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Governance gap: How cities plan for climate neutrality without planning the end of fossil gas

COLLECTION: SUSTAINABLE COMMUNITIES

PEER-REVIEWED PAPER

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ABSTRACT

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Many cities around the world have adopted a climate neutrality target. In the EU's mission 'Climate-Neutral and Smart Cities', 100 cities are pursuing the target of achieving climate neutrality by 2030. To achieve this, there needs to be a phase-out of fossil gas. However, municipal strategies for coping with declining gas demand and for the future of gas distribution networks are often lacking. This paper compares six European mission-cities – Barcelona, Budapest, Copenhagen, Ljubljana, Mannheim, and Warsaw – to investigate how local governments address fossil gas dependency, govern heat system transformation and address the infrastructural and economic challenges associated with decommissioning gas networks. The study reveals a discrepancy between climate-neutrality commitments and tangible measures to phase out gas.

While cities such as Copenhagen and Mannheim demonstrate integrated planning and substantial shifts towards low-carbon district heating (DH), others maintain gas grids as a long-term component of their heating supply and lack binding timelines or regulatory instruments for transformation or decommissioning. The comparison reveals that, although gas grid decommissioning is essential for managing declining throughput and ensuring affordability, it is rarely addressed explicitly within the EU. Overall, the findings point to structural barriers in planning, communication, and multilevel governance that limit credible transition pathways. The paper concludes that, without integrated infrastructure planning and coherent financing, many cities risk becoming dependent on fossil gas for much longer than their stated climate neutrality targets would allow.

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INTRODUCTION

To achieve climate neutrality in Europe, a rapid transformation of urban heat supply is necessary, with the phase-out of fossil gas as a key challenge. Cities play a central role in this process, accounting for around 75% of energy consumption and 70% of greenhouse gas emissions (IEA – International Energy Agency, 2021). The building sector alone contributes around a third of Europe's energy-related emissions (European Environment Agency, 2025).

Historically, fossil gas has been the dominant energy carrier in urban heating systems, both in individual buildings and in DH networks, except in parts of Central and Eastern Europe (e.g. Poland, Hungary, Slovenia), where coal has historically been more prevalent. However, the degree of gas dependency varies widely across countries and cities, reflecting differences in infrastructure, governance and socio-economic conditions. Consequently, the phase-out of gas is not a uniform transition, but rather involves heterogeneous pathways, costs and political challenges. Although EU-level policies such as the European Green Deal (European Commission, 2019) and the Fit for 55 package (European Commission, 2021) set binding targets, the responsibility for implementation largely rests with municipalities. Cities must plan and manage the transition to a low-carbon heating system while addressing declining gas demand, the future of gas distribution networks, and the risk of stranded assets.

Despite the growing importance of municipal action, there is limited comparative evidence on how cities govern and operationalise the phase-out of fossil gas. This paper addresses this issue by examining how European cities are approaching the phase-out of fossil gas.

The analysis draws on six Cities within the EU – Barcelona, Budapest, Copenhagen, Ljubljana, Mannheim and Warsaw – selected within the EU-funded ACHIEVE project (https://www.achieveproject.eu/) to represent a variety of institutional and technical contexts. By comparing municipal gas phase-out pathways, the paper provides policy-relevant insights for cities seeking to design credible transition strategies. The following section reviews relevant literature before the methodology is introduced.

LITERATURE REVIEW

The decarbonisation of urban heating systems is an important topic in research and policy. Three areas are particularly relevant for analysing pathways for phasing out fossil gas: gas infrastructure regulation, governance of urban heat transitions and municipal climate planning.

Research is examining how gas grid regulation interacts with climate targets. Rosenow, Lowes and Kemfert (2024) emphasise that current regulatory frameworks are not geared towards declining gas demand, which poses risks such as stranded assets and mounting costs for remaining users. Rosenow, Stobbe and Braungardt (2025) extend this analysis to seven European countries and find that gas grid planning remains largely disconnected from climate goals. Zwickl-Bernhard and Auer (2022) demonstrate the technical and economic feasibility of gas grid decommissioning at neighbourhood level, while Stobbe et al. (2024) identify regulatory gaps across EU Member States. At the urban governance level, a comparative study of seven European cities found that urban governments applied 'pragmatic incrementalism' rather than transformative change (Elisa Kochskämper and Jochen Monstadt, 2025). A study of Dutch municipalities identifies the absence of binding national policies and the unaffordability of alternatives as key lock-in effects (Herreras Martínez et al., 2022). Halleröd (2023) and Nicolletti et al. (2023) further document regulatory barriers and recommend stronger multilevel coordination. Research on the EU Cities Mission examines the credibility of municipal climate neutrality commitments (Shabb and McCormick, 2023), yet the specific role of fossil gas phase-out within these plans remains underexplored.

This paper addresses this gap by providing a cross-national comparison of municipal gas phase-out pathways, bridging infrastructure-level studies and urban governance research.

METHODS

This study uses a qualitative comparative case study approach to analyse how European cities plan and govern the phase-out of fossil gas. Six European cities were selected to represent diverse governance models, energy system structures and political contexts, including

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centralised and federal governance systems, varying levels of municipal ownership over heating infrastructure, and different starting points regarding the role of fossil gas. The empirical basis consists of a qualitative analysis of publicly available documents, including municipal climate strategies, heat plans, and publications from local utilities and energy agencies. The analysis focuses primarily on the residential heating sector, while commercial and public buildings are addressed where relevant. These documents were analysed using thematic categories covering strategic objectives, planning instruments, governance arrangements, financing aspects, and the presence or absence of gas phase-out timelines. The credibility of local strategies was assessed qualitatively. This was based on the presence of quantified and time-bound targets, identified implementation instruments, alignment between stated ambitions and concrete planning measures, and the degree of municipal governance capacity to influence key infrastructure decisions. The results were synthesised through cross-case comparison to identify recurring patterns, divergent pathways, and key explanatory factors. Figure 1 summarises the methodological approach.

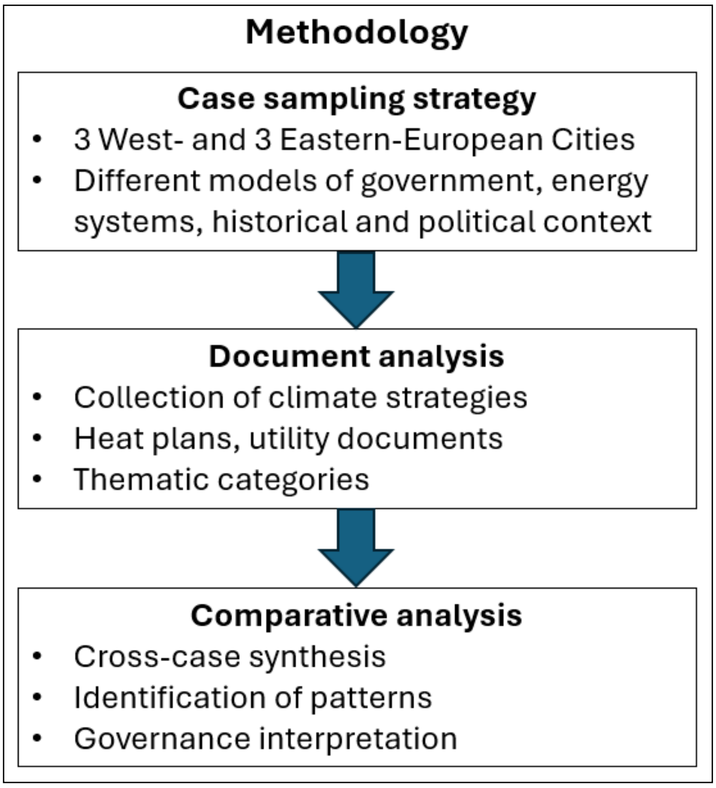

Figure 1 Methodology of the paper (own illustration).

The study analysed planning documents rather than implementation outcomes. Political dynamics over time, stakeholder negotiations and detailed technical assessments of building-level renovation requirements were beyond the scope of the study. Data availability varies across the cities.

RESULTS

First, we introduce the individual case studies, which examine how selected European cities are approaching the phase-out of fossil gas in the heating sector. The cases are presented in a concise, comparable format that focuses on strategic orientation, governance arrangements, and infrastructure-related decisions, rather than on detailed technical descriptions. Each case study illustrates how local starting conditions, such as the role of gas in the heating system, institutional responsibilities, and planning instruments influence municipal transition pathways. We conclude with a cross-case comparison.

CASE STUDY: BARCELONA

Barcelona is characterised by dense multi-family housing, a Mediterranean climate and comparatively low space-heating demand (Direcció de Serveis de l’Oficina de Canvi Climàtic i Sostenibilitat et al., 2024).

Table 1 summarises the key characteristics of Barcelona.

Table 1 Key characteristics of Barcelona's heating system infrastructure and gas transition.

CATEGORY	BARCELONA
Climate target[1]	–45% GHG emissions per capita by 2030 (vs. 2005); climate neutrality by 2050
Heating system structure[2]	Predominantly decentralised individual systems
Role of natural gas[3]	Mainly domestic hot water and cooking; limited role in space heating; gas network available
District heating (DH)[4]	No city-wide DH; decentralised District heating and cooling (DHC) networks (Districlima, Zona Franca)
Renewable/recovered heat[5]	Waste heat plant; residual cold from LNG regasification
Heat pumps[6]	No data for Barcelona; For Spain: Widespread use of reversible air-conditioning systems with a growing but still uneven uptake of aerothermal heat pumps.
Gas phase-out approach[7]	No explicit gas phase-out strategy; gas use indirectly reduced via electrification and efficiency measures
Gas network governance[8]	Privately operated; nationally regulated
Municipal heat planning[9]	Plan Clima 2018–2030 (no gas phase-out timeline)
Key transition barriers[10]	Ageing building stock; low renovation rates

Heat supply is predominantly decentralised, with natural gas playing a more modest role than in other European cities, primarily for domestic hot water and cooking. Two decentralised district heating and cooling (DHC) networks operate in specific redevelopment areas, including the 22@ district and Zona Franca. These systems combine gas cogeneration with recovered energy, including waste heat from the Besòs waste-to-energy plant and residual cold from LNG regasification at the Port of Barcelona. Despite their technological sophistication, the spatial coverage of these systems remains constrained, thus failing to effect a fundamental alteration to the city's decentralised heat structure (Barcelona City Council, 2024; Districlima, 2026).

Gas fulfils a dual function within Barcelona's heat system. At building level, it is primarily used in decentralised systems for domestic hot water and limited space heating. In contrast, within the two DH networks, gas is used in cogeneration plants that complement recovered energy sources. These distinct functions imply different transition challenges and policy approaches.

Barcelona's heat transition strategy forms part of its wider climate policy framework. The Plan Clima 2018–2030 prioritises building renovations, energy efficiency measures and the installation of aerothermal heat pumps, as well as the expansion of renewable heat sources, such as solar thermal systems. However, the plan does not define a quantified or time-bound phase-out of natural gas, nor does it outline a decommissioning strategy for gas networks. Central to this are governance constraints: gas infrastructure regulation, tariffs and long-term investment decisions are governed at a national level and implemented by a private network operator (Agencia Estatal Boletín Oficial del Estado, 1998; Ajuntament de Barcelona, 2018; Nedgia, 2025).

The structural characteristics of the building stock further constrain the transition. With approximately 794,000 dwellings, many built before modern thermal standards were introduced, renovation rates remain low. However, the key challenge is less the replacement of

1 Direcció de Serveis de l'Oficina de Canvi Climàtic i Sostenibilitat et al. (2024).

2 Barcelona City Council (2024); Battisti and Lazzari (2025).

3 International Energy Agency (2024).

4 Barcelona City Council (2024).

5 Barcelona City Council (2024); World first: Veolia, Enagás and Barcelona City Council inaugurate the first sustainable urban cold recovery network at an LNG terminal, 2024.

6 Asociación de Fabricantes de Equipos de Climatización (2023); European Commission (2024).

7 Àrea Metropolitana de Barcelona (2018).

8 Nedgia (2025); Agencia Estatal Boletín Oficial del Estado (1998).

9 Ajuntament de Barcelona (2018).

10 Ajuntament de Barcelona (2025, 2022).

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gas-based space heating than the substitution of gas used for domestic hot water and cooking. Electrifying these end uses requires significant technical adaptation at the building level (Lowes and Gibb, 2024).

CASE STUDY: BUDAPEST

Budapest represents a central-eastern European context characterised by a large, heterogeneous building stock and a historically strong reliance on fossil fuels for heat supply. The key facts about Budapest are summarised in Table 2.

Table 2 Key characteristics of Budapest's heating system infrastructure and gas transition.

CATEGORY	BUDAPEST
Climate target[11]	–80% GHG emissions by 2050 with offsetting of remaining emissions
Heating system structure[12]	large DH network combined with widespread individual gas boilers
Role of natural gas[13]	Dominant heating fuel, especially in single-family homes and many multi-family buildings
District heating[14]	Large, city-wide DH system
Renewable/recovered heat[15]	Emerging geothermal projects (e.g. Zugló); pilot-scale wastewater heat recovery
Heat pumps[16]	Very limited deployment; mainly pilot projects and small-scale applications
Gas phase-out approach[17]	No gas phase-out strategy; gas framed as unavoidable transitional fuel
Gas network governance[18]	State-owned (MVM Group); nationally regulated
Municipal heat planning[19]	Sustainable Energy and Climate Plan (SECAP); no municipal gas phase-out timeline
Key transition barriers[20]	Fossil lock-in of DH generation; ageing building stock; low renovation rates

Budapest operates one of the largest DH systems in central Europe (HungaroMet Magyar Meteorológiai Szolgáltató Nonprofit Zrt., 2024). Despite this extensive infrastructure, DH covers only part of the total heat demand. Individual gas boilers remain dominant, particularly in single-family homes and smaller multi-family buildings. Household surveys indicate that natural gas is the primary heating source in over 90% of single-family homes and in around two thirds of multi-family buildings (Gerőházi et al., 2024). Additional, national and sectoral analyses show that Hungary's DH production continues to rely heavily on gas- and coal-fired combined heat and power plants (Orbán, 2018).

Budapest's heat transition strategy is embedded in its Sustainable Energy and Climate Action Plan (SECAP) and the municipal climate strategy. These frameworks prioritise energy efficiency improvements, building renovation and the gradual integration of renewable heat sources. Concrete initiatives include the establishment of the Budapest Climate Agency and the Budapest CARES programme, which aim to support deep renovation and the replacement of outdated heating systems in buildings (Tatai et al., 2021). Neither strategy defines a gas phase-out.

Governance constraints play a decisive role in shaping Budapest's transition pathway. Gas infrastructure, fuel choice, tariffs and long-term investment decisions are regulated at the national level. The gas transmission and distribution networks in Budapest are managed by two state-owned companies (Hungarian Energy and Public Utility Regulatory Authority, 2015; MVM Zrt., 2021).

11 Tatai et al. (2021).

12 Gerőházi et al. (2024).

13 Gerőházi et al. (2024).

14 Budapest District Heating Service Ltd. (2025).

15 Erőss et al. (2015); ReUseHeat.

16 Gerőházi et al. (2024).

17 Orbán (2018); Gerőházi et al. (2024).

18 MVM Zrt. (2021); Hungarian Energy and Public Utility Regulatory Authority (2015).

19 Tatai et al. (2021).

20 Abrantes (2024); Kaiser and Jankowska (2013).

Renewable and low-carbon heat sources are emerging but remain at pilot scale. Budapest benefits from favourable geothermal conditions, and projects such as the planned geothermal DH system in Zugló are expected to deliver measurable emission reductions. Additional potential has been identified for wastewater heat recovery and large-scale heat pumps, yet deployment remains limited due to high upfront investment costs and regulatory uncertainty (EU Covenant of Mayors, 2024a; Strasszer and Xydis, 2024).

Around two thirds of dwellings were constructed before 1981 and exhibit low thermal performance (Hungarian Central Statistical Office, 2022). Renovation rates remain insufficient due to high costs, fragmented ownership and limited financing (Climate-KIC, 2024).

CASE STUDY: COPENHAGEN

Copenhagen represents a frontrunner case of an early phase-out of fossil gas in urban heat supply. The city is characterised by dense urban development, an exceptionally high penetration of collective heat infrastructure and strong municipal control through publicly owned utilities (Copenhagen Energy, 2021). Table 3 summarises the key issues relating to Copenhagen.

Table 3 Key characteristics of Copenhagen's heating system infrastructure and gas transition.

CATEGORY	COPENHAGEN
Climate target[21]	Climate neutrality by 2025 (an 80% reduction in emissions was achieved between 2012 and 2025); climate positivity by 2035
Heating system structure[22]	Highly centralised, collective heat supply
Role of natural gas[23]	Marginal for space heating; limited to cooking and small commercial uses
District heating[24]	>98% of buildings connected; world's largest urban DH network
Renewable/recovered heat[25]	Waste-to-energy, industrial & wastewater heat, geothermal energy, large-scale heat pumps
Heat pumps[26]	Large-scale heat pumps integrated into DH; limited relevance at individual building level
Gas phase-out approach[27]	No network shutdown; defossilisation via biogas (>70% in 2023, 100% by 2025)
Gas network governance[28]	State-owned distribution; city gas
Municipal heat planning[29]	Mandatory heat planning since 1979; Climate Plan 2021–2025
Key transition barriers[30]	Permitting for large heat pumps and geothermal projects; long-term biomass sustainability; long investment cycles in DH infrastructure

With fossil gas largely eliminated from heating, Copenhagen's transition strategy focuses on decarbonising an already extensive DH system that serves more than 98% of buildings. Decarbonisation is pursued through a portfolio of waste heat, large-scale heat pumps, geothermal energy and thermal storage, with biomass as a transitional fuel (C40 Cities, 2015; State of Green, 2024b; Vejrup, 2024).

Heat planning has been mandatory in Denmark since the late 1970s, providing a stable institutional framework for coordinated infrastructure development. The City of Copenhagen closely aligns its climate policy with investment strategies of municipal utilities, most notably HOFOR. The Climate Plan 2021–2025 consolidates these arrangements and anchors the city's ambition to achieve climate neutrality (City of Copenhagen, 2022).

21 City of Copenhagen (2022).
22 Copenhagen Energy (2021).
23 Hovedstadsområdets Forsyningsselskab (2025).
24 Copenhagen Energy (2021).
25 Edo (2021).
26 State of Green (2024b).
27 Hovedstadsområdets Forsyningsselskab (2023); Vejrup (2024).
28 Evida (2025); Hovedstadsområdets Forsyningsselskab (2025).
29 Ministry of Environment and Energy (2000); Energy Cities (2024).
30 Schneider et al. (2025); Gentili (2025); Hansen et al. (2020).

Copenhagen has not pursued the physical decommissioning of its gas network. Instead, the remaining city gas system is being fully defossilised by substituting fossil gas with biogas produced from wastewater sludge and organic waste (Hovedstadsområdets Forsyningsselskab, 2023; Vejrup, 2024).

Despite its advanced position, Copenhagen faces some structural challenges. Permitting procedures for large heat pumps and geothermal installations remain complex and can delay implementation. Public and scientific debate increasingly questions the sustainability of large-scale biomass use, highlighting risks related to land use, imports and long-term climate impacts (Gentili, 2025; Hansen et al., 2020; Schneider et al., 2025).

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CASE STUDY: LJUBLJANA

Ljubljana is a mid-sized European capital with a heterogeneous building stock and a mixed heating-system structure (Energetika Ljubljana, 2014, 2018; Statistical Office of the Republic of Slovenia, 2022). Table 4 summarises the most relevant facts about Ljubljana.

Table 4 Key characteristics of Ljubljana's heating system infrastructure and gas transition.

CATEGORY	LJUBLJANA
Climate target[31]	Climate neutrality by 2030
Heating system structure[32]	Strong DH and widespread individual systems
Role of natural gas[33]	Transitional fuel in DH (~60% of DH output); important in individual heating (~10% of total household energy use)
District heating[34]	Nearly 50% of apartments connected; operated by municipally owned Energetika Ljubljana
Renewable/recovered heat[35]	Planned 100 MW biomass plant; early-stage wastewater heat, geothermal energy and large heat pumps
Heat pumps[36]	Limited deployment; mainly in renovated buildings and pilot projects
Gas phase-out approach[37]	No municipal gas phase-out timeline; gas framed as transitional fuel
Gas network governance[38]	Gas market and tariffs regulated nationally; local distribution operated by municipal utility
Municipal heat planning[39]	Climate Neutrality Action Plan 2030
Key transition barriers[40]	Ageing building stock; high renovation costs; lack of national gas phase-out strategy

DH plays a central role in Ljubljana's heat supply. Operated by the municipally owned utility Energetika Ljubljana, the system supplies nearly half of all apartments as well as a large share of public and commercial buildings (Buhin et al., 2025; Energetika Ljubljana, 2018). Historically, heat production was dominated by coal-fired units at the TE-TOL combined heat and power plant. In recent years, coal has largely been phased out and replaced by gas, which now provides around 60% of DH output (Berbatović, 2025).

Ljubljana is preparing a further structural shift. A 100 MW biomass heating plant (expected by 2027), alongside wastewater heat, geothermal energy and heat pumps, form the basis of planned supply-side transformation (Buhin et al., 2025; City of Ljubljana, 2024).

31 City of Ljubljana (2024).

32 Energetika Ljubljana (2018).

33 Božič et al. (2023); Berbatović (2025).

34 Buhin et al. (2025); Energetika Ljubljana (2018).

35 Buhin et al. (2025).

36 City of Ljubljana (2024).

37 City of Ljubljana (2024).

38 Attorney (2024); CompanyWall business (2026).

39 City of Ljubljana (2024).

40 Božič et al. (2023); City of Ljubljana (2024).

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The heat transition strategy combines DH decarbonisation with energy efficiency improvements and deep renovation. Public housing has undergone thermal upgrades, and heat pumps are being promoted where technically feasible (City of Ljubljana, 2024; E-institute, 2024).

Governance conditions are comparatively favourable at the local level due to full municipal ownership of Energetika Ljubljana, enabling coordinated planning between the city administration and the utility. However, gas-market regulation, fuel pricing and tariff structures are determined at the national level. Slovenia has not adopted a national gas phase-out strategy (Attorney, 2024; CompanyWall business, 2026).

CASE STUDY: MANNHEIM

Mannheim is an urban centre in southwestern Germany, combining a dense inner city with post-war residential districts and comparatively high heating demand. Table 5 summarises the key aspects relating to Mannheim.

Table 5 Key characteristics of Mannheim's heating system infrastructure and gas transition.

CATEGORY	MANNHEIM
Climate target[41]	Climate neutrality by 2030; largely decarbonised heat supply by ~2040
Heating system structure[42]	District-heating-dominated system with remaining decentralised gas heating
Role of natural gas[43]	Still significant in individual buildings (~27% of apartments); declining role in DH
District heating[44]	One of Germany's largest DH systems, operated by MVV; backbone of future heat supply
Renewable/recovered heat[45]	Industrial waste heat, waste-to-energy, wastewater heat; large river-water heat pumps
Heat pumps[46]	Large-scale river-water heat pumps central to DH decarbonisation; limited building-level uptake
Gas phase-out approach[47]	Intention to decommission gas grid; target year 2035
Gas network governance[48]	Municipally influenced (MVV Netze), but regulated under federal energy law
Municipal heat planning[49]	Municipal Heat Plan (2024); Climate Action Plan 2030
Key transition barriers[50]	High renovation needs; high conversion costs; regulatory dependence on federal level

Mannheim operates one of Germany's largest DH systems, historically centred on a large coal-fired combined heat and power (CHP) plant (MVV Energie AG, 2026; Statistisches Bundesamt, 2022).

As Germany implements its national coal phase-out, Mannheim has embarked on a far-reaching restructuring of its heat system. The Climate Action Plan and the Municipal Heat Plan outline a pathway towards a decarbonised heat supply by around 2040. Central elements include the expansion of renewable and recovered heat, large-scale heat pumps, industrial waste heat, geothermal and wastewater heat (Stadt Mannheim – Fachbereich Klima, Natur, Umwelt, 2024; Stadt Mannheim Kommunale Statistikstelle, 2024).

A defining feature of Mannheim's strategy is its explicit intention to decommission the gas distribution network. The network operator has publicly announced plans to decommission the gas grid and initially named 2035 as a target year (IWR, 2024). This position remains

41 Geiser (2023); MVV Regioplan GmbH (2024).

42 Statistisches Bundesamt (2022); MVV Regioplan GmbH (2024).

43 Statistisches Bundesamt (2022).

44 MVV Energie AG (2026).

45 Stadt Mannheim Kommunale Statistikstelle (2024).

46 Euroheat & Power (2023).

47 IWR (2024).

48 MVV Energie AG (2020).

49 Stadt Mannheim Kommunale Statistikstelle (2024).

50 Stadt Mannheim Kommunale Statistikstelle (2024); Stadt Mannheim – Fachbereich Klima, Natur, Umwelt (2024).

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rare in the European context, although cities such as Basel and Zürich have already initiated or implemented partial gas network decommissioning. However, this timeline is non-binding and dependent on federal regulation and the pace of building conversion (Rhein-Neckar-Zeitung, 2025).

CASE STUDY: WARSAW

Warsaw's heating system is dominated by fossil fuel use, reflecting Poland's historical dependence on coal and the increasing role of natural gas as a replacement fuel. The key aspects relating to Warsaw are summarised in Table 6.

Table 6 Key characteristics of Warsaw's heating system infrastructure and gas transition.

CATEGORY	WARSAW
Climate target[51]	–40% GHG emissions by 2030; climate neutrality by 2050
Heating system structure[52]	District-heating-dominated system with fossil-based generation
Role of natural gas[53]	Important as coal replacement; widespread in individual heating
District heating[54]	~80% coverage; one of Europe's largest DH networks
Renewable/recovered heat[55]	Pilot waste-heat projects (metro, wastewater, data centres)
Heat pumps[56]	Growing nationally, but limited urban uptake due to building constraints
Gas phase-out approach[57]	No gas phase-out; gas framed as transitional fuel
Gas network governance[58]	Nationally regulated; operated by PSG/ORLEN
Municipal heat planning[59]	Green City Climate Action Plan; coal phase-out focus
Key transition barriers[60]	Coal legacy; continued gas prioritisation; low renovation rates

DH supplies around 80% of Warsaw's heat demand. However, unlike leading low-carbon district-heating systems, Warsaw's network is still largely supplied by coal- and gas-fired plants (EU Covenant of Mayors, 2024b).

Individual heating systems continue to play an important role, particularly in single-family homes and peripheral areas. Natural gas boilers are widespread, and gas remains a key fuel for residential heating outside the DH system. Heat pump uptake remains constrained by building quality and existing gas connections (Bloomberg, 2025).

Warsaw's heat transition strategy is characterised by small changes rather than a clear fossil-gas exit. Strategic documents such as the Green City Climate Action Plan and the Forum Energii transformation scenarios decarbonisation pathways focus primarily on phasing out coal by around 2035, improving grid efficiency and piloting renewable heat options. Natural gas is consistently framed as a transitional fuel (ARUP, 2024; Forum Energii, 2025).

Promising low-carbon initiatives are emerging, particularly in the use of waste heat. Studies identify significant potential for recovering heat from Warsaw's metro system, wastewater infrastructure and data centres. A large potential of recoverable heat has been identified in the metro system alone. Pilot projects are underway, and large heat pumps and thermal storage are discussed as long-term options (EU Covenant of Mayors, 2024b; State of Green, 2024a).

51 Maher (2025).
52 EU Covenant of Mayors (2024b).
53 ARUP (2024); Hanna Jędrzejuk and Dorota Chwieduk (2021).
54 EU Covenant of Mayors (2024b).
55 EU Covenant of Mayors (2024b); State of Green (2024a).
56 Bloomberg (2025).
57 Enerace Sp. z.o.o. (2025).
58 ORLEN (2025).
59 ARUP (2024).
60 Ujazdowski (2025); Joint Research Centre (2024).

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The gas network itself is embedded in Poland's national system. There are no plans to decommission or downsize the gas network. Instead, national policy increasingly frames the grid as compatible with future renewable gases, particularly biomethane. While Poland has significant theoretical biomethane potential, injection into the grid remains negligible at present (ORLEN, 2025; Sienkiewicz et al., 2024).

COMPARATIVE SYNTHESIS

CROSS-CUTTING PATTERNS

In five of the six cities (not Copenhagen), fossil gas is still part of the urban heating landscape, to varying degrees and with varying strategic importance. Even in cities with ambitious climate targets and advanced DH systems, gas often persists as a transitional fuel. There is a discrepancy between high-level climate neutrality commitments and the lack of tangible measures and strategies to phase out fossil gas.

A further pattern concerns ownership structures. Cities with strong municipal control over DH providers demonstrate a greater capacity to actively reduce gas dependency, while nationally regulated or private operated systems limit municipalities to incremental measures. This dimension is explored further in the Discussion.

The characteristics of the building stock represent a further bottleneck, as older buildings, fragmented ownership and slow renovation rates limit the rapid replacement of gas boilers.

Finally, the analysis shows that DH is a necessary but not sufficient condition for phasing out gas. Although the collective heating infrastructure forms a structural backbone for decarbonisation, it can also lead to renewed dependence on fossil fuels if heat generation continues to be predominantly based on coal or gas CHP.

DIVERGING PATHWAYS AND CITY TYPOLOGY

Despite these shared challenges, the case studies reveal clearly differentiated transition pathways. These differences can be explained by the interaction of three dimensions:

1. the structural role of gas in the existing heating system,
2. the explicitness and credibility of gas phase-out strategies, and
3. municipal control over heat and gas infrastructure.

Two infrastructure pathways for gas replacement emerge. For DH-based cities, DH is the primary vehicle for transition. However, coal-to-gas switching in Budapest, Warsaw and Ljubljana currently risks creating new fossil fuel dependency. For decentralised systems, building-level electrification and energy efficiency are essential. Notably, the analysed documents rarely address the consequences of declining gas consumption for gas networks. Exceptions are Mannheim, which pursues a decommissioning strategy, and Copenhagen, where fossil gas is being replaced by biogas. In Table 7 these dimensions are synthesised into a comparative typology.

Table 7 Comparative overview of municipal gas phase-out pathways.

CITY	ROLE OF GAS	GAS PHASE-OUT FRAMING	MUNICIPAL INFLUENCE	DOMINANT CHALLENGES	TRANSITION TYPE
Budapest	Dominant	No gas phase-out strategy	Low	National control; fossil DH	Fossil infrastructure lock-in
Barcelona	Persistent + decentralised	No explicit phase-out	Low-medium	governance limits	Incremental, sectoral transition
Copenhagen	Marginal	Explicit defossilisation (biogas + DH)	High	Biomass sustainability	Advanced DH decarbonisation
Ljubljana	Central (DH + individual)	Gas as transitional fuel	Medium	Gas in DH; financing	Transitional fuel consolidation
Mannheim	Declining but persistent	Strategic aspiration (non-binding exit)	High	Renovation pace; national regulation	Aspirational infrastructure transition
Warsaw	Central (DH + individual)	Gas as transitional fuel	Low	Coal legacy; national regulation	Coal-to-gas lock-in

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The table illustrates a clear differentiation between cities that actively frame gas as a declining technology and those where it remains structurally embedded. Copenhagen represents the most advanced pathway. Mannheim follows a similar trajectory, though gas remains more embedded in the building stock. Ljubljana occupies an intermediate position where gas has taken over as a transitional backbone. Barcelona, Warsaw and Budapest illustrate more constrained pathways, where decentralised structures and/or national regulation severely limit the room for action of municipalities.

It is important to note that the available data are heterogeneous across the case studies. It is evident that detailed figures on natural gas consumption in the building sector or at the level of distribution networks are not consistently available for all cities.

GOVERNANCE CAPACITY AS A DECISIVE FACTOR

Municipal ambition alone does not guarantee a gas phase-out. Outcomes depend on the degree of municipal control over heating infrastructure. Where cities strongly influence DH, they can actively reduce gas use within collective systems, as illustrated by Mannheim. However, DH decarbonisation does not automatically address decentralised gas supply or gas distribution networks, which often remain beyond direct municipal control. This is particularly evident in Budapest and Warsaw, where national regulation limits municipal room for manoeuvre, whereas Mannheim demonstrates how municipal ownership can enable proactive planning.

IMPLICATIONS FOR URBAN GAS PHASE-OUT

The comparative analysis suggests that moving away from fossil gas is less a technological challenge than a problem of governance and coordination. The continued use of gas is rarely due to technical necessities alone, but rather to institutional inertia, inconsistent regulations and infrastructure lock-in. Cities making progress combine long-term political commitment with strong infrastructure control and integration of building renovation strategies. Without greater coordination between municipal planning, national regulation and climate policy, gas risks remaining a 'hidden pillar' of urban heating.

DISCUSSION

The comparison demonstrates a marked disparity between climate neutrality objectives and concrete gas phase-out strategies. While all cities are committed to long-term decarbonisation, only Copenhagen and Mannheim have explicitly outlined infrastructure-related gas exit pathways.

In Budapest, Ljubljana and Warsaw gas is regarded as a transitional fuel replacing coal, with no defined exit strategy. This risks new forms of fossil lock-in, particularly where gas-fired CHP plants have lengthy investment cycles. In Barcelona, gas remains embedded in decentralised systems without a coordinated phase-out strategy.

Copenhagen and Mannheim illustrate different stages of municipal steering capacity. Copenhagen's integrated heat planning has already significantly reduced the role of fossil gas while Mannheim, though pursuing ambitious transition plans, remains at an earlier implementation stage.

A key factor in this is the degree of local authority control over the heating infrastructure. Cities that own their district heating supplier or exert significant influence over it, such as Copenhagen (Hovedstadsområdets Forsyningsselskab, HOFOR), Mannheim (MVV) and Ljubljana (Energetika Ljubljana), demonstrate a greater ability to align infrastructure investments with climate targets. Where the heating infrastructure is privately operated or regulated only at national level, as in Barcelona, Budapest and Warsaw, local authorities are largely restricted to indirect measures. This issue of ownership overlaps with the constraints imposed by multi-level governance: even where local authorities have local influence, national regulations on gas tariffs, fuel choice and network investments can restrict strategic planning for the gas phase-out.

It should also be noted that forthcoming policy changes at EU level, in particular the introduction of the EU Emissions Trading System 2 (ETS2), which will cover buildings and transport from 2027, could alter the economic incentives for phasing out gas by increasing the cost of fossil heating fuels. However, the distributional effects and the extent to which this will accelerate the municipal transition remain uncertain and deserve further investigation.

POLICY RECOMMENDATIONS

Based on the comparative findings, several policy recommendations emerge:

> First, municipal climate strategies and heat plans should explicitly integrate gas network planning, including scenarios for network contraction, repurposing or decommissioning. Second, even where immediate decommissioning is unrealistic, indicative timelines and conditional exit pathways can provide planning certainty for utilities, investors and households. Third, building renovation policy should be aligned with infrastructure transition to enable electrification and low-temperature heating. Fourth, national regulators must anticipate declining gas throughput to avoid unfair cost burdens for remaining users. Fifth, cities should seek to expand their influence over heating infrastructure through ownership participation, renegotiation of concession agreements or regulatory partnerships. Finally, investments in new gas infrastructure should be critically assessed against long-term climate targets to avoid new fossil lock-ins.

CONCLUSION

The analysis highlights significant discrepancies between climate neutrality ambitious and operational gas phase-out strategies. In several cities, gas remains structurally embedded and politically under-addressed. Phasing out gas use is less a technological challenge than a question of governance. Without planning for network decommissioning and the development of alternatives, fossil gas is likely to remain a cornerstone of urban heating systems.

Further research is needed to gain a deeper understanding of the factors influencing the process of phasing out municipal gas supply. Three areas appear particularly promising in this regard:

- Firstly, the role of ownership structures (whether municipal, state or private) in promoting or hindering proactive infrastructure planning.
- Secondly, the link between building renovation programmes and the decommissioning of gas networks. This includes the question of how cities can better integrate these policy areas.
- Thirdly, the specific barriers to deploying large-scale heat pump systems in densely populated urban areas. Building restrictions, grid capacities and regulatory challenges in these areas differ fundamentally from those in suburban or rural areas.

DATA ACCESSIBILITY STATEMENT

This study is based on the qualitative analysis of publicly available documents. All sources are listed in the reference list. No primary datasets were generated.

ADDITIONAL FILE

The additional file for this article can be found as follows:

- **Governance Gap: How cities plan for climate neutrality without planning the end of fossil gas.** PowerPoint Slides relating to this article. DOI: https://doi.org/10.66506/essp.5-090-26.s1

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REFERENCES

2024. 'World first: Veolia, Enagás and Barcelona City Council inaugurate the first sustainable urban cold recovery network at an LNG terminal'. *Enagás Noticias*, 2024 [Online]. Available at: https://www.enagas.es/en/press-room/news-room/press-releases/barcelona-veolia-cold-agreement/.

Abrantes, E. 2024. 'Preserving the Past, Building the Future: Budapest's Climate Challenge'. *NetZeroCities*, 12 July [Online]. Available at: https://netzerocities.eu/2024/07/12/preserving-the-past-building-the-future-budapests-climate-challenge/.

Agencia Estatal Boletín Oficial del Estado. 1998. 'Ley 34/1998, de 7 de octubre, del sector de hidrocarburos.' [Online]. Available at: https://www.boe.es/buscar/pdf/1998/BOE-A-1998-23284-consolidado.pdf.

Ajuntament de Barcelona. (ed.) 2018. *Plan Clima 2018–2030* [Online]. Available at: https://www.barcelona.cat/barcelona-pel-clima/sites/default/files/plan_clima_juny_ok.pdf.

Ajuntament de Barcelona. (ed.) 2022. *2030 Agenda – Ageing housing with poor energy efficiency but a huge potential for improvement* [Online]. Available at: https://ajuntament.barcelona.cat/agenda2030/en/actualitat/ageing-housing-with-poor-energy-efficiency-but-a-huge-potential-for-improvement-1188771.

Ajuntament de Barcelona. (ed.) 2025. *Nearly 8,700 homes to be renovated with Next Generation funds* [Online]. Available at: https://www.habitatge.barcelona/en/noticia/prop-de-8-700-habitatges-es-rehabilitaran-amb-els-fons-next-generation_1537444.

Àrea Metropolitana de Barcelona. (ed.) 2018. *El camí cap a una metròpoli més autosuficient, resilient i neutra en emissions* [Online]. Available at: https://docs.amb.cat/alfresco/api/-default-/public/alfresco/versions/1/nodes/a1fbaecd-a139-4f60-a807-196a041834a5/content/Pla_%20Adaptacio_Canvi_Clima_2030.pdf?attachment=false&mimeType=application/pdf&sizeInBytes=3822782.

ARUP. (ed.) 2024. *Warsaw Green City Climate and Action Plan* [Online]. Available at: https://www.arup.com/projects/warsaw-green-city-climate-and-action-plan/.

Asociación de Fabricantes de Equipos de Climatización. (ed.) 2023. *AFEC report on the HVAC market and solutions for thermal installations; growth of more than 21% in 2022* [Online]. Available at: https://www.afec.es/en/mercado-2023.

Attorney, M. 2024. *Oil & Gas Laws and Regulations in Slovenia* [Online]. Available at: https://ceelegalmatters.com/slovenia/27406-oil-gas-laws-and-regulations-in-slovenia-2024.

Barcelona City Council. (ed.) 2024. *Heating and cooling networks* [Online]. Available at: https://www.energia.barcelona/en/saving-energy/heating-and-cooling-networks.

Battisti, R and **Lazzari, C.** 2025. *Advancing Catalonia's transition with district heating and cooling networks* [Online]. Available at: https://musedhc.ambienteitalia.it/2025/11/13/advancing-catalonias-transition-with-district-heating-and-cooling-networks/.

Berbatović, V. 2025. *Slovenia keeps phasing out coal as key heating plant boosts natural gas share to 60%* [Online]. Available at: https://balkangreenenergynews.com/slovenia-keeps-phasing-out-coal-as-key-heating-plant-boosts-natural-gas-share-to-60/.

Bloomberg. 2025. 'Europe's Cold Snap Puts Thousands of New Heat Pumps to the Test'. *Energy Connects*, 20 November [Online]. Available at: https://www.energyconnects.com/news/renewables/2025/november/europe-s-cold-snap-puts-thousands-of-new-heat-pumps-to-the-test/.

Božič, T, Deželak, K, König, S and **Rutar, T.** 2023. *Domestic energy production down, energy dependency up* [Online]. Available at: https://www.stat.si/StatWeb/En/News/Index/11405.

Budapest District Heating Service Ltd. (ed.) 2025. *Budapest District Heating Service Ltd.* [Online]. Available at: https://hungairy.hu/en/node/42.

Buhin, Peharec Snjezana and **Grieß, K.** 2025. 'Sloweniens Hauptstadt stellt auf klimafreundliche Fernwärme um'. *GTAI*, 17 March [Online]. Available at: https://www.gtai.de/de/trade/slowenien/branchen/sloweniens-hauptstadt-stellt-auf-klimafreundliche-fernwaerme-um-1876608.

C40 Cities. (ed.) 2015. *Cities100: Copenhagen – Carbon Neutral District Heating* [Online]. Available at: https://www.c40.org/case-studies/cities100-copenhagen-carbon-neutral-district-heating/.

City of Copenhagen. (ed.) 2022. *The CPH 2025 Climate Plan* [Online]. Available at: https://urbandevelopmentcph.kk.dk/climate.

City of Ljubljana. (ed.) 2024. *Climate City Contract – 2030 Climate Neutrality Action Plan of the City of Ljubljana* [Online]. Available at: https://netzerocities.app/_content/files/knowledge/4444/city_of_ljubljana_ccc.pdf.

Climate-KIC. (ed.) 2024. *Preserving the past, building the future: Budapest's climate challenge* [Online]. Available at: https://web.archive.org/web/20240907184804/https:/www.climate-kic.org/news/budapests-climate-challenge/.

CompanyWall business. (ed.) 2026. *Energetika Ljubljana, d.o.o.* [Online]. Available at: https://www.companywall.si/podjetje/energetika-ljubljana-doo/MM5K58ZD.

Copenhagen Energy. (ed.) 2021. *District heating in Copenhagen: An energy efficient, low carbon, and cost effective energy system* [Online]. Available at: https://www.beankinney.com/wp-content/uploads/2021/10/District_heating_in_Copenhagen1.pdf.

Direcció de Serveis de l'Oficina de Canvi Climàtic i Sostenibilitat, Gerència de Serveis Urbans i Manteniment de l'Espai Públic and Gerència d'Àrea de Mobilitat, Infraestructures i Serveis Urbans. 2024. *Pla Clima: mesura de govern* [Online]. Available at: https://bcnroc.ajuntament.barcelona.cat/jspui/handle/11703/138564.

Districlima, SA (ed.) 2026. *La Red – Districlima Barcelona* [Online]. Available at: https://www.districlima.com/en/la-red.

Edo, M. 2021. *Waste-to-Energy and Social Acceptance: Copenhill WtE plant in Copenhagen* [Online], RISE- Research Institutes of Sweden. Available at: https://www.ieabioenergy.com/wp-content/uploads/2021/03/T36_WtE-and-Social-Acceptance_Copnehhill-WtE-plant-in-Copenhagen.pdf.

E-institute. (ed.) 2024. *Ljubljana, Slovenia: Energy efficiency and public housing* [Online]. Available at: https://www.climatehub.si/en/ljubljana-slovenia-energy-efficiency-in-public-housing/.

Enerace Sp. z.o.o. (ed.) 2025. *How can Poland replace coal-fired electricity?* [Online], Bowwe.com. Available at: https://enerace.eu/blog/poland-coal-power-replacement#.

Energetika Ljubljana. (ed.) 2014. *Energy in a heartbeat* [Online]. Available at: https://www.energetika.si/en/about-us-2.

Energetika Ljubljana. (ed.) 2018. *Energy in a heartbeat* [Online]. Available at: https://www.energetika.si/sites/www.jhl.si/files/dokumenti/energetika-id-brosura-ang-web_1.pdf.

Energy Cities. (ed.) 2024. *EU Tracker – Local heating and cooling plans in Denmark* [Online]. Available at: https://energy-cities.eu/countries/denmark/.

Erőss, A, Zsemle, F and **Pulay, E.** 2015. *Heat potential evaluation of effluent and used thermal waters in Budapest, Hungary* [Online]. Available at: https://real.mtak.hu/38164/1/24.58.2015.1-2.4.pdf.

EU Covenant of Mayors. (ed.) 2024a. *Budapest's heat detox against all odds* [Online]. Available at: https://eu-mayors.ec.europa.eu/en/budapest-heat-detox-against-all-odds.

EU Covenant of Mayors. (ed.) 2024b. *Warsaw's plans to heat the city with metro's waste heat* [Online]. Available at: https://eu-mayors.ec.europa.eu/en/warsaws-plans-to-heat-the-city-with-metros-waste-heat.

Euroheat & Power. (ed.) 2023. *Large district heat pump operation in Mannheim* [Online]. Available at: https://www.euroheat.org/news/large-district-heat-pump-operation-in-mannheim.

European Commission. 2019. *The European Green Deal* [Online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0640.

European Commission. 2021. *'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality* [Online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0550.

European Commission. (ed.) 2024. *Spain: Status of the Heat Pump Market* [Online]. Available at: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC137131/JRC137131_025.pdf.

European Environment Agency. 2025. *Greenhouse gas emissions from energy use in buildings in Europe* [Online]. Available at: https://www.eea.europa.eu/en/analysis/indicators/greenhouse-gas-emissions-from-energy.

Evida (ed.) 2025. *Nøgletal i Evida* [Online]. Available at: https://evida.dk/nogletal/.

Forum Energii. (ed.) 2025. *Scenariusze transformacji energetycznej Warszawy* [Online]. Available at: https://www.forum-energii.eu/download/pobierz/scenariusze-transformacji-energetycznej-warszawy.

Geiser, J. 2023. *Ambitionierte Klimaziele* [Online]. Available at: https://www.mannheim.de/de/stadt-gestalten/local-green-deal/ambitionierte-klimaziele.

Gentili, E. 2025. *No smoke without fire: the impact of Denmark's biomass energy on Estonian and Latvian forests – EU Bioenergy* [Online]. Available at: https://www.eubioenergy.com/2025/03/13/no-smoke-without-fire-the-impact-of-denmarks-biomass-energy-on-estonian-and-latvian-forests/.

Gerőhazi, E, Katona, N, Szemző, H, Hegedus, J and **Teller, N.** 2024. *Socio-economic analysis of the residential building stock in Budapest* [Online]. Available at: https://mri.hu/wp-content/uploads/2025/02/Survey-of-households-in-Budapest-about-energy-efficiency-%C3%89va-Ger%C5%91h%C3%A1zi.pdf.

Halleröd, L. 2023. *Policy Paper – Changing regulatory frameworks and conditions for a rapid and just phase out of natural gas: Which issues and solutions for local authorities?,* EnergyCities [Online]. Available at: https://energy-cities.eu/wp-content/uploads/2024/04/VF_EnergyCities_2024_PolicyPaper_Phase-out-of-natural-gas_A4_EN_Web.pdf.

Hansen, L, Stobbe, M and **Grüner, S.** 2020. *Testing Large-Scale Heat Pumps in Greater Copenhagen* [Online]. Available at: https://dbdh.org/large-scale-heat-pumps-2/.

Herreras Martinez, S, Harmsen, R, Menkveld, M, Faaij, A and **Kramer, GJ.** 2022. 'Municipalities as key actors in the heat transition to decarbonise buildings: Experiences from local planning and implementation in a learning context'. *Energy Policy*, 169: p. 113169 [Online]. DOI: https://doi.org/10.1016/j.enpol.2022.113169

Hovedstadsområdets Forsyningsselskab (HOFOR). (ed.) 2023. *Town gas* [Online]. Available at: https://www.hofor.dk/english/hofor-utilities/town-gas/.

Hovedstadsområdets Forsyningsselskab (HOFOR). (ed.) 2025. *Bliv klog på bygas – privat* [Online]. Available at: https://www.hofor.dk/privat/bygas/bliv-klog-paa-bygas-privat/.

Hungarian Central Statistical Office. (ed.) 2022. *Census database* [Online]. Available at: https://nepszamlalas2022.ksh.hu/en/database/#/table/WBL004/N4IgFgpghgJiBcBtEAVAkgWQKIH0AKWASmgPIAiIANKkQKoAyOA4liQCxUhYEBq-JAYQCMIALrUAzgEsYEBInEgJEAMYAXKQHsAdvMUAzKQBs1EAE4SEoANZTtceCAxQADpwja1ZqREtJk6Nj-4RKQUlDZ2DiAAyhBqnABuUEYArr7yIABMAAyZmWIAvuIBdIws7FQR9ggxcYnJaX7IABK0QiKiRZ0FQA.

Hungarian Energy and Public Utility Regulatory Authority (MEKH). (ed.) 2015. *Natural Gas* [Online]. Available at: https://www.mekh.hu/natural-gas.

HungaroMet Magyar Meteorológiai Szolgáltató Nonprofit Zrt. (ed.) 2024. *Budapest District Heating Service Ltd.* [Online]. Available at: https://hungairy.hu/en/node/42.

IEA – International Energy Agency. 2021. *Empowering Cities for a Net Zero Future* [Online]. Available at: https://iea.blob.core.windows.net/assets/4d5c939d-9c37-490b-bb53-2c0d23f2cf3d/G20EmpoweringCitiesforaNetZeroFuture.pdf.

International Energy Agency (IEA). (ed.) 2024. *Spain – Natural gas supply* [Online]. Available at: https://www.iea.org/countries/spain/natural-gas.

IWR 2024. 'Wärmewende im Fokus: MVV will Gasnetz bis 2035 stilllegen'. *IWR Online*, 14 November [Online]. Available at: https://www.iwr.de/news/waermewende-im-fokus-mvv-will-gasnetz-bis-2035-stilllegen-news38921.

Jędrzejuk, H and **Chwieduk, D.** 2021. 'Possibilities of Upgrading Warsaw Existing Residential Area to Status of Positive Energy Districts'. *Energies*, 14(18) [Online]. DOI: https://doi.org/10.3390/en14185984

Joint Research Centre (JRC). (ed.) 2024. *Poland: Status of the heat pump market* [Online]. Available at: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC137131/JRC137131_020.pdf.

Kaiser, U and **Jankowska, K.** 2013. *Energieeffizienz an Gebäuden in Ungarn* [Online]. Available at: https://publica-rest.fraunhofer.de/server/api/core/bitstreams/f0b1610f-1403-46d8-a912-e8dc266d9140/content.

Kochskämper, E and **Monstadt, J.** 2025. 'Decarbonizing urban heating systems in Europe: Navigating governance challenges in seven pioneering cities'. *Energy Research & Social Science*, 130, p. 104438 [Online]. DOI: https://doi.org/10.1016/j.erss.2025.104438

Lowes, R and **Gibb, D.** 2024. *Heat pumps for Spain: Reforming Spanish energy policy to support the transition to clean heating* [Online]. Available at: https://www.raponline.org/wp-content/uploads/2025/05/RAP-Lowes-Gibb-Spain-heat-pump-policy-September-2024.pdf.

Maher, A. 2025. 'Building for the Future: How Warsaw's Green Building Standard is Changing the City'. *NetZeroCities*, 16 September [Online]. Available at: https://netzerocities.eu/2025/09/16/building-for-the-future-how-warsaws-green-building-standard-is-changing-the-city/.

Ministry of Environment and Energy. (ed.) 2000. *The heat supply act* [Online]. Available at: https://speed.energybrokers.co.uk/wp-content/uploads/2015/10/Danish_Heat_Law_2000EN1.pdf.

MVM Zrt. (ed.) 2021. *Földgázelosztás* [Online]. Available at: https://mvm.hu/hu-HU/Tevekenysegunk/Elosztas.

MVV Energie AG. (ed.) 2020. *Gesellschafterstruktur – MVV Energie AG* [Online]. Available at: https://www.mvv.de/investoren/die-aktie/aktionaersstruktur.

MVV Energie AG. (ed.) 2026. *Fernwärme für Mannheim und Umgebung von MVV Energie AG* [Online]. Available at: https://www.mvv.de/waerme/fernwaerme.

MVV Regioplan GmbH. (ed.) 2024. *Kommunale Wärmeplanung für die Stadt Mannheim* [Online]. Available at: https://www.mannheim.de/sites/default/files/2024-03/Anlage%204%20der%20V813-2023_Abschlussbereicht.pdf.

Nedgia. (ed.) 2025. *Nedgia Catalonia* [Online]. Available at: https://www.nedgia.es/en/our-distributors/catalonia/.

Nicolletti, M, Berensson, M, Myllyvirta, L and **Cui, RY.** 2023. 'The Cost of Fossil Gas: Policy Recommendations for a Clean Energy Transition and a Swift Gas Phase-out in Cities'. *Journal of City Climate Policy and Economy*, 2(1), pp. 77–94. DOI: https://doi.org/10.3138/jccpe-2023-0009

Orbán, T. 2018. 'PRESENT STATE OF THE HUNGARIAN DISTRICT HEATING SECTOR: WITH FUTURE TRENDS AND INVESTMENTS' [Online]. Available at: https://www.tavho.org/uploads/hirek/2018-12-14_Hot_Cool_4_2018-2.pdf.

ORLEN. (ed.) 2025. *Struktura akcjonariatu ORLEN S.A* [Online]. Available at: https://www.orlen.pl/pl/o-firmie/o-spolce/organy-i-struktura-spolki/struktura-akcjonariatu.

ReUseHeat. (ed.) *Heat recovery at a hospital in Budapest, Hungary* [Online]. Available at: https://smart-cities-marketplace.ec.europa.eu/insights/solutions/heat-recovery-hospital-budapest-hungary.

Rhein-Neckar-Zeitung. 2025. 'Plötzlich ist das Gas-Aus der MVV doch nicht mehr so fix'. *Rhein-Neckar-Zeitung*, 22 March [Online]. Available at: https://www.rnz.de/region/metropolregion-mannheim_artikel,-Mannheim-Ploetzlich-ist-das-Gas-Aus-der-MVV-doch-nicht-mehr-so-fix-_arid,1535682.html.

Rosenow, J, Lowes, R and Claudia Kemfert, C. 2024. 'The elephant in the room: How do we regulate gas transportation infrastructure as gas demand declines?'. *One Earth*, 7(7), pp. 1158–1161 [Online]. DOI: https://doi.org/10.1016/j.oneear.2024.05.022

Rosenow, J, Stobbe, M and **Braungardt, S.** 2025. 'Gas grid regulation in the context of net zero transitions: A review of seven European countries'. *Energy Research & Social Science*, 122, p. 103987 [Online]. DOI: https://doi.org/10.1016/j.erss.2025.103987

Schneider, N, Nagendiram, T, Nielsen, RS and **Mangelsen, O.** 2025. *Regulation and planning of district heating in Denmark* [Online]. Available at: https://dbdh.org/large-scale-heat-pumps-2/.

Shabb, K and **McCormick, K.** 2023. 'Achieving 100 climate neutral cities in Europe: Investigating climate city contracts in Sweden'. *npj Climate Action*, 2(1), p. 6. DOI: https://doi.org/10.1038/s44168-023-00035-8

Sienkiewicz, M, Burry, M, Dach, J, Pinkas, A, Nowakowski, R, Romanowska, A and **Zając, U.** 2024. *From natural gas to biomethane – Decarbonising the Polish gas industry* [Online]. Available at: https://dise.org.pl/Report-From-natural-gas-to-biomethane.pdf.

Stadt Mannheim – Fachbereich Klima, Natur, Umwelt. (ed.) 2024. *Klimaaktionsplan 2030: Mannheims Strategie zur Klimaneutrlität* [Online]. Available at: https://www.mannheim.de/sites/default/files/2024-02/Brosch%C3%BCre%20Klimaschutz-Aktionsplan%202030.pdf.

Stadt Mannheim Kommunale Statistikstelle. (ed.) 2024. *Bevölkerung* [Online]. Available at: https://www.mannheim.de/de/stadt-gestalten/daten-und-fakten/bevoelkerung.

State of Green. (ed.) 2024a. *Leveraging excess heat to accelerate Warsaw's green transition* [Online]. Available at: https://stateofgreen.com/en/solutions/leveraging-excess-heat-to-accelerate-warsaws-green-transition/.

State of Green. (ed.) 2024b. *Warming up Copenhagen by harnessing heat from seawater and wastewater* [Online]. Available at: https://stateofgreen.com/en/news/warming-up-copenhagen-by-harnessing-heat-from-seawater-and-wastewater/.

Statistical Office of the Republic of Slovenia. (ed.) 2022. *Households by type of household, municipalities, Slovenia, multiannually* [Online]. Available at: https://pxweb.stat.si/SiStatData/pxweb/en/Data/-/05F3010S.px/.

Statistisches Bundesamt (ed.) 2022. *Zensus 2022* [Online]. Available at: https://www.destatis.de/static/DE/zensus/gitterdaten/Regionaltabelle_Gebaeude_Wohnungen.xlsx.

Stobbe, M, Hesse, T, Braungardt, S, Bei der Wieden, M, Bürger, V, Loschke, C, Rosenow, J, Anderson, M and **Claeys, B.** 2024. *Planning and regulating Europe's gas networks: breaking up with fossil gas* [Online]. Available at: https://www.raponline.org/toolkit/gas-distribution-system-planning-regulation-europe/ (Accessed 24 April 2026).

Strasszer, D and **Xydis, G.** 2024. 'Integrating geothermal energy in Hungary: A case study on sustainable urban heating and emissions mitigation through the district heating infrastructure'. *Tunnelling and Underground Space Technology*, 149, p. 105804 [Online]. DOI: https://doi.org/10.1016/j.tust.2024.105804

Tatai, Z, Bódi-Nagy, A, Orosz, I, Becsák, P, Pető, Z and **Szabó, K.** 2021. *Sustainable energy and climate action plan of Budapest* [Online]. Available at: https://archiv.budapest.hu/sites/english/Documents/BP_klimastrategia_SECAP_EN_final.pdf.

Ujazdowski, A. 2025. 'PTEC: District Heating Transformation Could Cost up to PLN 466 Billion by 2050 – Poland Insight'. *Poland Insight*, 25 August [Online]. Available at: https://polandinsight.com/ptec-district-heating-transformation-could-cost-up-to-pln-466-billion-by-2050/.

Vejrup, K. 2024. *Nyt HOFOR-anlæg får mere biogas ud af spildevand* [Online]. Available at: https://danskfjernvarme.dk/aktuelt/nyheder/2024/nyt-hofor-anlaeg-faar-mere-biogas-ud-af-spildevand.

Zwickl-Bernhard, S and **Auer, H.** 2022. 'Demystifying natural gas distribution grid decommissioning: An open-source approach to local deep decarbonization of urban neighborhoods'. *Energy*, 238, p. 121805 [Online]. DOI: https://doi.org/10.1016/j.energy.2021.121805

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