reflect perceived or actual end-user costs, due to insufficient mechanisms for validating data[228] or price volatility from economic crises or energy providers' decisions around tariff structures.[229] The city does enforce national standards (e.g., by issuing building permits), but these largely apply to new buildings (e.g., prohibition on connecting new buildings to the gas network; energy neutrality standards for new buildings).[230] Its main tools for encouraging existing buildings to transition are subsidies and technical assistance, both of which are explored below.

Districts with "enthusiastic" stakeholders who qualify for subsidies have led the implementation of Amsterdam's TVW.[231] This began with PAW-funded pilot projects in two districts, one in which a housing corporation owned the majority of homes, and another in which a residential cooperative formed to locally sourced heating solution.[232] The housing corporation received over $6.39 million USD to insulate homes and connect them to district heating during building renovation projects, yielding complaints from residents in the neighborhood that they were not consulted enough in the process and that the district heating "monopoly" would raise their energy prices. The residential cooperative took a more bottom-up approach, exploring various heating solutions in collaboration with housing companies, utilities, and homeowners' associations, before receiving $8.52 million USD to construct a small-scale aquathermal heating network.

Now, 50 "City Deal" districts are working with the municipal government to draft plans for implementing the TVW's recommendations, in an initiative that is now called "Warm Amsterdam."[233] City Deals are cooperative agreements between public entities, private entities, and non-profits within a city to achieve a certain goal.[234] [207] Participants in Amsterdam's City Deal to phase out natural gas designated these 50 districts as ripe for the transition, and most housing corporations were initially enthusiastic to connect to the district heating network.[235]

225. Amsterdam civil servant in discussion with the author, March 2024.
226. City of Amsterdam, Climate Report 2023: Progress in reducing CO2 emissions in the city, 2023. Link to downloaded report (accessed February 20, 2024).
227. City of Amsterdam, Heat Transition Vision, 2020. Link to downloaded report (accessed February 8, 2024).
228. Herreras Martínez, Sara, Robert Harmsen, Marijke Menkveld, André Faaij, and Gert Jan Kramer. "Municipalities as Key Actors in the Heat Transition to Decarbonise Buildings: Experiences from Local Planning and Implementation in a Learning Context." Energy Policy 169 (October 2022): 113169. https://doi.org/10.1016/j.enpol.2022.113169. Link to downloaded article.
229. Zoelen, Bart van. "Costs Too High: Housing Associations No Longer Connect Houses to the Heating Network." Het Parool, March 15, 2024. https://www.parool.nl/amsterdam/kosten-te-hoog-woningcorporaties-sluiten-geen-huizen-meer-aan-op-warmtenet~be26fb8e/. Link to downloaded article.
230. City of Amsterdam, New Amsterdam Climate: Roadmap Amsterdam Climate Neutral 2050, 2020. Link to downloaded report (accessed February 20, 2024).
231. Amsterdam civil servant in discussion with the author, March 2024.
232. Going Dutch?, Amsterdam, University of Sussex, n.d. Link to downloaded report (accessed February 4, 2024).
233. Amsterdam civil servant in discussion with the author, March 2024.
234. "City Deals." Agendastad, December 4, 2023. https://agendastad.nl/city-deals/. Link to downloaded page.
235. Going Dutch?, Amsterdam, University of Sussex, n.d. Link to downloaded report (accessed February 4, 2024).

Social housing corporations, which serve around 60% of the residents in these neighborhoods,[236]initially sought to do so in line with an agreement between the city, heat companies, and housing corporations to progressively connect 1,100 low-income homes to the network.[237] However, obstacles to district heating have paused Warm Amsterdam in recent months. The following section will explore these obstacles in further detail.

Amsterdam has limited funding to incentivize building owners to transition and is thus lobbying the Dutch government for additional funds.[238]The two main sources of funding for Warm Amsterdam are the Amsterdam Climate Fund (AKEF) and the Heat Networks Investment Grants (WIS).[239] Private fund managers run AKEF, a municipal financing mechanism which provides large subordinated loans ($532K - 5.3 million USD) to high-risk, commercial sustainability projects at a minimum interest rate of 8%.[240] Very few funds remained in AKEF at the end of 2023, prompting the city's plans to replace AKEF with grant funding from WIS.[241] These funds will cover some of the costs that network operators and building owners face in expanding and decarbonizing district heating,[242] but they cannot assuage residents' fears about future energy prices from district heating networks. Applications for WIS grants ended in December 2023, and an extension of this policy is uncertain under the Netherlands' current right-wing government.[243]

The city is using technical assistance in an attempt to cover the large gap between the subsidies at their disposal and the resources needed to implement the TVW's recommendations.

To help cultivate their heating transition expertise, the municipal government collaborates with consultants and local academics, and they also conduct dedicated research around key areas of importance for stakeholders. For example, the city analyzed the practicality and feasibility of alternative energy sources for the district heating network. They also created scenarios to chart future heat demand and heating network needs to inform plans to expand district heating.

One category of technical assistance is focused on providing expertise and coordination assistance to major, "enthusiastic" stakeholders. In addition to supporting the creation of district-level implementation plans, they are working with Vattenfall and Westpoort Warmte to expand and decarbonize district heating, and with Liander to prepare for increased strain on the electric grid from home electrification. Vattenfall is moving slowly to build out their subsurface infrastructure, and most of the 19,000 home equivalents that have connected to its network are new buildings rather than existing ones which need to decarbonize.[244] The waste incineration plant which powers the Western region of Vattenfall's network has chosen to install carbon capture and storage (CCS) using a national subsidy. Vattenfall explored the option of transitioning the Eastern region of the network to bioenergy, but they scaled these plans back following residents' pushback around the sustainability of bioenergy.[245] They are now working with the city to explore alternative sustainable energy sources, including geothermal energy and data center waste heat,[246] which are promising but cannot escape the price concerns and investment risks around district heating which the next section will explore.[247]

236. Amsterdam civil servant in discussion with the author, March 2024.
237. City of Amsterdam, New Amsterdam Climate: Roadmap Amsterdam Climate Neutral 2050, 2021. Link to downloaded report (accessed February 20, 2024).
238. City of Amsterdam, New Amsterdam Climate: Roadmap Amsterdam Climate Neutral 2050, 2021. Link to downloaded report (accessed February 20, 2024).
239. Amsterdam civil servant in discussion with the author, March 2024.
240. "C40 Good Practice Guides: Amsterdam – Sustainability Fund and Amsterdam Climate & Energy Fund," C40 Cities, November 2016, link to downloaded page
241. City of Amsterdam, Climate Report 2023: Progress in reducing CO2 emissions in the city, 2023. Link to downloaded report (accessed February 20, 2024).
242. "Heat Networks Investment Subsidy (WIS)," Netherlands Enterprise Agency, April 17, 2023, https://business.gov.nl/subsidy/heat-network-investment-subsidy-wis/
243. Amsterdam civil servant in discussion with the author, March 2024.
244. City of Amsterdam, Climate Report 2023: Progress in reducing CO2 emissions in the city, 2023. Link to downloaded report (accessed February 20, 2024).
245. Amsterdam civil servant in discussion with the author, March 2024.
246. City of Amsterdam, New Amsterdam Climate: Roadmap Amsterdam Climate Neutral 2050, 2020. Link to downloaded report (accessed February 20, 2024).
247. Zoelen, Bart ban. "A boost for plans with a heating network: Amsterdam's soil is suitable for geothermal energy." Het Parool, April 10, 2024. Link to downloaded article.

Finally, the city provides various forms of guidance and information to a broader set of stakeholders. It has conducted public outreach to encourage individual homeowners to upgrade their heating infrastructure. Through an "Insulation Offensive" initiative, the city sent pamphlets about the benefits of insulation to households across Amsterdam. They also funded a truck which drove around the city to model certain low carbon heating solutions (e.g., heat pumps, induction stoves), helping residents understand what it would look like to transition their homes. The city also publishes information for residential and commercial building owners online (e.g., New Amsterdam Climate Online Platform and sustainability guide, or Duurzame Wegwijzer) and offers more tailored energy consultations and process guidance to individuals, housing corporations, and small businesses.[248]

Challenges

Slow Pace of the Heat Transition

Like in other Dutch cities, Amsterdam is moving much more slowly than the national or municipal government imagined they would. Despite the significant administrative resources at the city's disposal (e.g., to hire consultants; to provide technical assistance based on in-house expertise), the city does not have the legal or funding authority necessary to create a positive business case for building owners to invest in transitioning their heating sources. The city's outsized focus on CO2 emissions over practical challenges in the early stages of planning the heat transition likely intensified those challenges as implementation began.

Moreover, the uncertain market and policy context around the heat transition has increased the complexity of an already complex planning process.

Public Pressure Against District Heating

In recent weeks, obstacles to district heating have paused Warm Amsterdam. Although housing corporations promised tenants that they would not experience energy price increases after connecting to the district heating network, tenants experienced major price increases in recent months. Not only are variable costs from district heating higher in the Netherlands than in other European countries due to Dutch price-structuring norms, but Vattenfall raised the annual fixed costs of connecting to the network by $212 USD this year, a 30% increase over fixed costs in 2023.[249], [250] In response to residents' protests, housing corporations are refusing to connect to the network and are shifting their focus to insulation and electrification upgrades.[251] Uncertainty around the potential passage of the Dutch Collective Heat Supply Act (Wcw) has also paused municipal efforts to expand district heating. To encourage insulation and electrification, the city is conducting targeted outreach to owner-occupier associations and facilitating cooperative agreements between housing corporations and tenants.[252]

248. City of Amsterdam, New Amsterdam Climate: Roadmap Amsterdam Climate Neutral 2050, 2021. Link to downloaded report (accessed February 20, 2024).
249. Zoelen, Bart van. "Costs Too High: Housing Associations No Longer Connect Houses to the Heating Network." Het Parool, March 15, 2024. https://www.parool.nl/amsterdam/kosten-te-hoog-woningcorporaties-sluiten-geen-huizen-meer-aan-op-warmtenet~be26fb8e/. Link to downloaded article.
250. Zoelen, Bart van. "Why is district heating in the Netherlands so much more expensive than in other Western European countries?" Het Parool, April 3, 2024. https://www.parool.nl/amsterdam/waarom-is-stadsverwarming-in-nederland-zoveel-duurder-dan-in-andere-west-europese-landen~b5e3c36f/. Link to downloaded article.
251. Zoelen, Bart van. "Why is district heating in the Netherlands so much more expensive than in other Western European countries?" Het Parool, April 3, 2024. Link to downloaded article.
252. City of Amsterdam, Climate Report 2023: Progress in reducing CO2 emissions in the city, 2023. Link to downloaded report (accessed February 20, 2024).

Municipality's Limited Political Authority & Funding

Amsterdam cannot easily get building owners, residents, and energy providers on board with the heating transition, or with specific heating transition plans, without greater authority and funding schemes from the national government. Since 2021, the city has been lobbying the Dutch government for more funding earmarked for the heat transition (e.g., subsidies for sustainable heat sources, state co-financing initiatives), for the enhancement of national incentives (e.g., raise the existing energy tax, maintain the carbon tax on industry), and for key municipal authorities (e.g., require gas disconnections when alternative options exist, require installation of solar panels on large, private roofs).[253] The Dutch Climate and Energy Minister does plan to sit down with the Amsterdam government to discuss a path forward on district heating,[254] and Dutch legislators are currently debating a new policy that would provide municipalities dedicated funding for the heat transition.[255]

Cost and Feasibility Challenges to Expanding & Decarbonizing District Heating

Finally, Amsterdam has faced major obstacles to expanding and decarbonizing their heating network. Vattenfall has experienced technical challenges in conducting feasibility studies for building out the network, given the need to navigate around existing subsurface infrastructure (e.g., telecommunications networks), and low demand for district heating (e.g., due to residents' concerns about prices), has limited resources they can spend on its expansion.[256]

Moreover, the adoption of CCS in the Western region of the network does not align with guidance from the national government to prioritize renewable energy sources.[257] The city's efforts to research sustainable heating sources for the Eastern region may bear fruit, but the implementation of research findings will face practical and financial challenges, especially given the relative nascency of technologies like geothermal energy. This is especially surprising given that waste heat from data centers could theoretically provide up to 30% of the city's heat needs.[258]

Proposed Solutions & Recommendations

Plan for a Gradual Heat Transition

Amsterdam's experience demonstrates the need for municipalities to take a slower, more bottom-up approach to planning their heat transition. If municipalities cannot require building owners to transition, and if the state or federal governments do not offer enough funding to change the business case for sustainable heating solutions, municipalities' guidance around the heat transition will not persuade enough stakeholders to transition. While certain building owners (e.g., housing corporations) may be enthusiastic to transition, they cannot easily do so without buy-in from their tenants, who will experience the burden of high energy costs. Forums (e.g., online town halls, information sessions) that sincerely address tenants' concerns about post-transition energy prices may be one avenue through which NYS could facilitate successful heat transition projects in such a context.

253. City of Amsterdam, Climate Report 2023: Progress in reducing CO2 emissions in the city, 2023. Link to downloaded report (accessed February 20, 2024).
254. Bunschoten, Stefan, and Lotte Rigter. "Minister Jetten Looked 'with Some Surprise' at the Urgent Letter about the Heating Network, but Will Discuss It." Echt Amsterdams Nieuws, April 10, 2024. Link to downloaded article.
255. "Municipal Instruments Heat Transition Act." Tweede Kamer der Staten-Generaal, March 28, 2024. https://www.tweedekamer.nl/kamerstukken/plenaire_verslagen/kamer_in_het_kort/wet-gemeentelijke-instrumenten-warmtetransitie/. Link to downloaded page.
256. Amsterdam civil servant in discussion with the author, March 2024.

Real-World Validity of Models

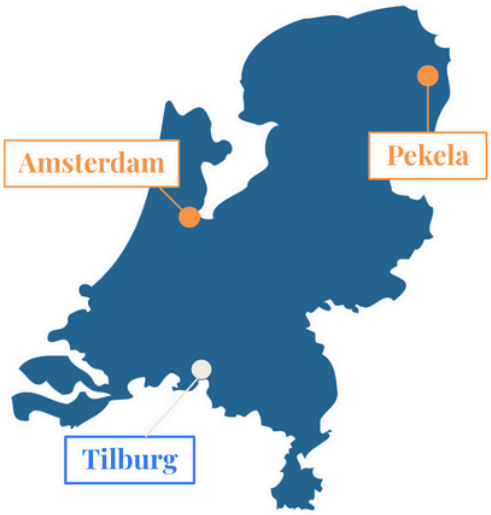
NYS may also consider cautioning municipalities against over-reliance on techno-economic modeling, which does not always reflect the actual costs to end-users (i.e., residents), whose buy-in is critical for the heat transition. Modeling does provide an efficient starting point for cities like Amsterdam which face a diverse range of challenges and opportunities in the heating transition. NYS could support cities in developing more robust models by offering open-source data for those models and technical assistance around model design. Technical assistance may include guidance around meaningfully engaging residents in model design (e.g., providing resources for residents to understand technical aspects of the model; highlighting issues that may be of importance to residents; ensuring residents understand the implications of the model's results; encouraging municipalities to sincerely listen to residents' concerns rather than persuade residents). Models which identify current and future end-user costs (i.e., district heating tariffs) and specify the uncertainty around these figures (e.g., to assuage concerns about crisis-related price spikes), are most likely to lead to feasible recommendations. Models may also be more successful if they identify multiple optimal solutions per neighborhood where possible, given the diversity of buildings and residents within even one neighborhood.

Anticipate Practical Obstacles to District Heating

NYS may also choose to caution municipalities against over-relying on district heating, even if models recommend it.While collective heating solutions seem more efficient for decarbonizing heating systems, they face four challenges: (1) they are practically challenging to construct, requiring extensive coordination with operators of other subsurface infrastructure; (2) local sustainable heating sources tend to be early-stage energy solutions which are high-risk and expensive; (3) residents will be reluctant to connect to district heating (especially privately owned networks) in the absence of a regulatory framework to control prices; and (4) district network operators will not invest in constructing or expanding heating networks unless all households in a neighborhood agree to connect. In addition to informing cities of these challenges, NYS can build cities' capacity to overcome them (e.g., by coordinating operators of subsurface infrastructure; by creating the necessary regulatory frameworks).

Targeted Implementation Efforts & Technical Assistance

Finally, cities with a dense and diverse building stock may benefit from incorporating some of the heat transition strategies that Amsterdam has implemented. One strategy is to begin the transition in key neighborhoods with a critical mass of "enthusiastic" stakeholders (i.e., housing associations, energy network operators, residents), forming cooperative agreements to understand the opportunities and challenges, and extracting lessons and knowledge that can apply to other neighborhoods. The state could offer guidance to cities around meaningfully engaging both residents who are enthusiastic to transition and those who are hesitant. The state could also support municipalities' capacity to provide technical assistance to local stakeholders by connecting them with external experts (e.g., academia, consultants) or offering them resources to enhance their in-house expertise. Finally, if the state cannot provide sufficient funding for the heat transition, they may choose to encourage municipalities opportunities to transition heating systems when costs will be lowest, including during renovations or upgrades that building owners have already planned and obtained some funding for.



Tilburg, The Netherlands

Source: Expedia, *Tilburg, the Netherlands*


Source: Living in Holland

Tilburg, The Netherlands

Population: 222,601 (2021)	**Level of Urbanization:** Urban
Buildings: Mix of historic and modern. Two-thirds are single-family.	**Affluence/Fuel Poverty:** Poor

Heating Decarbonization Goals:
49% reduction in GHG emissions by 2030; Climate neutrality by 2045; full phase-out of natural gas in residential buildings by 2045.

Heating Fuel Type Distribution: 95% of homes heated through individual natural gas boilers; 2% of homes heated through electricity.

Key Takeaways:

- Tilburg TVW highlights a district-oriented approach that has gained notable support from residents.
- The Quirijnstok district in Tilburg participated in a pilot project that received a $4 million USD grant from the Programma Aardgasvrije Wijken (PAW) in 2018.
- The success of the heat transition vision depends on effective stakeholder engagement, although ongoing collaboration is currently a challenge.

INTRODUCTION

Tilburg is a major city in the southern region of the Netherlands, with a population of 222,601.[259] The city has transformed from a small village into a bustling industrial center in the last two centuries, first known for its woolen textiles before diversifying into other industries like food processing, printing, and manufacturing.[260] Its location along a central canal has facilitated economic growth and cultural diversity. The municipality developed a Heat Transition Vision (TVW) in 2021, focusing on low-emission and low-cost heating due to its climate targets and the Dutch Climate Agreement.[261] The first draft of the TVW was developed in April of 2021. This city-wide vision was based on engagement campaigns that allowed stakeholders to play an integral role in the TVW development.[262]

Local Context

Tilburg has joined with national and provincial governments in embracing sustainability in recent years. The city sets ambitious climate targets, aiming for a 49% reduction in GHG emissions by 2030 and climate neutrality by 2045, along with a full phase-out of natural gas in residential buildings by 2045. Civil society groups in Tilburg actively promote sustainable energy and energy-saving initiatives, with the presence of five energy cooperatives. The city's participation in the Social Innovation Labs for a Zero Energy Housing Stock (SMILE) project from 2017 to 2020 further underscores its commitment to citizen engagement and area-based decarbonization solutions.[263]

SMILE is centered in finding solutions to achieve energy neutrality in neighborhoods through learning-by-doing and collaboration amongst regional and local stakeholders.[264] With a unique building stock, diverse energy dependencies, and active civil society groups, Tilburg may offer important lessons for a wide range of municipal heating transitions.

Building Stock

Tilburg's building stock includes a mix of historical and modern structures, with 16.4% of homes built before 1945 and 16.2% constructed after 2005. Nearly two-thirds of its homes are single-family and the rest are multi-family.[265] Additionally, there is an equal distribution of owner-occupied and rental properties. Housing associations own 65% of rental residences, setting the stage for collaborative partnerships between the municipal government and housing associations to advance the heating transition.[266]

The city's energy landscape is as diverse as its building stock. Only 59% of its homes relied on individual natural gas boilers in 2021, the lowest proportion among our Dutch case studies.[267] In Tilburg, block heating makes up 5% of heating technologies while electricity makes up 3%, and there is no data on the remaining 5% of homes.[268] The city also relies heavily on district heating, with 28% of homes connected to the district heating network, a significantly higher proportion than the national average of around 7%.[269] This network, known as the Amernet heat network, serves Tilburg and several surrounding municipalities, providing heat to 51,000 households and 355 companies.[270]

259. "Tilburg, Netherlands - Intercultural City - Intercultural Cities Programme - Www.coe.int," Intercultural cities programme, Council of Europe Portal, 2024, https://www.coe.int/en/web/interculturalcities/tilburg.
260. Radboud University Nijmegen, "PDF Hosted at the Radboud Repository of the Radboud University Nijmegen," Radbound Repository , 2024, https://repository.ubn.ru.nl/bitstream/handle/2066/145859/mmubn000001_187489424.pdf?sequence=1.
261. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview_ref.pdf.
262. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview_ref.pdf.
263. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview_ref.pdf.
264. "Tilburg University Magazine," Tilburg University, April 23, 2024, https://www.tilburguniversity.edu/magazine.
265. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview_ref.pdf.
266. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview_ref.pdf.267. "Energy Transition," ENEXIS, 2024, https://www.enexis.nl/energietransitie.

Strategy for Planning the Heat Transition

To develop its TVW, Tilburg assembled a steering committee and working groups comprising a diverse range of stakeholders, including housing associations, tenant organizations, the electricity and gas network operator Enexis, the business community, Tilburg University, and the city councilor. These stakeholders collaboratively developed a first draft of the TVW in April 2021.[271]

Municipal policy officers and heat transition advisors led the development of the TVW, relying on specialized knowledge from external energy experts and consultants. Consultants played a key role in various aspects of the heat transition vision, including data modeling, participation approaches, and financial strategy development.[272]

Data has been pivotal in Tilburg's planning process, obtained from sources such as the Regional Climate Monitor for CO2 emissions data, Enexis for energy consumption and infrastructure data, and the Dutch Central Bureau of Statistics. However, the absence of certain data, such as gas grid connection details, presents a challenge for precise planning.[273]

Tilburg also incorporated public input in the TVW, taking a two-pronged approach to citizen engagement. They leveraged the Tilburger Tafel, a citizen assembly of 20 representative Tilburg residents, to offer diverse perspectives in a collaborative manner.[274] They also leveraged a "Digital Dialogue," a platform to gather citizen's insights and spatially map responses. A total of 1,500 residents responded to the survey. [275] This approach helped the municipality tailor the TVW to citizen needs across specific districts.[276]

The district-oriented approach is central to the TVW receiving widespread support from Tilburg residents. The approach focuses on making a transition to decarbonize heat technologies in neighborhoods while addressing apprehensions from residents voiced in the Digital Dialogue survey. Through the Digital Dialogue survey, 66.4% of the respondents endorsed a district heating approach to decarbonize heat.[277] The feedback emphasized the importance of property value increases, the need for financial solutions, and the prioritization of decarbonizing older homes. The municipal government formally adopted the TVW in December 2021 and will review it every two years to ensure flexibility and adaptability to the practical challenges of the heat transition.

Heat Decarbonization & Natural Gas Phase Out

Tilburg's TVW is underpinned by the goal of decarbonizing heat and phasing out natural gas in the residential sector by 2045, aligning with its net-zero target.[278] There are three distinct categories that the city is targeting to execute the vision: the age of the building stock, building density, and existing infrastructure.

The northwest part of the municipality, connected to the Amer heat network, aims to reduce reliance on the Amer power plant and transition to more sustainable heat sources, such as geothermal energy. The municipality of Tilburg encompasses about 103,930 residential homes that will potentially use district heating as a way to lower emissions and further achieve a green heat supply.[279] Areas with high building density will focus on building or expanding heat networks, and exploring local heat sources and storage solutions.

268. "Energy Transition," ENEXIS, 2024, https://www.enexis.nl/energietransitie.
269. "Energy Transition," ENEXIS, 2024, https://www.enexis.nl/energietransitie.
270. "Energy Transition," ENEXIS, 2024, https://www.enexis.nl/energietransitie.
271. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview_ref.pdf.
272. Tijs van & Robert Kint Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024
273. Tijs van & Robert Kint Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024
275. Tijs van & Robert Kint Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024
276. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview_ref.pdf.
277. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview_ref.pdf.

The approach for areas with low building density in the northeast will be determined post-2030, with a focus on home insulation. Approximately 40 years ago Tilburg made significant investments in the municipality district heating network.[280] Today, nearly 28,000 households and 300 businesses are connected to the municipality's current district heating network which has ultimately contributed to the greening of existing buildings.[281] However, to achieve climate neutrality by 2045, the municipality must consider other technologies. The city center will prioritize individual hybrid heat pumps to reduce natural gas usage, while the south will explore fifth-generation heat and cold networks due to the absence of existing district heating.[282]

Within these zones, the municipality has begun to develop plans for each district, starting with areas near existing heat networks and those with upcoming renovation or new construction projects.[283] To ensure the heat transition is equitable, the vision emphasizes cost neutrality by ensuring that the increase in rental costs for homeowners do not exceed energy bill savings.[284]

Strategy for Implementing the Heat Transition

Tilburg has actively pursued a heat transition pilot to test and implement sustainable heating solutions. One notable example is the Quirijnstok district, which received a grant of $4.05 million USD from the Programma Aardgasvrije Wijken (PAW) in 2018[285]. This pilot focused on terraced houses heated through a high-temperature heat network using the Amer power plant. The project emphasized insulation measures and provided homeowners with tailored energy advice through a sustainability broker that informed residents on sustainability strategies. The Quirijnstok district is made up of owners' associations (VVE) which consist of residents in different neighborhoods throughout the district.[286] The owner associations allow for common decisions to be made amongst residents as it relates to management and maintenance.[287] A notable neighborhood and owners association is VVE Mozartlaan which had the most success in the municipality's push to make 500 homes gas-free. [288]

Tilburg has taken steps towards a heat transition, which is seen through the Quirijnstok Gas-Free Neighborhood Pilot Project[289]. Launched in 2018, the project set its targets to make existing homes gas-free by the end of 2022. While the original goal of 500 gas-free homes was not met, substantial progress has been made, along with valuable insights and experiences for future efforts.[290]

The project encountered significant challenges due to the COVID-19 pandemic, resulting in unavoidable delays.[291] However, these obstacles spurred innovative solutions. The team improved their marketing efforts through the use of social media and distribution of neighborhood newspapers to maintain effective communication with residents.[292] Despite setbacks, the project achieved key milestones. Notably, the completion of gas-free homes in the VVE Mozartlaan (256 apartments), and the introduction of a sustainability facilitator role, filled by Maaike Wolfs. Wolfs successfully engaged residents, offering valuable energy advice and guidance.[293]

278. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview_ref.pdf.
279. "Data.europa.eu," European Union, 2023, https://data.europa.eu/data/datasets/basisregistratie-adressen-en-gebouwen-bag-?locale=en.
280. Except Integrated Sustainability , "Visiebrochure_doorontwikkeling_WNT," Verduurzaming warmtenet Tilburg, 2013, https://except.eco/documents/75/Visiebrochure_doorontwikkeling_WNT_v12_web.pdf.
281. Except Integrated Sustainability , "Visiebrochure_doorontwikkeling_WNT," Verduurzaming warmtenet Tilburg, 2013, https://except.eco/documents/75/Visiebrochure_doorontwikkeling_WNT_v12_web.pdf.
282. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview
283. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview
284. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview
285. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview
286. "Wat Houdt Een Vereniging van Eigenaars (VvE) In? - Rijksoverheid.nl,"Ministerie van Algemene Zaken, August 13, 2019, https://www.rijksoverheid.nl/onderwerpen/huis-kopen/vraag-en-antwoord/wat-houdt-een-vereniging-van-eigenaars-vve-in.
287. "Wat Houdt Een Vereniging van Eigenaars (VvE) In? - Rijksoverheid.nl,"Ministerie van Algemene Zaken, August 13, 2019, https://www.rijksoverheid.nl/onderwerpen/huis-kopen/vraag-en-antwoord/wat-houdt-een-vereniging-van-eigenaars-vve-in.
288. GEMEENTE TILBURG, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Vervolg Proeftuin Aardgasvrije Wijken Quirijnstok)," 2023.

A key factor in the project's success was engaging a network of local stakeholders passionate about the energy transition. This collaboration increased awareness and knowledge about energy efficiency and sustainability among residents. The neighborhood-based approach was effective and also proved to be replicable, demonstrating the feasibility of transitioning entire communities to gas-free living. This model has set the stage for future initiatives in the city, showing the power of community engagement in driving sustainable change.

The project's success has encouraged the government to extend it until the end of 2026.[294] This extension will allow for the efficient utilization of remaining budget resources to support homeowners and VVEs in their journey towards sustainability.[295] Continuing this initiative will enable further data collection, gathering of valuable insights, and engagement of stakeholders, thereby enhancing our understanding of the challenges and opportunities that come with the energy transition.[296]

Another crucial funding option for Tilburg's municipality is the Decentralized Authorities for Climate and Energy Policy (CDOKE) regulation. This regulation authorizes a significant amount ($1.1 billion USD) to municipalities, available until 2025.[297] The CDOKE funds enable municipalities to hire additional employees and bring in external expertise to strengthen their capacity to fulfill climate and energy-related responsibilities.[298]

By leveraging these funding options and exploring pilot projects and new technologies, Tilburg is actively addressing the financial aspects of its heat transition journey. These funds are essential for supporting the development and implementation of sustainable heating solutions and ensuring the municipality's progress toward its climate goals.

Significant progress has been made in the project, especially in making existing homes gas-free, with notable success in VVE Mozartlaan.[299] The introduction of a sustainability facilitator role was effective in engaging residents and offering tailored support. Additionally, the formation of a network of local stakeholders who are passionate about the energy transition increased community awareness and knowledge.[300] These successes highlight the project's positive impact and potential for future initiatives.

This pilot project provides valuable insights for future projects. Emphasizing community engagement and trust-building is essential, especially when navigating unforeseen challenges. Streamlining decision-making processes within VVEs expedites implementation and ensures timely outcomes. Continuous evaluation and adaptation based on lessons learned will optimize future initiatives' effectiveness.[301] These recommendations provide a framework for enhancing efficiency and resilience in similar projects.

289.GEMEENTE TILBURG, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Vervolg Proeftuin Aardgasvrije Wijken Quirijnstok)," 2023.
290. Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023.
291. Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023.
292. Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023.
293. GEMEENTE TILBURG, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Vervolg Proeftuin Aardgasvrije Wijken Quirijnstok)," 2023.
294. Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023
295. Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023
296. GEMEENTE TILBURG, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Vervolg Proeftuin Aardgasvrije Wijken Quirijnstok)," 2023.
297. "Uitvoeringsmiddelen Voor Gemeenten (CDOKE)," Nationaal Programma Lokale Warmtetransitie, 2024, https://www.nplw.nl/financiering/subsidies+en+regelingen/2587513.aspx?t=cdoke-subsidie.
298. "Uitvoeringsmiddelen Voor Gemeenten (CDOKE)," Nationaal Programma Lokale Warmtetransitie, 2024, https://www.nplw.nl/financiering/subsidies+en+regelingen/2587513.aspx?t=cdoke-subsidie.
299. Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023.
300. Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2
301. Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2

The Quirijnstok Gas-Free Neighborhood Pilot Project is a significant step toward Tilburg's heat transition goals. The insights gained from this initiative establish Tilburg as a leader in the national effort to reduce greenhouse gas emissions and build a sustainable future for its residents on a local level.[302] By leveraging the project's successes and learnings, Tilburg can continue to spread its sustainability initiatives effectively through stakeholder and resident engagement, setting an example for other districts in Tilburg to follow.[303]

The municipality, in partnership with Tilburg University, worked closely with residents to determine the most suitable heat decarbonization approaches.[304] The pilot highlighted the need for additional financial instruments and the importance of homeowner associations and housing associations in facilitating transitions.[305]

Another innovative pilot is the development of a small heat network in the Fabriekskwartier (Factory Quarter). This project explores the use of Piushaven canal water as a heat source, providing heat for approximately 400 homes.[306] The municipality is working with a developer to pilot aqua thermal energy and test the business case and cost structure of the heat network, which will be owned by a residents' cooperative. Initial findings suggest that a cost price model, where costs are included in the price of newly built homes, could save households money on heating bills.

Challenges

Continuing Stakeholder Engagement and Participation

The municipality of Tilburg is facing a few challenges as it transitions to more sustainable heat technologies. Critical challenges highlighted include stakeholder engagement, funding equity, and technical hurdles. Tilburg had much success with citizen engagement endeavors, which yielded positive results; however, continuing stakeholder participation is a remaining challenge. Collaboration throughout the heat transition will be crucial to its success, so constant involvement of stakeholders—including residents, businesses, and community organizations—is essential.[307] The success of the TVW is heavily dependent on the collaboration of stakeholders, including residents, businesses, and community organizations. Achieving consistent engagement with stakeholders has been particularly challenging due to priorities, interests, and levels of awareness. [308]

Equitable Funding Distribution Across Communities

As substantial resources are available for large-scale heat transition projects, the issue of guaranteeing equitable funding distribution across communities arises and can be complex to navigate.[309] Factors such as socio-economic status and access to resources should be considered to avoid further exacerbating current inequities. An inclusive approach to distributing financial resources must be taken when tackling a heat transition in both marginalized and affluent neighborhoods.[310]

302.Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023.
303.Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023.
304.Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023.
305. "Academic Collaborative Center for Climate and Energy," OECD, 2024, https://www.tilburguniversity.edu/collaboration/program-broad-prosperity/climate-and-energy.
306. "Tilburg_interview_ref.pdf," Going Dutch?, 2023, https://static1.squarespace.com/static/618517f3df84155380e5f689/t/63c92f43066bd236f63f9f44/1674129220232/Tilburg_interview_ref.pdf.
307. Tijs van & Robert Kint (Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024
308. Tijs van & Robert Kint (Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024
309. Tijs van & Robert Kint (Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024
310. Tijs van & Robert Kint (Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024

Relative poverty rates range from 11% to 20% across regions in the Netherlands.[311] These rates have contributed to the University of Tilburg creating a zero poverty lab that seeks to mitigate generational poverty.[312]

Implementation of New Heating Technologies

Next, technical hurdles present an obstacle in Tilburg as they begin implementing their TVW. Careful planning is needed to implement new heating technologies. These technical challenges include grid stability, retrofitting buildings, and obtaining permits while staying within regulatory frameworks that present technical hurdles.[313]

Pilot Projects Struggle to Meet Initial Targets

The Quirijnstok Gas-Free Neighborhood Pilot Project, launched in 2018, faced several challenges. Meeting the initial target proved difficult due to technical complexities and unforeseen delays. Engaging residents and building trust required persistent efforts, especially during the COVID-19 pandemic.[314] Additionally, decision-making processes within VvE sometimes posed challenges, resulting in delays in project implementation.[315] Other challenges included technical complexities and delays.[316] Despite these obstacles, the team was able to overcome these difficulties and push the project forward.

Minimizing Financial Burden

Securing funding for the heat transition can also pose a challenge, especially given the concurrent need to establish equity among different socio-economic groups. There should be minimal financial burdens on low-income and marginalized communities concerning implementation, maintenance, and use costs.

Subsidies from programs like the PAW get new heating technologies into marginalized communities by having income-based subsidies. The PAW funds subsidize implementation costs as well. The municipality of Tilburg has autonomy over which neighborhoods they would funnel PAW funds into. Ultimately, these communities should be able to access clean energy solutions to decrease existing inequalities. [317]

Proposed Solutions & Recommendations

Tilburg municipality leaders deem consistent communication with residents essential. Communication can encourage the adoption of clean heat technologies, but will also require transparency about pricing, costs, and benefits. There are complexities in transitioning to more sustainable heat technologies; a learn-by-doing approach works best. This would consist of conducting experiments with pilot projects and analyzing the results. Moreover, using those results to adapt and refine strategies rooted in data and qualitative insight will improve implementation activities. Overall, these insights can enhance the adaptability and effectiveness of the transition efforts in NYS.[318]

Addressing affordability concerns is a step to gain a wide range of support for this transition among citizens.[319] Diverse funding sources can include subsidies, incentives, and low-interest loans to make technologies and solutions that will provide sustainable heating accessible to everyone, even those who face economic hardships and other constraints.[320] A similar approach to funding types and allocation in

311. "Netherlands," OECD, 2022, https://www.oecd.org/regional/NLD-RCG2022.pdf.
312. Zero Poverty Lab: Stopping Generational Poverty" Tilburg University, 2024, https://www.tilburguniversity.edu/research/institutes-and-research-groups/zero-poverty-lab#:~:text=In%20August%202022%2C%20the%20Netherlands
313. Tijs van & Robert Kint (Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024
314. Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023.
315. Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023.
316. Tijs Van, "Continuation of the Quirijnstok Gas-Free Neighbourhood Pilot Project (Aan de Leden van de Gemeenteraad)," 2023.
317. Tijs van & Robert Kint (Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024
318. Tijs van & Robert Kint (Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024

NYS would similarly help to ensure that people from low-income communities can afford to engage in the heat transition.

If subsidies, incentives, and low-interest loans are accessible in NYS to diverse socio-economic groups, equitable access to sustainable heating sources can be achieved.

The municipality of Tilburg has unique, context-specific challenges. Through techniques such as effective communication that allows for buy-in from the residents, and the popularity of the heat district networks utilizing geothermal energy, the municipality displays its strengths as a community. Tilburg's experiences in decarbonizing heat can be leveraged to inform the decision-making process and enhance NYS's adaptability and effectiveness for its own TVW.

319. Tijs van & Robert Kint (Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024
320. Tijs van & Robert Kint (Heat Transition Advisor, Tilburg Municipal Government) in discussions with authors, March 2024

PEKELA, THE NETHERLANDS

Source: B&B de Wiekeborg in Oude Pekela

Source: B&B de Wickeborg in Oude Pekela

Pekela, The Netherlands

Population: 12,404 (2023)	**Level of Urbanization:** Rural
Buildings: Mixed Age; Mostly single-family homes.	**Affluence/Fuel Poverty:** Poor

Heating Decarbonization Goals:
50% reduction in natural gas consumption by 2025;
Implementation/use of all PAW Grant funds in Pekela Geeft Gas! pilot program

Heating Fuel Type Distribution: 95% of homes heated through individual natural gas boilers; 2% of homes heated through electricity (2022).

Key Takeaways:

- Pekela is a living lab for home insulation and electrification; with a PAW-funded pilot program that spans the entire municipality.
- Since 2018, Pekela has spent only a quarter of its PAW grant funds due to homeowner resistance around the costs and disruptive installation of alternative heating technologies and the complexity of applying for subsidies.
- To address stakeholder concerns Pekela is highlighting the human element of the heat transition. Municipal energy coaches and advisors are one solution for educating and guiding residents through the heat transition.

INTRODUCTION

This case study presents a unique example of a federally-funded and municipality-led heat decarbonization pilot program. In the last century, Pekela, a remote municipality in Groningen province, underwent three major transitions. It started as a peat colony, then transitioned to become a natural gas exporter, and finally, became a national example of a sustainable heat transition living lab. To accomplish this, Pekela hired external consultants to draft their TVW per national mandates. The process of developing their plan consisted of a technological feasibility study and associated costs study of sustainable heating solutions.[321]

With the use of federal funds, Pekela launched a local heat transition pilot program focused on working with individual homeowners to plan and implement personal home heat transitions. Pekela has embraced a 'learning by doing' approach and hopes to address decarbonization challenges through human-centered stories and solutions that promote ownership equity and inclusion.

Local Context

Pekela is a small municipality located in Groningen province, situated in the northeastern part of the Netherlands. In 1990, two municipalities—Oude (old) Pekela and Nieuwe (new) Pekela—merged to form modern day Pekela. The municipality has historically been considered one of the poorest in the Netherlands.[322] Major geographic features in the municipality include the river Pekela (Pekel Aa), which runs through the center of the municipality.

Like most municipalities in Groningen province, Pekela has an oceanic temperate climate. At the provincial level, Groningen is home to the largest natural gas field in the Netherlands and in continental Europe.[323] Due to its rich geological fossil fuel supply, Groningen province has experienced a number of human-induced seismic events.[234] Oude Pekela and Nieuwe Pekela were productive peat colonies in the Netherlands before the turn of the century, supplying regional supplies of peat for fuel use. Peat is an accumulation of organic matter that is mined or collected, dried and then burned to be used as an energy heating fuel. It was the main form of residential heating for Pekela and a large portion of the rural provinces of the Netherlands before the discovery and use of coal and later natural gas.[325]

Following a series of damaging earthquakes in 2018, Groningen began to acknowledge the significant seismic risks associated with natural gas extraction. In 2018 a tandem approach to reduce natural hazards and to later reach Climate Plan 2019 sustainable energy goals was announced. Gas extraction in Groningen was phased out in October 2023, exactly 60 years after production started.[327]

Pekela consists of 6 neighborhoods, with each in different stages of the localized heat decarbonization transition. As of 2023, Pekela has a population of about 12,404 with a population density of 255/km2.[328] The population skews older and continues to age without many young families moving in.[329]

321. Going Dutch?, Pekela, University of Sussex, n.d. (Link to downloaded report)
322. Financial Times, Return to Oude Pekela: a Dutch model for resisting the far right https://www.ft.com/content/17665404-3d12-11e8-b9f9-de94fa33a81e.
323. European Gas Hub Editor, Groningen gas field: the end of an era, but the timing is unfortunate, November 2023 https://www.europeangashub.com/groningen-gas-field-the-end-of-an-era-but-the-timing-is-unfortunate.html.
324. Going Dutch?, Pekela University of Sussex, n.d. (Link to downloaded report).
325. Terug in Drenthe "New Worlds: Peat Colony," https://www.terugindrenthe.nl/en/stories/new-worlds/peat-colonies/ (accessed March 25, 2024)
326. Pekela, Netherlands Wikipedia, https://nl.wikipedia.org/wiki/Pekela (accessed February 5, 2024)
327. Dutch National Government, "Gas extraction in Groningen will stop on October 1, 2023," June 23, 2023 Link to National Government Press Release (accessed March 25,2024)
328. Pekela, Netherlands Wikipedia, https://nl.wikipedia.org/wiki/Pekela (accessed February 5, 2024)
329. Municipality of Pekela 2022-2030 Future Vision, Page 20

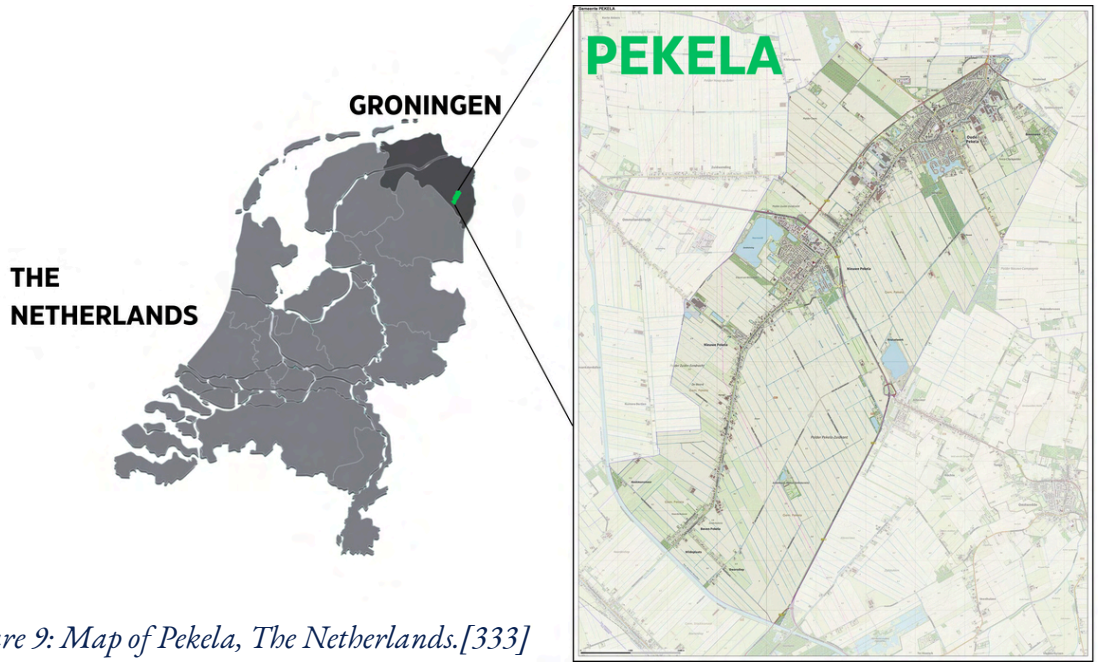


Figure 9: Map of Pekela, The Netherlands.[333]

Building Stock

There are 5,782 housing units in Pekela. Of those, 63% are privately-owned homes and 37% are rental properties.[330] Housing associations own about 69% of the available residential rental properties and private landlords own about 31%.[331] Housing stock data revealed that 26% of the dwellings were built prior to 1945 and about 8% were built after 2005.[332] A recent statistical survey reported that 91% of dwellings were constructed before 2000,[333] and that there is a localized need for new housing. Pekela's housing stock is dominated (88%) by single-family homes; the remaining 12% of homes are multi-family residences . [334] Current heat sources and technologies of the rural municipalities' homes tend to be older. Approximately, 95% of homes in Pekela are heated through individual natural gas boilers.[335] About 2% of homes are heated through electricity. Currently, no homes are heated through district heating.[336] Due to Pekela's low building density, collective district heating is not considered to be cost effective, so no heat networks will be explored.

Strategy for Planning the Heat Transition

To plan the Heat Transition Vision (TVW), Pekela engaged in outreach with residents regarding TVW development.[337] The municipality used a digital questionnaire where residents were able to share their feedback. In creating the TVW, the city underscored the Netherland's Climate Agreement goals and how they apply to Pekela, stating that by 2050 all of Pekela's 5,775 homes "must be made more sustainable."[338] The Municipality of Pekela hired and worked with two consultant firms to help them with their local heat transition vision planning process. Consultants at Witteveen+Bos examined technological feasibility and associated costs of heating solutions while consultants at Bureau Stroom organized stakeholder engagement related to the drafting of the municipal heat transition vision.[339] No formal TVW document is publicly accessible for Pekela. The document appears to be continuously undergoing review, similar to the municipality's goal.

330. Going Dutch?, Pekela University of Sussex, n.d. .(Link to downloaded report).
331. Housing in Europe, Eurostat, European Union, (https://ec.europa.eu/eurostat/web/interactive-publications/housing-2023).
332. Going Dutch?, Pekela University of Sussex, n.d. (Link to downloaded report).
333. Municipality of Pekela, AllCharts, (Link to downloaded report).
334. Housing in Europe, Eurostat, European Union. (accessed March 15, 2024)
335. Going Dutch?, Pekela University of Sussex, n.d. .(Link to downloaded report).
336. Going Dutch?, Pekela University of Sussex, n.d. .(Link to downloaded report).
337. Municipality of Pekela, Pekela residents can help develop the TVW, Gemeente Pekela, Municipality of Pekela, 2022.(Link to report).
338. Municipality of Pekela, Pekela residents can help develop the TVW, Gemeente Pekela, Municipality of Pekela, 2022.(Link to report).
339. Going Dutch?, Pekela University of Sussex, n.d. .(Link to downloaded report).

While energy policy and local initiatives were mentioned in various sections of Pekela's 'Future Vision 2022-2030 Municipal Plan' and 'Coalition Agreement of 2022-2026', their place in the TVW cannot be substantiated since the TVW is not accessible. In-depth analyses of the municipality's local heat transition goals for homeowners and properties, however, are publicly shared throughout the Pekela Duurzaam and Pekela Geeft Gas! official websites.[340]

Pekela's 'Future Vision 2022-2030 Municipal Plan,' created by the Municipal Government of Pekela with input from civic and social organizations and surveyed residents, detailed their residential environmental sustainability pillars, highlighting the availability of energy decarbonization initiatives and programs for Pekelders (colloquial term for inhabitants of Pekela), by Pekelders.[341] By 2030, Pekela hopes to address energy equity and advance the home and residential environment by supporting and gaining traction on sustainability initiatives that help residents address the needs for and move towards more affordable energy bills.[342]

Pekela's 'Future Vision 2022-2030 Municipal Plan' also notes that residents in Pekela are concerned about rising energy prices.[343] The 'Future Vision 2022-2030 Municipal Plan' highlighted the sustainability programs available to residents through Pekela Duurzaam Pekela Geeft Gas! pilot program.[344] In our interview, the municipality acknowledged that not all homeowners and residents are financially able to consider investments in the energy transition (which might include insulation upgrades and installation of solar panels).

The Sustainable and Affordable Housing section of Pekela's 'Coalition Agreement 2022-2026,' published in February 2024, detailed the Pekela Geeft Gas! pilot project as a means for homeowners to mitigate the burden of high energy bills.[345] The Coalition Agreement also acknowledges Pekela's objective to meet the energy transition mandated by the national government and states that its heat transition vision is being drawn up and a second resolution in line with Groningen's Regional Energy Strategy (RES) is in progress.[346] Pekela's local heat transition vision will be heavily influenced by Groningen's RES, which sets the TVW on the provincial level.[347] The Coalition Agreement also highlights the municipality's commitment to connecting homeowners to existing subsidies and incentive schemes available for energy saving and the use of energy coaches to help homeowners navigate the application process (explored later in the case study).[348]

It is important to note that the national program, Programma Aardgasvrije Wijken (PAW), started in 2018, while the Netherland's Climate Agreement was published in 2019. Municipalities were required to finish their heat transition visions in 2021 (although some delayed publishing TVW's until 2022). Although the pilot program in Pekela is already in the implementation stage, Pekela's TVW is still undergoing revision.

Pursuant to the Dutch Climate Agreement, Pekela's municipal government launched a local energy initiative (LEI) to prioritize community benefits and resident-led ideas in the energy transition.[349]

340. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, February 2024
341. Municipality of Pekela, Pekela Future Vision 2022-2030, Pekela on the move. Gemeente Pekela 2022 (Link to downloaded report)
342. Municipality of Pekela, Pekela Future Vision 2022-2030, Pekela on the move. Gemeente Pekela 2022 (Link to downloaded report)
343. Municipality of Pekela, Pekela Future Vision 2022-2030, Pekela on the move. Gemeente Pekela 2022 (Link to downloaded report)
344. Municipality of Pekela, Pekela Future Vision 2022-2030, Pekela on the move. Gemeente Pekela 2022 (Link to downloaded report)
345. Municipality of Pekela, Pekela Coalition Agreement 2022-2026, Gemeente Pekela 2024, (Link to download report)
346. Municipality of Pekela, Pekela Coalition Agreement 2022-2026, Gemeente Pekela 2024, (Link to download report)
347. Anna Devenish, Matthew Lockwood, Locally-led governance of residential heat transitions, Energy Policy Volume 187, April 2024. (https://doi.org/10.1016/j.enpol.2024.114027).
348. Municipality of Pekela, Pekela Coalition Agreement 2022-2026, Gemeente Pekela 2024, (Link to download report).
349. Amineh Ghorbani, Leonardo Nascimento, Tatiana Filatova, Growing community energy initiatives from the bottom up, Edition 70 https://www.sciencedirect.com/science/article/pii/S2214629620303571

The municipality created a formal organization, sustainability co-operative Pekela Duurzaam (Sustainable Pekela) to advance its goal of promoting sustainability in Pekela. Projects focus areas included renewable energy usage and residential heating decarbonization. As the local authority leading Pekela's sustainability initiatives and heat transition, Pekela Duurzaam applied for a grant from the national PAW program with a working group of residents from the neighborhood Boven Pekela to fund Pekela Geeft Gas!, which is an LEI pilot program that helps homeowners adopt sustainable heating technologies, including rooftop solar, insulation upgrades, and hybrid or fully electric heat pumps.[350]

The initiative was spearheaded by Pekela Duurzaam and a working group of residents in Boven Pekela. Support for the pilot project was provided by the Samen Energie Neutraal (SEN) Foundation, who co-authored the application for the PAW grant.[351] The SEN foundation was founded in 2013 to guide residents and municipalities in their efforts to achieve energy neutrality. The initial project proposal authored by the team detailed helping 600 homes in a localized heat transition pilot, focusing on the neighborhoods of Boven Pekela. The homes would undergo insulation improvements to address gap sealing, the installation of a hybrid or fully electric heat pump to replace natural gas boilers, and the installation of solar panels on home roofs to generate and power home electricity.[352]

Pekela's Pekela Geeft Gas!, translated literally as "Pekela Gives Gas," is one of 27 projects across the Netherlands selected by the Ministry of the Interior as testing grounds for natural gas-free districts in association with the PAW program.[353]

Initially, more than half of the PAW grant funds were intended for the construction of a green gas facility. In Pekela's application for pilot funding, goals for building heat decarbonization aimed to achieve a 50% reduction in natural gas consumption and develop local green gas generation by 2025.[354] This goal was eventually revised to solely focus on making all homes natural gas-free since issues with green gas generation arose.[355] However, Pekela ran into issues navigating the feasibility and scaling of the green gas initiative, and the funds meant for the initiative have been reallocated towards expanding the pilot program to other neighborhoods.[356] Currently, updates on the green gas initiative show that the project is still in the research and development phase.

Strategy for Implementing the Heat Transition

Following application review and approval, the PAW program awarded Pekela Duurzaam $4.26 million USD in October 2018 for Pekela Geeft Gas![357] PAW grant funds are paid out as contributions to residents who participate in the Pekela Geeft Gas! pilot program.[358] Other available national subsidies such as the De Investerings Subsidie Duurzame Energie (ISDE) subsidy help make it financially feasible for residents to make their homes natural gas-free, while minimizing increases in housing costs.[359] Along with the financial support, both Pekela Duurzaam and Pekela Geeft Gas! made it a priority to highlight the importance of stakeholder engagement.[360] The project stated that any resident who is interested in learning more about becoming more sustainable and participating in the local heat transition can 'receive tailor-made advice free of charge provided by an independent energy consultancy firm.'[361]

350. Project Pekela Geeft Gas, Pekela Duurzaam, 2021. (https://www.pekeladuurzaam.nl/onze-projecten/pekela-geeft-gas/)
351. Samen Energie Neutraal (SEN) Foundation https://samenenergieneutraal.nl/projecten/
352. Project Pekela Geeft Gas, Pekela Duurzaam, 2021. (https://www.pekeladuurzaam.nl/onze-projecten/pekela-geeft-gas/)
353. Project Pekela Geeft Gas, Pekela Duurzaam, 2021. (https://www.pekeladuurzaam.nl/onze-projecten/pekela-geeft-gas/)
354. Project Pekela Geeft Gas, Pekela Duurzaam, 2021. .(https://www.pekeladuurzaam.nl/onze-projecten/pekela-geeft-gas/)
355. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, February 2024
356. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, February 2024
357. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, February 2024
358. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author February 2024

The PAW grant, along with supplemental funding from other national subsidies, have fully funded the development and implementation of Pekela's heat transition plan and pilot projects thus far. To access Pekela's PAW funds to help finance these home upgrades, homeowners must first apply for the national ISDE subsidy. To maximize the impact of their PAW funding, the program encourages residents with sufficient savings to pay for home upgrades out of their own pockets, and then to apply for the ISDE subsidy before applying for PAW funding from Pekela Geeft Gas![362] To qualify for the ISDE subsidy, "homeowners must have a company install at least two sustainable heating technologies at once."[363] Pekela Geeft Gas! typically prioritizes lower income households to meet their energy equity goals and alleviate energy cost burdens.[364] However, due to limited participation from the residents of Pekela, the program has been opened up to individuals of all income brackets.[365]

Challenges

Behavioral Bottlenecks Prevent Residents from Utilizing Funding

Since 2018, Pekela Geeft Gas! has only deployed about a quarter of the $4.26 million USD they received.[366] Paul Inklaar, the treasurer of Pekela Duurzaam, noted that fewer homeowners have sought PAW funds than the program initially expected. While the program's initial plan anticipated the involvement of 600 homes, only around 120 homes are currently involved, roughly half of which have completed their upgrades and the rest of which are in the construction phase.[367] The PAW program allows grantees to continue administering funds until they run out, Pekela Geeft Gas! plans to continue operating through 2024 and 2025 to disburse the remaining funds. Homeowners in Pekela typically upgrade heating when their equipment is at the end of its useful life.[368] Thus, one of the largest barriers to entry with accessing financing is behavioral. Pekela consists of older and low-to-moderate income homeowners who are hesitant to engage in heating upgrades; these upgrades are time-consuming and disruptive, particularly to older homeowners. Additionally, homeowners may not understand the need to upgrade equipment that still functions. The war in Ukraine and subsequent energy crisis has sparked some homeowners' interest in the heat transition, especially as residents seek to address the burden of high energy bills. Still, these events did not yield enough of an incentive for significantly more residents to engage in the heat transition.[369]

Tiered Financing Process Leads to High Administrative Burden

The tiered financing process (personal fund use, ISDE subsidy and then PAW grant access) latent in the building heating transition has also complicated Pekela's heat transition. Each home requires a unique approach to its heating system transition. Unique considerations include differential costs, equipment upgrades, and construction plans.[370] To access the two funding streams necessary to account for these home-level differences – namely, PAW grant funds and ISDE subsidy funds – homeowners need to submit two applications. While the speed of the subsidy process is not typically an issue, those unfamiliar with the application process and technical aspects of the heat transition often find applying for the heat transition process overwhelming.[371] For these reasons, older homeowners typically prefer to wait until they are ready to retire their heating systems before upgrading.[372]

359. Pekela Geeft Gas!, Finances, 2024 https://www.pekelageeftgas.nl/financiering/
360. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, February 2024
361. Pekela Geeft Gas!, Finances, 2024 https://www.pekelageeftgas.nl/financiering/
362. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, February 2024
363. Pekela Geeft Gas!, Finances, 2024 https://www.pekelageeftgas.nl/financiering/
364. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, February 2024
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367. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, February 2024

Homeowners Must Invest Personal Funds Prior to Reimbursement

Since engaging in the heat transition requires homeowners to front personal funds before they're reimbursed by PAW grant funds and ISDE subsidies, some homeowners are resistant.[373] Homeowners can only apply for reimbursement once upgrades are made.[374] Some homeowners are unable to front these initial costs, and some do not trust they will receive their reimbursement. Overall, Pekela faces not only a challenge with the limited amount of savings homeowners personally have access to in order to begin their home heat transitions but also residents' limited willingness to apply for heating transition financing opportunities in the first place.

Proposed Solutions & Recommendations

As New York State (NYS) strategizes for heat decarbonization, it can draw key insights from Pekela's learning-by-doing approach. Pekela demonstrates the Netherlands' ability to learn through action at the local level. Stakeholder engagement and collaboration with community members at the local-level are critical components of advancing heat transition visions, particularly given the challenges discussed above with residential reticence to upgrade home heating systems. Effective community engagement can help to address these challenges. In Pekela, neighborly discussion turned into more formal social media campaigns and web-based efforts to promote the heat transition and educate homeowners on the funding application process.[375] The pilot program developed a Facebook page for communication and resource sharing. Further, Pekela Geeft Gas! developed an interactive online platform to assist homeowners in the initial stages of planning their heat transition.

Pekela's local online newspaper, PrachtigPekela.NL, also has a section dedicated to Pekela Duurzman's sustainability project updates. These elements of stakeholder engagement are applicable to the heat transition in similar rural settings throughout NYS, where homeowner reticence and lack of understanding may limit the speed and uptake of home heating upgrades.

Resident hesitancy, particularly with respect to costs and financing, can be addressed through other door-to-door residential engagement measures. These measures can help to establish trust and build active partnerships with residents. Energy coaches are highlighted as a potential avenue for addressing community engagement. In Pekela, energy coaches are paid by the municipality (using federal funding) and are assigned to neighborhoods in order to educate and help property owners navigate the technical processes and details of their personal home heat transition. Energy coaches can be trained and equipped with the expertise, knowledge, and resources necessary to provide detailed technical guidance to homeowners through the subsidy process.[376] The Pekela energy coach recommendation is modeled after Groningen's energy coach model, an initiative created in light of the awareness gaps and stakeholder resistance experienced by Pekela.[377]

One of Pekela's success stories in the heat transition comes from its focus on local community engagement. Energy clubs were created in the municipality to stimulate conversations around sustainability initiatives and goals. Existing community clubs were also encouraged by the government to discuss the energy transition as a focal point during scheduled community activities.

368. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, February 2024
369. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, February 2024
370. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, February 2024
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376. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, April 2024

In small and rural population settings, community influence is a core factor of creating change. A Pekela in-country expert, Paul Inklaar (treasurer of Pekela Duurzaam) created an energy club in his neighborhood which helped neighbors develop interest and support for the energy transition of their local sporting club building which is now outfitted with solar panels on the roof and a hybrid heat pump.

When asked if he had any specific recommendations for NYS as it seeks to develop and implement its own heat transition pilot program, Paul Inklaar stated: "Don't make it too big. People are more willing to make small steps in their own time and with respect to their own budget."[378] With respect to ownership equity and inclusion, it is important for NYS to remember that success in any heat transition, no matter how small or how big, is only possible if folks on the ground level are able to actively participate in the process.

Pekela's pilot program highlights the importance of not losing sight of the human element of the heat transition in the rural context. Challenges learned by Pekela through their learning-by-doing-approach show that municipalities of such scale must focus on relationship building, focusing on stakeholders, establishing trust with communities and homeowners in order to efficiently and effectively create influence through their subsidy programs. While the heat transition may seem theoretically feasible, resistance from homeowners can prove to be a widespread challenge frequently overlooked by policymakers.

Given the diverse socio-economic groups in NYS, the state may encounter similar issues to those Pekela faced. To effectively manage these issues, NYS can look to Pekela's diverse array of community engagement strategies. Ultimately, this can help ensure residents in NYS feel properly informed about the heat transition while helping them establish ownership over the process.

377. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, April 2024
378. Interview with Paul Inklaar (Pekela Duurzaam Treasurer) in discussion with the author, April 2024

SUMMARY TABLE

Municipality	Key Takeaways	Recommendations for NYS
Amsterdam	• Hired an external consultant to lead the planning process, leveraging techno-economic modeling with some stakeholder input • Slow progress in implementing the heating transition plan due to: (1) lack of legal and funding authority; (2) district heating challenges — causing the city to rethink its 2040 target • City's main implementation strategies are to coordinate "enthusiastic" stakeholders and provide them technical assistance • Transition plan overemphasizes district heating, failing to anticipate major practical and financial challenges	• Caution municipalities against over-reliance on techno-economic modeling and offer resources to ensure that modeling reflects residents' price concerns and practical challenges • Caution cities against leaning heavily on district heating unless NYS can support them in overcoming challenges • Encourage cities to start with key neighborhoods with a critical mass of enthusiastic stakeholders and to partner with housing corporations, utilities, and residential cooperatives on research and planning • Meaningfully engage all residents (including resistant ones) in early stages of pilot project planning, provide resources for them to understand technical concepts and future energy prices
Pekela	• Pekela is a living lab for home insulation and electrification; with a PAW-funded pilot program that spans the entire municipality • Since 2018, Pekela has spent only a quarter of its PAW grant funds due to homeowner resistance around the costs and disruptive installation of alternative heating technologies and the complexity of applying for subsidies • To address stakeholder concerns Pekela is highlighting the human element of the heat transition. Municipal energy coaches and advisors are one solution for educating and guiding residents through the heat transition	• Employ designated energy educators (in Tilburg, they are dubbed "Energy Coaches") • Work with communities to engage, educate, and facilitate heat transition planning and build trust • Adopt a learn-by-doing approach
Tilburg	• Tilburg TVW highlights a district-oriented approach that has gained notable support from residents • The Quirijnstok district in Tilburg participated in a pilot project that received a $4.05 million USD grant from the Programma Aardgasvrije Wijken (PAW) in 2018 • The success of the heat transition vision depends on effective stakeholder engagement, although ongoing collaboration is currently a challenge	• Using diverse funding sources can lower the cost of the heat transition, and thus increase public participation • Use pilot projects to inform strategy; learn-by-doing approach

Recommended Actions & Considerations

These case studies suggest the following takeaways as New York plans its heating decarbonization strategy:

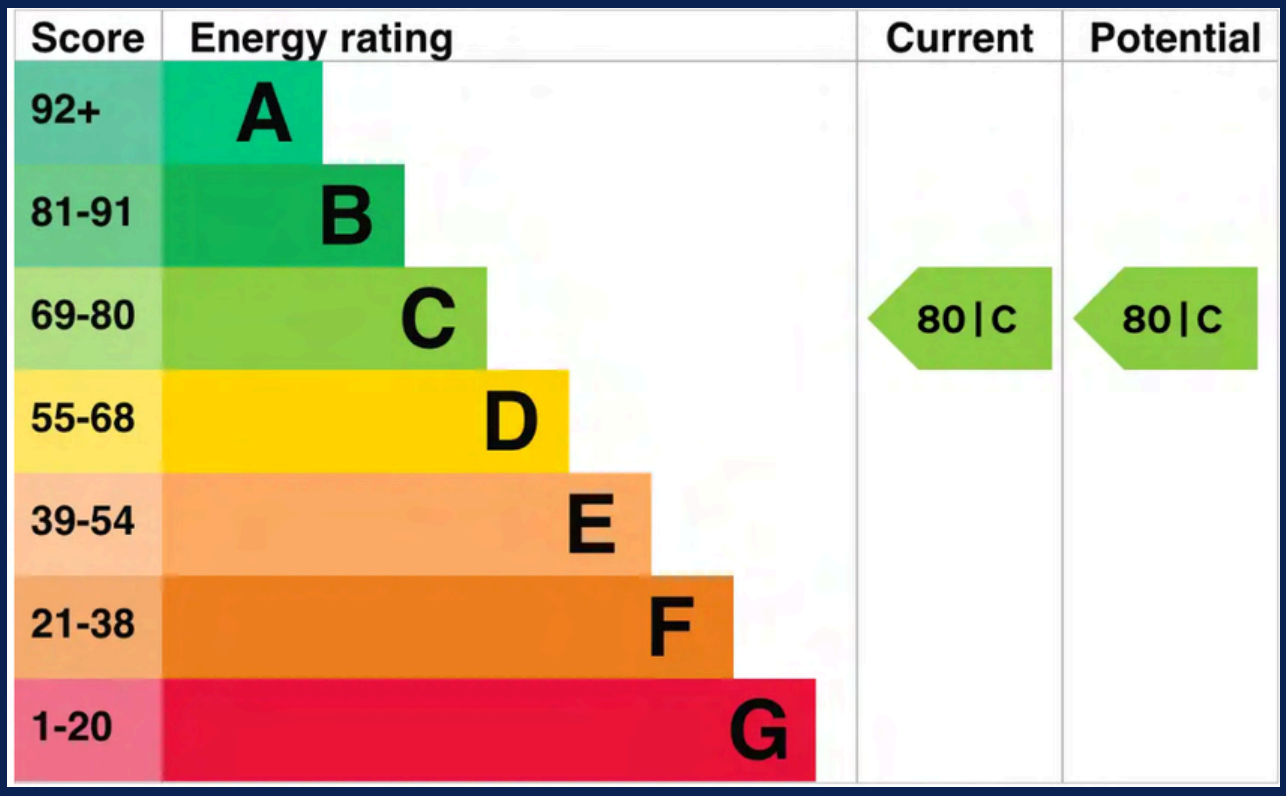
1. **Entrusting localities with the responsibility to plan their own heating decarbonization strategies is an effective approach. Local communities understand their own needs best, and have unique place-based expertise.** However, if required by law, this responsibility must be paired with funding and capacity support to ensure plans can become reality. Experts in interviews and plans submitted by localities communicated a common theme: the need for additional support to execute the plans. Ensuring the creativity of local councils and municipalities is transformed into lasting heating decarbonization success requires additional funding and technical assistance from the national level. This funding and technical assistance will allow municipalities to hire additional staff with relevant skill sets, pay for software or data analytics services, and get guidance as they develop their decarbonization strategies. Providing capacity support ensures that communities across the spectrum of density, wealth, and size have the resources to develop and execute their heating decarbonization plans.
2. **Heating decarbonization efforts at the local level must be paired with utility engagement.** Whether utilities are partially regulated, owned by the public sector, or privately owned, decarbonizing electricity generation and investing in grid resilience and expanded capacity is crucial to realizing heating decarbonization. Many heating decarbonization strategies demand increased grid capacity and decarbonized electricity to ensure emissions reductions. Simultaneously, electrification as a strategy for heating decarbonization means that electricity must be affordable to avoid increasing fuel poverty. In interviews with Glasgow, Fife, and national LHEES advisors, experts stressed the need for utility engagement. The Fife case study in particular is an example of a council taking an especially proactive approach to utility engagement, and many localities identify utility engagement as a crucial next step to align local retrofit and upgrade efforts with utility action.
3. **State and national governments can support municipalities address key implementation barriers through strategically leveraging funding.** Municipalities described that private investor perceptions of risk makes capital more expensive and harder to attract. Because of this, if the public sector is able to provide financial support that reduces the risk to private investors for developing heat network infrastructure, as detailed in the Glasgow and Amsterdam case studies, heat transition efforts can become significantly more feasible (i.e. through public infrastructure banks or green banks). Additionally, support for policies that enable green residential leases can address the split incentive issues that municipalities highlighted. The recommendations offered by Scotland's Green Heat Finance Taskforce serve as an example of how to address barriers posed by perceived financial risk or lack of capital.
4. **Public information campaigns are crucial to spur decarbonization retrofit uptake, but will be most successful if paired with research and outreach on main barriers to access.** Across case studies, experts highlighted the detrimental effect of misinformation or lack of information in supporting households to take advantage of currently-available energy efficiency and heating decarbonization retrofit programs.

As explored in the Pekela case study, public information campaigns that are based on stakeholder engagement, focus groups, and research on the main barriers to accessing decarbonization retrofit programs are key to ensuring that public information campaigns address the true concerns of households and businesses.

5. **Prioritizing equity is crucial for the viability of decarbonization strategies.** Experts mentioned that current electricity costs weaken the case for heating electrification from a consumer perspective, especially in communities already burdened with high electricity bills. Developing concrete strategies for how to decarbonize heating for low-efficiency units with already-high electricity bills is crucial to be able to decarbonize without increasing fuel poverty.
6. **Setting up frameworks for municipalities to communicate and work together is an effective way to support capacity.** Creating a framework for municipalities to communicate about their local heat transition planning efforts, like helps municipalities avoid duplicating work or reinventing the wheel, and is a straightforward way to support capacity building. LHEES advisors at the national level in Scotland offered connections between councils, providing points of contact that supported the sharing of relevant expertise. Meanwhile, the Netherlands created the National Program for Local Heat Transition to communicate common experiences and approaches between municipalities.4
7. **Support localities in developing and accessing detailed datasets to inform their decarbonization strategy.** Municipalities depended on high-quality, up-to-date, granular data to develop their decarbonization strategies. In interviews, experts spoke to challenges around data availability, data privacy restrictions, and data sharing that presented barriers to developing decarbonization strategies. Based on interviews with experts across a range of municipalities, a centrally-managed data platform that aggregates data and energy usage at the building level, and data privacy regulations that support that use are integral to local heat decarbonization planning efforts.

Appendix

Item I. Sample Scorecard for an Energy Performance Certificate



Item II. Scotland Data Sources

SCOTLAND DATA SOURCES		
Link	**Name of Source**	**Description of Source**

https://cdn.zerowastescotland.org.uk/managed-downloads/mf-mzzcjdbu-1710234023d	Non-Domestic Baseline Tool	• Non-Domestic Baseline tool is provided by Energy Saving Trust, and has four key elements:
		• Summary statistics
		  ◦ High-level overview of the non-residential building stock for the whole LA or examined for one strategic zone of interest.
		• Considerations
		  ◦ These examine heat networks for a whole LA, or the heat decarbonisation pathways at a strategic zone.
		• Outputs
		  ◦ Summary of information for visualization in GIS. Support data export for use in GIS for use later in LHEES Stage 4.
		• Data Store of the Non-domestic Analytics dataset.
		  ◦ Includes input data, also has several additional tabs that carry out background analysis
		  ◦ Key information includes
		  ▪ UPRNs/parent
		  ▪ UPRNsBuilding use
		  ▪ Property age
		  ▪ Floor area
		  ▪ Main fuel type
		  ▪ Primary heating system
		  ▪ Secondary heating system
		  ▪ Heat demand
		  ▪ Space heat demand
		  ▪ Hot water demand
		  ▪ Urban/rural 8-fold classification

https://statistics.gov.scot/data/domestic-energy-performance-certificates	EPC scoring	Energy Performance Certificate (EPC) data quantifies a building's energy performance according to the scale included in Item I of the Appendix. Energy Performance Certificates are managed by the Energy Saving Trust, and are available for: • All buildings which were newly constructed, with a building warrant application made after January 9, 2013 • Dwellings sold or rented to a new tenant after 1 December 2008 • Non-domestic buildings sold, rented to a new tenant and public buildings from January 2013
https://energysavingtrust.org.uk/service/home-analytics/	Home Analytics Dataset	Home Analytics is provided by Energy Saving Trust, and includes over 100+ energy efficiency metrics for many properties throughout Scotland, including energy efficiency potential and renewable energy potential at address level

Item III. Netherlands Data Sourcess

NETHERLANDS DATA SOURCES		
Link	**Name of Source**	**Description of Source**
	Regional Climate Monitor	For CO2 emissions data
https://www.enexis.nl/	Enexis	For energy consumption and infrastructure data
https://www.cbs.nl/en-gb	Dutch Central Bureau of Statistics	Publish reliable and consistent statistical information that responds to society's demands

Item IV. Netherlands Funding Mechanisms

NETHERLANDS FUNDING MECHANISMS	
Governance Level	**Description**
National Programs	**Specific Benefit (SpUk) - Specifieke Uitkering:** • Provides $9.58 million USD annually (2023 to 2025) to strengthen regional cooperation for heat transition among municipalities. Implementation for municipalities - Capaciteitsregeling Decentrale Overheden Klimaat en Energie (CDOKE): • Supports municipalities and provinces in building an internal organization for climate and energy tasks. Green Projects Regulations - Regeling Groenprojecten: • Allows green banks and funds to apply for a green declaration to finance sustainable customer projects at low interest rates. National Green Fund - Nationaal Groenfonds: • Finances various projects, including sustainable energy and innovative green initiatives for entrepreneurs.
Provincial Programs	**South Holland:** Subsidy Sunny South Holland - Subsidie Zonnig Zuid-Holland: • Encourages double use of space for solar energy generation by installing PV panels. Subsidy EII South Holland - Subsidie EII Zuid-Holland: • Supports the reduction of industrial CO_2 emissions.
	Overijssel: Subsidy SEM Overijssel - Subsidie SEM Overijssel: • Provides reimbursement for energy-saving measures and energy research for companies. LEI-F Overijssel - LEI-F Overijssel: • Supports local energy initiatives for sustainable energy generation or energy savings with financing and expertise.
	North Holland: Subsidy VW North Holland - Subsidie VW Noord-Holland: • Available for collaborative initiatives to make housing more sustainable at lower costs.
	Groningen: Subsidy WTP Groningen - Subsidie WTP Groningen: • Supports innovative heating solutions, such as (heating) infrastructure, heat storage, etc. FND Groningen - Fonds Nieuwe Doen Groningen: • A fund providing financing for social initiatives, including those related to sustainable energy.

Item IV. Netherlands Funding Mechanisms

NETHERLANDS FUNDING MECHANISMS	
Governance Level	**Description**
Provincial Programs	**Gelderland:** Subsidy LHE Gelderland - Subsidie LHE Gelderland: • Supports residents' initiatives for generating sustainable energy. Subsidy EPWT Gelderland - Subsidie EPWT Gelderland: • Provides support for hiring an external process supervisor to reduce fossil fuel use in districts. CETF Gelderland - CETF Gelderland: • Offers co-financing for knowledge institutions and governments using European thematic funds.
	Fryslân: Subsidy VE Fryslân - Subsidie VE Fryslân: • Assists start-up energy cooperatives in engaging independent experts for legal, financial, fiscal, or organizational support. FSFE - Fûns Skjinne Fryske Enerzjy: • Finances projects focusing on energy savings and/or sustainable energy production through loans, guarantees, and share capital.
Municipal Programs	**Subsidy SpUk Regional Structure - Subsidie SpUk Regionale Structuur:** • Supports municipalities in their regional cooperation for the heat transition. **Subsidy E-Utrecht - Subsidie E-Utrecht:** • Provides financing for projects related to energy saving, generation, environmental studies, and innovation. **Subsidy WIS - Subsidie Warmtenetten InvesteringsSubsidie:** • Assists entrepreneurs in installing heat networks with an unprofitable top. **Subsidy SVOH - Subsidie Verduurzaming Particuliere Huurwoningen:** • Helps landlords finance energy-saving measures in combination with maintenance or energy advice. **Subsidy SAH - Subsidie Aardgasvrije Huurwoningen:** • Encourages the connection of rental homes to heating networks, available for various types of landlords and mixed homeowners' associations. **Subsidy SVvE - Subsidie Verduurzaming Verenigingen van Eigenaren:** • Enables (mixed) homeowners' associations, housing associations, and cooperatives to request energy advice, implement energy-saving measures, and receive charging point advice.

Item IV. Netherlands Funding Mechanisms

NETHERLANDS FUNDING MECHANISMS	
Governance Level	**Description**
Tax Schemes	Tax scheme MIA/Vamil - Milieu-investeringsaftrek / Vamil: • Allows entrepreneurs to invest in environmentally friendly assets and technologies with tax benefits. EIA tax scheme - Energie-investeringsaftrek: • Enables entrepreneurs to deduct investment costs for generating sustainable energy, assets that save CO_2, or energy-efficient solutions. Tax scheme 9% VAT - BTW-tarief van 9%: • Offers a reduced VAT rate of 9% for insulating, painting, plastering, and wallpapering homes older than 2 years.
Loans and Mortgages	Redemption - Aflossing: • A loan based on the surplus value of the home, allowing homeowners to invest in sustainability measures. Mortgage - Hypotheek: • Provides additional mortgage space for sustainability measures when purchasing a house. Energy saving loan - Energiebespaarlening: • Financial support for making homes more sustainable, including options for owners with limited borrowing space. Energy saving mortgage - Energiebespaarmortgage: • A loan for sustainability measures, specifically for owners without sufficient borrowing space, applicable within municipal neighborhood approaches. Sustainability loan (SVn) - Duurzaamheidslening (SVn): • A favorable loan to encourage private homeowners to take energy-saving measures, applied through municipalities or provinces. WOAB - Woonsubsidie: • A partnership with provinces and municipalities offering a personalized approach to help homeowners make their homes more sustainable without financial risk.
Subsidies	BNG Sustainability Fund - BNG Groen Fonds: • Supports business initiators contributing to the sustainability goals of municipalities or provinces. DuMaVa - Duurzaamheidslening voor Maatschappelijk Vastgoed: • Provides subsidies to owners of existing social real estate for making their properties more sustainable. BOSA subsidy - BOSA-subsidie: • Assists amateur sports organizations with the construction and maintenance costs of sports facilities and the purchase of sports materials. Subsidy SpUk LAI - Specifieke Uitkering voor lokale aanpak isolatie: • Offers an insulation program for owner-occupied homes with poor insulation (energy label D, E, F, or G) whose owners lack the financial means for improvements. SDE++ subsidy - Stimulering Duurzame Energieproductie en Klimaattransitie: • Provides subsidies to companies and non-profit organizations generating large-scale renewable energy or reducing CO_2 emissions. ISDE subsidy for homeowners - ISDE-subsidie voor huiseigenaren: • Encourages energy-saving techniques and insulation measures, supporting the purchase of insulation and heat pumps by private homeowners and business users. Municipalities can apply on behalf of homeowners. ISDE business subsidy - ISDE-subsidie voor bedrijven: • Stimulates investments in sustainable energy generation and energy-saving techniques and measures for governments and private landlords, also providing support for a single energy measure.