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Citation:

PALM, Jenny, AMBROSE, Aimee, DAVIES, Kathy, KILPELÄINEN, Sarah, VON PLATTEN, Jenny, JIGLAU, George, PELSMAKERS, Sofie, CASTAÑO-ROSA, Raúl and SINEA, Anca (2026). Home heating transition in Finland, Romania, Sweden and the United Kingdom through the combined lens of energy democracy, energy citizenship and energy justice. *Energy, Sustainability and Society*, 16: 31. [Article]

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RESEARCH

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Home heating transition in Finland, Romania, Sweden and the United Kingdom through the combined lens of energy democracy, energy citizenship and energy justice

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Abstract

Background Heating is a key challenge for Europe's decarbonisation goals, accounting for a large share of energy use and emissions while shaping everyday life, comfort, and vulnerability. This article compares home heating transitions in Finland, Romania, Sweden, and the United Kingdom through an integrated framework combining energy democracy, energy citizenship, and energy justice. The study examines how ownership, everyday practices, and inequality intersect to shape citizen roles in heating transitions across diverse political and infrastructural contexts.

Results Based on archival and secondary material, the analysis reveals strong contextual variation in how citizens engage with heating systems. In Finland and Sweden, municipally owned district heating offers collective stability but limited direct agency. In Romania, the collapse of state-controlled networks has left households dependent on individual and often inefficient systems. In the United Kingdom, liberalised markets promise consumer choice but deepen vulnerability through cost pressures and weak accountability. Across all cases, household participation is structured by infrastructures, welfare regimes, and historical legacies rather than by individual choice. Integrating democracy, citizenship, and justice highlights how governance models, daily practices, and inequalities interact in shaping heating transitions.

Conclusions Citizen-centred heating transitions require policy approaches sensitive to national contexts and social realities. Empowerment must go beyond rhetoric to include participatory governance in collective systems, equitable regulation in liberalised markets, and targeted support for vulnerable households. The study contributes an analytical framework that captures the social depth of decarbonisation and supports the design of heating transitions that are democratic, participatory, and just.

Keywords Energy democracy, Energy citizenship, Energy justice, Heating transition, Decarbonisation, Europe

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Background

Heating represents one of the most pressing challenges for Europe's decarbonisation agenda. Across the EU, space and water heating account for nearly half of building energy consumption and contribute to an estimated 38% of carbon emissions [1, 2]. Providing reliable warmth and hot water is also a basic energy service, needed by around 40% of households globally [1]. Yet nearly two-thirds of heating demand continues to be met with fossil fuels, making heating a critical sector for reducing emissions. Decarbonising heating is not only a technological task but also a societal transformation that affects everyday life in profound ways [3, 4]. Shifts in heating practices alter domestic routines, cultural practices [5] and comfort expectations, while also exposing and creating social vulnerabilities and inequalities [6–8]. Against this background, this article aims to examine how questions of energy democracy, energy citizenship, and energy justice are expressed in heating transitions across Europe.

The European Commission's Clean Energy Package (CEP) frames citizens as central actors in the energy transition, promoting concepts of empowerment, participation, and fairness [9–12]. By emphasising "active" citizens through ownership, participation in energy communities, and behavioural change, the CEP seeks to align decarbonisation with democratic and just energy systems. However, these framings raise questions about how they resonate with national histories and practices of heating. Energy transitions are always context-dependent: what counts as empowerment or fairness in one setting may mean something different in another [13]. This is partly because, as research has shown, household heating practices are shaped not only by technologies and policies but also by social norms, cultural attachments, gender roles, and peer influences [14, 15]. Thus, a central problem is whether the EU's universal framing of citizen participation adequately captures the lived realities of heating transitions across diverse member states and the varied communities within them.

The aim of this article is to compare how energy democracy, energy citizenship, and energy justice manifest in heating systems across four European countries: Finland, Romania, Sweden, and the United Kingdom. These countries were selected because they represent diverse political, cultural, and infrastructural trajectories: from Nordic municipal district heating systems, to post-socialist infrastructures in Romania, to the liberalised market model of the UK. By analysing how citizens have been positioned in past and present heating transitions, the article aims to identify commonalities, divergences, and contextual factors that shape contemporary decarbonisation challenges.

Building on the comparative analysis of the four European countries studied, the contribution of the paper is

to introduce an integrated framework for analysing heating transitions. Energy democracy is here understood in terms of ownership and governance structures; energy citizenship refers to everyday practices and household participation in decision-making and energy justice highlights vulnerabilities and inequalities in costs, access, and recognition [11, 16–18]. While these concepts are often applied separately, the article demonstrates how valuable they are when brought together to capture the full spectrum of citizen roles in energy transitions. The framework is both a conceptual tool for research and a practical diagnostic tool for policymakers seeking to design heating transitions that are low-carbon, democratic, inclusive, and just. In doing so, it highlights how policies can remain sensitive to everyday household realities while addressing the social consequences of technological and digital innovations.

Article structure

The remainder of this article is organised into five sections. Section 2 presents earlier research and the analytical framework, outlining how energy democracy, energy citizenship, and energy justice are conceptualised and integrated as complementary lenses. Section 3 describes the methodology and case selection, explaining how secondary and archival material from Finland, Romania, Sweden, and the United Kingdom were analysed comparatively. Section 4 presents the empirical findings, structured thematically around ownership and governance (democracy), everyday practices and participation (citizenship), and vulnerability and inequality (justice). Section 5 develops the discussion, reflecting on how these findings relate to path-dependent developments in heating systems, misalignments between EU-level framings and national realities, and the conceptual value of the integrated framework. Section 6 concludes by summarising the key contributions, drawing out policy implications for citizen-centred heating transitions, and suggesting directions for future research.

Earlier research on home heating transitions and analytical framework

Changes to heating systems restructure daily life and cultural attachments, while also reshaping comfort expectations and the attainment of thermal comfort [8]. As Velicu & Barca [6] note, energy transitions have the capacity to mitigate, reproduce and extend inequalities, underscoring the need for attention to social implications of the challenge as well as technological viability. This is not the first heating transition experienced by European households. Over the past seventy years, most countries have undergone multiple shifts, from solid fuels to centralised gas and district heating, and more recently toward electric solutions such as heat pumps [19–21].

These past transitions demonstrate that heating is never merely about efficiency or cost but involves profound reconfigurations of infrastructures, institutions, and household practices [8, 22]. They also illustrate that transitions are uneven, shaped by path dependencies, governance choices, and social norms [22, 23].

A growing body of research emphasises that heating practices are deeply embedded in routines and social organisation, making change inherently difficult [24, 25]. Heating is intertwined with the rhythms of work, care, and leisure, and is shaped by how people interact with technologies in practice [15, 24]. Transitions therefore depend not only on technological substitution but on the reconfiguration of everyday practices [26]. Policy interventions can trigger short-term behavioural change, but sustained transformation requires alignment with social norms, institutional support, and infrastructural conditions [27, 28]. Strong cultural attachments to familiar systems, such as wood-burning stoves, together with the historical proximity and availability of solid fuels, can act as barriers despite environmental drawback [8, 29–33]. Policy approaches have often framed households as rational actors expected to adopt new technologies through behaviour change, yet this framing has been criticised for overlooking the structural conditions that shape everyday energy practices and limit meaningful participation [34–36].

Equity concerns are equally central in the literature and have increasingly been conceptualised through the lens of energy justice. Research shows that heating transitions risk can disproportionately burden low-income households, who face higher upfront costs, limited access to finance, and constrained capacity to adapt [18]. At the same time, transitions offer potential benefits, including reduced bills, improved indoor air quality, and health gains [17]. However, these benefits are unevenly distributed. Studies highlight how vulnerabilities intersect with gender, class, disability, and race, and how certain groups remain underrepresented in both research and policy design [37–40]. The literature therefore converges on the view that while low-carbon heating is technically feasible and prices are falling, success requires policies that address the intertwined social, cultural, and distributive dimensions of change [7, 41].

This body of work emphasises that households cannot be treated as homogeneous actors. Instead, heating transitions must be understood in relation to diverse lived experiences and structural inequalities that shape access to energy services and participation in transition processes [38, 42]. Intersectional perspectives further demonstrate that transitions may shift rather than eliminate inequalities, reinforcing the need for policies that address underlying social conditions rather than focusing solely on technological uptake [8, 39, 40].

Taken together, the literature suggests that heating transitions are socio-technical and political processes in which governance structures, everyday practices, and inequalities are deeply intertwined. While low-carbon heating technologies are increasingly available, successful transitions depend on addressing the institutional, social, and distributive dimensions of change. This has led to growing recognition of the need to integrate perspectives from energy democracy, energy citizenship, and energy justice to better understand how participation, power, and vulnerability shape heating transitions in practice.

Analytical framework: energy democracy, energy citizenship, and energy justice

The European Union's Clean Energy Package and related strategies highlight the need to place citizens at the centre of energy transitions. In doing so, they invoke principles that closely align with the three concepts examined here: energy democracy, energy citizenship, and energy justice. These concepts have become increasingly prominent in research since the 2010s [11, 43]. All three are rooted in broader debates on sustainable development and the governance of climate change, and they share a critical stance towards the technocratic approaches that have traditionally dominated energy research [44]. In particular, they challenge the persistent neglect of the public and of democratic engagement in shaping energy futures [45, 46].

While analytically distinct, the three concepts partly overlap, particularly regarding questions of participation and decision-making. For example, procedural justice, energy democracy, and energy citizenship all address who participates in energy systems and how. In this study, the concepts are therefore not treated as mutually exclusive, but as complementary lenses that foreground different dimensions of citizen involvement: governance (democracy), everyday practices (citizenship), and distributive and recognition aspects (justice).

Although the three concepts are often used interchangeably [11, 47, 48], each one raises distinct questions. Together, however, they provide a complementary set of lenses through which heating transitions can be understood as social as well as technical processes. Energy democracy asks: Who owns and governs heating systems? Energy citizenship asks: How do households and communities interact with heating systems in everyday life, and how does access to energy strengthen or weaken their capacity to function fully as citizens in modern society? Energy justice asks: Who is most vulnerable in transitions, and how are inequalities addressed? By bringing these questions together, the framework functions as a diagnostic tool to reveal blind spots in governance and highlight the complexities of inclusivity and fairness in

practice, and how they are enacted, or neglected, in different contexts.

Energy democracy: ownership and governance

Energy democracy directs attention to the political nature of energy systems and the distribution of power over infrastructures. It is primarily concerned with ownership and decision-making: who controls the means of production and distribution, and how authority is exercised [49]. The literature often links energy democracy to collective ownership, prosumerism, and cooperatives, which are viewed as steps towards the redistribution of economic and decision-making power [11]. In the context of heating, this translates into questions about municipal ownership of district heating, the role of private utilities, and the extent to which governance arrangements enable or constrain citizen influence [50, 51].

The comparative question raised here is: *Who owns and governs heating systems?* Applying this lens enables analysis of how different ownership trajectories, municipal, cooperative, state, or private, shape citizen opportunities for democratic accountability in heating transitions.

Energy citizenship: everyday practices and participation

Energy citizenship focuses on the role of individuals and communities as participants in energy transitions, shifting attention from ownership to everyday practices and responsibilities. It emphasises that citizens are not passive consumers but active participants who can shape transitions through behaviour, awareness, and engagement [52, 53]. Energy citizenship encompasses practical participation in decisions, recognition of responsibilities,

and the balancing of rights with sustainability principles [12, 54].

Scholars describe energy citizenship both as a normative vision where citizens actively engage with energy systems and as an empirical phenomenon that varies across contexts [47, 55]. It may involve small-scale decisions in the home, such as fuel choice and thermostat use, or participation in collective schemes such as community heating projects [56]. In heating transitions, the key question is: *How do households and communities interact with heating systems in everyday life?* This lens directs attention to how mundane practices and decision-making power shape the adoption, acceptance, and contestation of heating technologies.

Energy justice: vulnerability and inequality

Energy justice, which complements the two concepts above, asks who bears the costs and who receives the benefits of energy transitions. It highlights fairness and equity in distribution, decision-making, and recognition of diverse groups [57, 58]. The energy justice literature identifies three core dimensions: distributive, procedural, and recognition justice [16]. Distributive justice concerns the fair allocation of costs and benefits, procedural justice addresses the fairness of decision-making processes, and recognition justice emphasises the acknowledgement of different needs, values, and identities.

Recent contributions have also emphasised formal and substantive equality, where the latter justifies positive discrimination in favour of disadvantaged groups to ensure equality of conditions [43, 59]. Applied to heating, the central question is: *Who is most vulnerable in transitions, and how are inequalities addressed?* This involves assessing how policies account for energy poverty, affordability, and the needs of marginalised groups, including low-income households, renters, individuals with health vulnerabilities, and those who are excluded from digital technology.

Integration: an analytical tool

While each concept is valuable in its own right, their integration allows for a more holistic assessment of heating transitions. Energy democracy draws attention to ownership structures and governance logics; energy citizenship highlights how people engage with heating in their everyday lives; and energy justice focuses on vulnerabilities and distributive outcomes. Analysed together, these lenses expose tensions and trade-offs. For example, municipal ownership (democracy) may enable trust but limit everyday choice (citizenship), while liberalised systems may expand individual choice but exacerbate inequality (justice).

The integrated framework thus functions as an analytical tool for comparative analysis (see Table 1). By

Table 1 Analytical framework guiding transnational comparison of heating transition

Comparative question	Lens applied	Key indicators for comparison
Who owns and governs heating systems?	Energy democracy	Ownership of production and distribution (municipal, cooperative, state, private); degree of participatory governance; transparency and accountability in decision-making.
How do households and communities interact with heating in everyday life?	Energy citizenship	Household practices and routines; scope for individual or collective choice; participation in community or cooperative schemes; perceptions of responsibility and agency.
Who is most vulnerable in transitions, and how are inequalities addressed?	Energy justice	Presence of energy poverty; affordability of heating; protection of disadvantaged groups (e.g., renters, low-income, digitally excluded); mechanisms for distributive, procedural, and recognition justice.

applying the three questions in tandem - who owns and governs, how do citizens interact, and who is vulnerable - researchers and policymakers can identify blind spots in governance and better understand how citizen-centred heating transitions are enacted across diverse national contexts. This framework structures the empirical analysis that follows, guiding comparison of Finland, Romania, Sweden, and the United Kingdom.

Methods and case selection

This article draws on research conducted within the JustHeat project, which examines how major changes to home heating technologies over the last seventy years have played out in everyday life across Europe. The empirical material consists primarily of detailed analysis of historical policy documents, government documents and other historical documentation (incl. media sources), and secondary literature. The purpose of this material is to provide a historically informed analysis of national heating systems, combining insights from past developments with an assessment of contemporary configurations. Rather than offering a full historical reconstruction, the analysis uses historical material to contextualise current heating systems and policy debates.

Sources were selected to capture key policy developments, institutional changes, and public debates related to heating in each country (see Table 2 below). The selection focused on national-level policy documents, parliamentary reports, and widely circulated media sources, complemented by secondary literature over the period from the mid-20th century to 2025. The aim was to ensure coverage of both formal policy frameworks and broader societal discourses.

In Sweden, the analysis included 27 government reports concerning energy and housing, accessed through the Riksdagen Dokument och Lagar archive, and 169 newspaper articles retrieved from *Svenska tidningar*. In Finland, the focus was on 15 parliamentary committee reports alongside energy and housing policy papers, complemented by coverage in *Helsingin Sanomat* and YLE. In the United Kingdom, sources included

parliamentary papers and debates, newspaper reporting across the political spectrum, private papers from figures in the energy industry, and records from relevant social and political organisations such as the National Union of Mineworkers. In Romania, key sources were government strategy documents, including the national energy strategy, the National Integrated Plan for Energy and Climate (as required by the European Commission), and reports from the Romanian Energy Poverty Observatory, as well as media commentary on energy reform.

Archival materials were complemented by desk research on secondary literature, allowing triangulation between policy documents, media reporting, and scholarly analysis over time. The material was analysed through qualitative coding guided by the three analytical lenses: energy democracy, energy citizenship, and energy justice. This involved identifying themes related to ownership and governance, everyday practices, and vulnerability, which were then compared systematically across the four cases.

Case selection

The four countries Finland, Romania, Sweden and the United Kingdom were selected to capture variation in infrastructural traditions, governance regimes, and vulnerability profiles. The Nordic cases provide examples of countries with strong municipal traditions in district heating and relatively high levels of public trust, though they differ in their reliance on bioenergy and integration of emerging technologies such as heat pumps. The UK represents a liberalised energy market dominated by individual gas boilers, offering a counterpoint to the collective infrastructures of the Nordic model. Romania exemplifies post-socialist transitions, where centrally controlled Soviet-era district heating systems have deteriorated and fragmented, exposing households to both unreliability and affordability challenges. Together, these cases illustrate contrasting historical legacies and policy environments, enabling a richer analysis of how citizen roles in heating transitions are shaped across Europe.

Comparative strategy

Each case was analysed chronologically to trace how heating systems evolved, focusing on major policies, infrastructural investments, and public debates. These narratives were then reinterpreted through the three lenses and compared across countries. Instead of presenting four stand-alone case studies, the findings are synthesised thematically to highlight commonalities and divergences. This approach reflects what Skocpol & Somers [60] call a “parallel demonstration of theory”: applying the same analytical framework to multiple cases in order to reveal broader patterns.

Table 2 Overview of empirical material

Country	Policy documents	Media sources	Other material
Finland	Parliamentary reports	Helsingin Sanomat, YLE	Policy papers
Romania	National strategies, policy reports	National newspaper articles	Reports (e.g. Energy Poverty Observatory)
Sweden	Government reports	National newspaper articles	Secondary literature
UK	Parliamentary records, archives	National newspaper articles	Industry and organisational records

By integrating historical and contemporary evidence, the method captures both the path-dependent nature of heating infrastructures and the emerging challenges of decarbonisation. While the study relies primarily on documentary and secondary material rather than fieldwork, its strength lies in combining diverse sources to generate a comparative, historically informed account of heating transitions. The results therefore provide analytical insights into how ownership, everyday practices, and vulnerability intersect in different contexts, and how these insights can inform more inclusive approaches to heating decarbonisation in Europe. It also follows the logic of Yin (64), who set up multiple case studies to allow theoretical generalisation by comparing similar phenomena in diverse contexts.

Results: comparative analysis

This section presents a comparative analysis of heating transitions in Finland, Romania, Sweden, and the United Kingdom, structured through the three analytical lenses of energy democracy, energy citizenship, and energy justice. Rather than presenting each country in isolation, the findings highlight cross-national similarities and divergences, showing how ownership, everyday practices, and vulnerability intersect to shape heating transitions.

Ownership and governance (energy democracy)

Ownership and governance arrangements play a central role in shaping how heating systems develop, who controls decision-making, and the degree of accountability to citizens. Across the four countries, significant variation exists in the balance between municipal, cooperative, private, and state ownership.

In Sweden and Finland, district heating is the backbone of urban heating provision. Sweden supplies 90% of heat demand in multifamily buildings and 17% in detached houses through district systems [61]. Finland similarly relies heavily on district heating, which covers 45% of heating demand [62]. These systems are primarily operated by municipal or state-owned companies, though in both countries private firms also play a role. Such ownership structures provide a degree of local accountability, with municipal utilities often seen as part of the welfare state. Nevertheless, households have limited direct choice: while they may opt out of collective systems and install heat pumps, they cannot typically choose between competing district heating suppliers due to natural monopolies [55].

Romania illustrates a very different governance trajectory. During communism, urban heating was dominated by state-controlled district heating. Following the collapse of the regime, investment in maintenance dwindled, and over 260 facilities closed in just one decade [63]. Today, only around 1.1 million households (out of

around 7 million) remain connected, mainly in Bucharest. Elsewhere, individual gas boilers and wood-burning dominate, reflecting both infrastructural decline and a preference for autonomy after years of rationed provision [64]. The Romanian case thus reveals how the erosion of collective infrastructure weakens democratic accountability in heating provision: fragmented individual systems place responsibility on households while local authorities struggle to exercise oversight.

In the UK, the heating landscape is defined by individual gas boilers, still present in 74% of households (reduced from a peak of 95%) [65], and provided by a privatised, liberalised energy market. At the beginning of the national transition to gas in the 1960s, provision was nationalised. By the end of the national transition British fuel and power industries had been transferred to private hands.

Today, 22 companies compete in the market, supplying both gas and electricity, though satisfaction is low and households exercise little real influence [66]. District heating is marginal (meeting less than 2% of heat demand), serving mainly social housing. The UK case highlights the limits of “consumer choice” as a proxy for democratic engagement: while households can theoretically switch providers, they remain dependent on the same centralised infrastructure and exposed to volatile markets.

The variation across the four cases underscores how ownership structures affect citizen agency. Municipal systems, as in the Nordics, offer stronger democratic accountability but limit consumer choice. Liberalised markets, as in the UK, expand nominal choice but reduce collective influence. Post-socialist collapse, as in Romania, leaves households with autonomy in name but vulnerability in practice. Energy democracy in heating therefore cannot be reduced to a single model: rather, it reflects how ownership and governance distribute both decision-making and accountability. Table 3 provides a comparative summary of ownership structures across the four countries.

Everyday practices and participation (energy citizenship)

If ownership sets the structural framework, everyday practices reveal how households actually experience and interact with heating. Energy citizenship highlights the extent to which people are active participants or passive recipients in heating transitions.

In Sweden, district heating is often described as “invisible” to users [21]. Heat arrives automatically, and households simply adjust radiators, with little sense of cost or control, especially under “warm rent” systems where heating is included in rent [67, 68]. In both Sweden and Finland recent fluctuations in electricity prices have made electric heating more salient. Spot-price contracts

Table 3 Summary of ownership structures

Category	Finland	Romania	Sweden	UK
District heating and central heating	Operated at the municipal level; includes public companies, public-private partnerships, and private operators. District heating is prominent but under pressure due to rising prices and competition from individual heating solutions.	Historically dominated by district heating during communism, now mostly defunct or underfunded. Only 1.1 million households remain connected, primarily in urban areas like Bucharest.	District heating dominates urban areas, supplying 90% of heat demand in multifamily buildings and 17% in single-family homes. Operated by private, municipal, or state-owned companies with natural monopolies.	District heating is limited to a small proportion of homes, most of which are social housing. Central heating mainly uses natural gas, with rural areas relying on oil.
Individual heating ownership	Households can choose heat pumps or electric heating, with growing adoption of heat pumps. Biomass also plays a key role in individual systems while the phase-out of oil is supported.	Majority of households use individual systems (gas boilers, wood, coal) with inefficient technology.	Homeowners can install heat pumps, boilers, or other systems; electricity is widely used for single-family homes.	Wealthier households dominate adoption of low-carbon heating technologies like heat pumps and photovoltaics.

exposed households to volatile bills, sparking campaigns such as *Astetta Alemmas* (“one degree lower”), which encouraged energy saving [69] and meant a stronger reliance on hybrid heating systems, where possible [70, 71]. Here, citizenship emerges less through collective governance and more through demand-response practices shaped by market signals. While both Sweden and Finland rely heavily on district heating, there are important differences in how citizens engage with heating systems. In Finland, exposure to electricity price fluctuations has made heating more visible and subject to active management, whereas in Sweden heating remains more “invisible” in everyday life, particularly in multifamily housing.

In Romania, dissatisfaction with unreliable district heating drove a mass switch to individual gas boilers. For many urban households, the ability to control indoor temperatures symbolised autonomy after decades of rationed supply [72]. However, this autonomy is limited. Gas prices are volatile, and infrastructure breakdowns in the remaining district systems leave citizens with few alternatives. In rural Romania, reliance on wood requires manual management of stoves, ordering fuel, and even participation in informal wood markets. Here, energy citizenship is highly active but often precarious, with choice limited.

In the UK, households interact daily with central heating systems, adjusting boilers and radiators to balance comfort with affordability. Smart meters have further heightened awareness of energy use, making costs more visible [73], even if earlier studies also have highlighted the limitations of using smart meters as demand management policy [74]. These forms of participation are shaped by constraints: households adopt practices such as only heating certain rooms or heating to relatively low temperatures (16–19 degrees C) primarily to cope with costs, rather than acting as empowered co-producers. Moreover, policies like the forced installation of pre-payment meters where households are struggling to pay, exemplify a model where “citizenship” is experienced as surveillance and discipline rather than empowerment [75].

Across the four cases, energy citizenship varies from invisibility (Sweden) to demand-management (Finland), autonomy-seeking (Romania), and cost-driven responsibility (UK). What unites them is that household practices are deeply structured by infrastructures and markets. Active engagement often emerges not through choice but through necessity when? coping with price volatility, unreliable networks, or poor insulation. Energy citizenship in heating transitions is therefore less about voluntary empowerment and more about the uneven distribution of agency across contexts. Table 4 summarises the key findings on everyday practices and citizen control.

Inequality and vulnerability (energy justice)

The third lens, energy justice, highlights how heating transitions affect vulnerable groups and whether policies address or neglect inequality. All four countries face challenges, but the forms and severity of vulnerability differ markedly.

In the UK, fuel poverty has been recognised since the 1970s and has increased to record levels, affecting around 20% of households after hovering around 10% for decades [76]. Vulnerability is concentrated among single parents, ethnic minorities, private renters, and those on pre-payment meters and is starting to affect more elderly people, too after reductions in government support [77]. Social

Table 4 Summary of the main results for everyday practices and citizen control

Country	Citizens' control
Finland	Citizens have limited direct control over district heating systems, but electricity pricing mechanisms, such as spot or fixed-price contracts, make electric heating usage more visible and impactful on household budgets. Public campaigns like "Astetta Alemmas" promote energy-saving behaviours, fostering greater awareness and engagement in energy decisions. Homeowners exercise greater agency since they can select and manage systems such as heat pumps or electric heating, which offer more flexibility and control.
Romania	Citizens in urban areas largely transitioned to individual gas boilers for greater autonomy after dissatisfaction with inefficient district heating systems, but lack flexibility and are vulnerable to sudden increases in prices of the fuel they use. However, those still connected to district heating often have limited alternatives during breakdowns. In rural areas, reliance on wood heating is constrained by environmental regulations, leading to frustration and informal markets.
Sweden	District heating users experience little to no direct interaction with, or influence over, their heating systems. Multifamily dwellings with "warm rent" further disconnect households from heating costs. Detached homeowners, however, have more agency, as they can choose and manage systems like heat pumps or electric heating, which provide greater flexibility and control.
UK	Citizens have limited influence due to top-down energy policies and declining competition among energy providers. Vulnerable households face constraints such as pre-payment meters, which prioritise debt repayment over energy access. Smart meters enable better awareness of usage, but affordability concerns dominate decisions, especially in poorly insulated homes.

housing tenants often benefit from better efficiency standards, but poorer owner-occupiers and private renters face high costs and limited access to subsidies [78]. Current policies, such as subsidies for heat pumps, are insufficient to cover full costs, making low-carbon transitions inaccessible for many [79].

Romania frames energy poverty primarily as an issue of income. Social assistance programmes provide heating benefits to low-income households, but structural issues such as inefficient housing, reliance on wood, and the decaying infrastructure remain unresolved. Universal compensation schemes introduced during recent energy price crises applied to all consumers, but critics argue they failed to target those most in need [72]. Rural households remain particularly vulnerable, unable to switch fuels due to cost and limited grid coverage.

In Finland and Sweden, energy poverty has not historically been a major concern, partly due to robust welfare systems and relatively affordable energy. Yet recent spikes in electricity and district heating prices have exposed new vulnerabilities [80]. In Finland, subsidy schemes to

Table 5 Summary of the results for vulnerable households

Country	Vulnerable households
Finland	As energy poverty is not addressed as an independent issue, rising electricity prices have brought to the fore concerns on the precarious energy situations in vulnerable groups. Support schemes for heating system replacement are not adequately accessible to low-income households, and a lack of clear energy poverty definitions and indicators hinder effective targeting of vulnerable groups.
Romania	Energy poverty is addressed mainly through income-based heating benefits, leaving structural issues unresolved. Rural households relying on wood or coal face high costs and lack alternatives, while urban vulnerable households live in poorly insulated homes. Universal compensation schemes fail to target those most in need.
Sweden	Energy poverty is a relatively new concern. Lower-income households in multifamily buildings face multiple disadvantages limiting sufficient access to heating. Warm rent systems reduce heating costs but disconnect tenants from energy-saving incentives and overall participation. Detached homeowners face challenges due to limited subsidies for upgrading inefficient heating systems.
UK	Vulnerable groups include single-parent households, ethnic minorities, private renters in inefficient homes, and pre-payment meter users. These households struggle to transition to low-carbon heating systems due to high upfront costs, insufficient subsidies and high electricity prices compared to gas. Pre-payment meters exacerbate energy poverty by increasing energy costs.

replace oil boilers are poorly accessible to low-income groups [81]. In Sweden, debates have emerged around equity in rental housing, where "cold rent" systems place disproportionate burdens on tenants in poorly insulated buildings [82]. At the same time, insufficient heating access in warm rent apartments, often connected to a lack of power and influence among tenants, have also been raised as a form of hidden energy poverty in Sweden [68]. In detached housing, factors such as renting and/or relying on inefficient modes of heating can limit both influence and affordability to improve one's situation, and subsidies have not been specifically targeted to these groups [67]. Scholars have also criticised the lack of income-sensitive measures in implementing EU directives on energy efficiency [83].

Vulnerability in heating transitions is shaped both by welfare regimes and infrastructural legacies. In the Nordics, justice concerns are emerging as new issues linked to affordability and subsidy design. In Romania, vulnerability is long-standing and exacerbated by infrastructural decay. In the UK, fuel poverty is entrenched and exacerbated by liberalised markets and regressive practices such as pre-payment meters. Taken together, the cases highlight that energy justice is not a marginal concern but

central to the viability of heating transitions. Table 5 summarises comparative findings on vulnerable households.

Discussion

This comparative analysis of Finland, Sweden, Romania, and the United Kingdom demonstrates how the EU's ambition to place citizens at the centre of the clean energy transition interacts unevenly with national histories, infrastructures, and welfare regimes. By applying the three complementary lenses of energy democracy, energy citizenship, and energy justice, the analysis highlights both the opportunities for inclusive transitions and the structural blind spots that limit citizen empowerment in practice. Together, these lenses serve as an analytical tool for understanding the strengths and weaknesses of EU-level citizen-centred policies when translated into national contexts. Although the UK is no longer a member of the EU, its policies remain closely aligned with EU approaches, and many of the changes referred to in this paper occurred during its period of membership. For this reason, the UK is treated alongside the EU member states.

Cross-cutting synthesis: strengths and blind spots of EU policy

Although the EU's Clean Energy Package [9, 10] positions citizens as empowered actors in energy transitions, the four cases show stark differences in how such empowerment is realised in practice.

Ownership and governance

Nordic municipal systems demonstrate how district heating can provide collective sustainability benefits and relatively stable prices, but they also illustrate a blind spot in EU discourse: centralised infrastructures risk limiting citizens' direct agency. Where households cannot choose suppliers or engage in governance processes, democratic accountability depends entirely on municipal institutions rather than citizen participation [22, 55, 84]. In the UK, by contrast, liberalised energy markets promise consumer choice, but in reality citizens remain passive customers of privatised utilities, with little influence over infrastructure decisions, aside from objecting to or supporting planning applications [66]. Romania reveals a different challenge: the erosion of collective infrastructure after communism left citizens with fragmented, individual systems, often polluting and inefficient. In each case, the CEP's call for "citizen empowerment" interacts differently with national legacies, raising the risk of either overestimating agency in liberalised markets or underestimating the inertia of collective infrastructures.

Everyday practices

EU framings often assume that citizens will act as rational prosumers who actively optimise their energy use. Yet across the cases, heating practices remain deeply embedded in routines and shaped by infrastructural lock-in. In Sweden, district heating is largely invisible, reducing scope for everyday engagement [55]. In Finland, fluctuating electricity prices and public campaigns have made households more conscious of consumption [71], but participation here is primarily market-driven rather than democratic. In Romania, autonomy over heating was partially reclaimed after communism through individual gas boilers, but precarious infrastructures limit real flexibility [72]. In the UK, high costs and pre-payment meters mean that practices are often shaped by necessity rather than empowerment [75]. These examples reveal a blind spot in EU citizen framings: energy practices are not merely a matter of individual choice but are structured by infrastructures, markets, and welfare regimes.

Inequality and vulnerability

Energy justice is the area where the disjuncture between EU visions and national realities is most visible. The CEP's universal rhetoric of "clean energy for all" often overlooks structural inequalities. The UK has a long-standing recognition of fuel poverty, with targeted interventions including various energy bill subsidies, insulation and boiler upgrade schemes, yet many vulnerable groups remain excluded due to high upfront costs for low-carbon technologies [20, 79]. Romania's policies often treat energy poverty as a matter of income alone, neglecting structural and infrastructural drivers [85]. In Finland and Sweden, energy poverty has only recently emerged as a policy concern, with limited positive discrimination for vulnerable groups [8]. These disparities highlight that vulnerability is not marginal but central to heating transitions, and EU frameworks risk glossing over the diversity of national challenges.

Path dependency in heating transitions

The findings highlight the importance of path dependency in shaping contemporary heating systems. In Finland and Sweden, long-standing investments in district heating infrastructures continue to structure both governance arrangements and household practices, limiting the scope for rapid transformation. In Romania, the collapse of centrally planned district heating systems has created fragmented and often inefficient individual solutions, with long-term implications for both sustainability and equity. In the United Kingdom, the historical expansion of gas-based heating systems has resulted in strong infrastructural lock-in, making the transition to low-carbon alternatives particularly challenging. These cases illustrate how past policy choices and infrastructural

developments continue to shape present opportunities and constraints in heating transitions.

Theoretical contribution: an analytical tool

This study contributes theoretically by demonstrating how energy democracy, energy citizenship, and energy justice can be used in combination as an analytical tool for analysing heating transitions. While often treated separately in energy research, the three concepts are best understood as complementary perspectives that, when integrated, capture the multidimensionality of citizen-centred transitions. By applying these three lenses together, the analysis avoids the pitfalls of narrow approaches. For example, focusing solely on democracy risks celebrating municipal ownership while overlooking everyday disengagement. A citizenship lens alone risks assuming active participation where infrastructures limit agency. Justice, when isolated, may highlight inequities but miss how governance arrangements and daily practices reproduce them. Integrated, the three lenses form a triangular diagnostic framework that captures the barriers posed by historical, institutional, and material conditions. This framework also contributes to socio-technical transitions theory. Much of the multi-level perspective literature focuses on niche innovations and regime shifts but applying democracy–citizenship–justice as a diagnostic lens reveals the social depth of transitions: ownership arrangements, everyday practices, and inequality are not peripheral but central to whether transitions succeed or fail.

Policy implications: tailoring EU frameworks

The findings have several implications for EU energy policy and for inclusive energy policy in the UK. While the CEP emphasises citizen empowerment, the analysis shows that one-size-fits-all framings are insufficient.

1. Recognise diverse governance legacies. In Nordic countries, strengthening participation within municipal and district heating systems could deepen energy democracy, for instance by expanding cooperative ownership or citizen representation in utility governance. In the UK, where liberalised markets have left households vulnerable, empowerment requires stronger regulatory frameworks and targeted subsidies rather than reliance on consumer choice. In Romania, investment in district heating renewal and local governance capacity is essential for restoring trust and collective accountability.
2. Acknowledge everyday practices. Policies should not assume that citizens are automatically willing or able to act as prosumers. In contexts where heating is invisible (e.g. Swedish district heating), engagement

strategies must focus on institutional transparency rather than individual behaviour. Where practices are cost-driven (e.g. UK pre-payment meters), addressing affordability is a prerequisite for participation and restoring trust.

3. Prioritise vulnerability. EU-level goals of “clean energy for all” require stronger mechanisms for positive discrimination in favour of vulnerable groups. This means designing subsidy schemes that are accessible to low-income households, avoiding regressive measures such as pre-payment meters, and ensuring that rental housing policies do not disadvantage tenants in poorly insulated dwellings [86].
4. Integrate analytical tools. The European Green Deal already signals an ambition to integrate concerns of democracy, citizenship, and justice into the energy transition [59]. However, these intentions have not yet been fully realised in practice. Applying frameworks that explicitly combine these perspectives would strengthen policymakers’ ability to assess not only technological feasibility but also democratic accountability, citizen engagement, and social equity. Without such integration, there is a continued risk that transitions will be efficient in technical terms but socially unsustainable.

Conclusions–synthesis and outlook

This comparative analysis underscores the importance of tailoring citizen-centred frameworks for heating transitions to diverse national contexts. While the EU’s CEP offers a powerful narrative of empowerment, its effectiveness depends on how ownership, everyday practices, and vulnerabilities are mediated by specific historical and institutional settings.

Three findings stand out. First, ownership structures shape the scope of energy democracy. In Finland and Sweden, district heating systems provide collective sustainability benefits and relatively stable provision, yet their character as natural monopolies limits citizen agency [55, 84]. In Romania, the erosion of centralised infrastructures after communism has left households dependent on fragmented and often inefficient individual systems, undermining both sustainability and trust [63, 72]. In the United Kingdom, privatised gas-based systems offer nominal choice but little genuine democratic accountability, with affordability constraints and weak regulation curtailing citizen influence [66, 78].

Second, everyday practices reveal the potential and limitations of energy citizenship. In Sweden and Finland, district heating is largely invisible to households, reducing opportunities for meaningful daily interaction [33, 55], while fluctuating electricity contracts in Finland have stimulated some awareness of heating demand [71]. In

Romania, the shift to individual gas boilers represented a search for autonomy after decades of underheating, but rural reliance on wood continues to expose constraints on flexibility [72, 85]. In the UK, routine engagement with heating revolves around affordability, where prepayment meters and thermostat adjustments highlight how necessity, rather than empowerment, structures citizen practices [21].

Third, vulnerabilities highlight the centrality of energy justice. Energy poverty is long recognised in the UK but persists despite targeted interventions [76, 87]. In Romania, policy tends to frame energy poverty primarily as an income issue, neglecting structural and infrastructural inequalities [85, 88]. In Finland and Sweden, energy poverty has only recently entered the political agenda, but support measures remain limited in scope and accessibility [81, 82]. Across all contexts, the high upfront costs of low-carbon technologies disproportionately burden vulnerable households, exposing a justice gap between EU-level aspirations and national realities [79, 86].

Taken together, these findings demonstrate the value of integrating energy democracy, energy citizenship, and energy justice into a single analytical framework. Each lens captures distinct dynamics, but only in combination do they reveal how ownership arrangements, everyday practices, and vulnerabilities interact to shape inclusivity in heating transitions [11, 16]. This triangular framework not only enriches research into socio-technical transitions but also offers a practical diagnostic tool for assessing the democratic, participatory, and equitable dimensions of energy policy [42, 84].

The broader implication is that EU policy cannot rely on one-size-fits-all framings of “citizen empowerment.” Collective infrastructures must be paired with participatory governance [50]; liberalised markets must be complemented by strong protections for vulnerable households [20]; and subsidies and incentives must be designed to be genuinely accessible to low-income groups [8]. For research, the integrated framework provides a pathway for comparative studies that move beyond technology or economics to place citizens at the centre of transition analysis [23, 89, 90].

Ultimately, the transition to low-carbon heating is not only a technical or economic challenge but a profoundly social and political one as well as historically loaded. By combining the perspectives of democracy, citizenship, and justice, this study provides both conceptual clarity and empirical insight that can guide more inclusive, equitable, and sustainable energy transitions across Europe and beyond [7, 44].

Acknowledgements

Thanks to the reviewers and the editor for their constructive comments, which have improved the paper substantially. This research has been conducted as part of the project Looking Back to Move Forwards: a Social and Cultural

History of Heating (JustHeat), supported by Forte (Grant Number 2021-01626), Sweden, The Research Council of Finland, The Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI), Romania and United Kingdom Research and Innovation under CHANSE ERA-NET Co-fund programme, which has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement no 101004509.

Author contributions

J.P. conceived and designed the study and wrote the main manuscript text. A.A., K.D., S.K., J.v.P., G.J., S.P., R.C.R., and A.S. each contributed to the country-specific analyses and sections for the United Kingdom, Finland, Sweden, and Romania. All authors reviewed, commented on, and approved the final manuscript.

Funding

Open access funding provided by Lund University. This research has been conducted as part of the project “Looking Back to Move Forwards: a Social and Cultural History of Heating” (JustHeat), supported by Forte (Grant Number 2021–01626), Sweden, the Research Council of Finland, the Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI), Romania and United Kingdom Research and Innovation under the CHANSE ERA-NET Co-fund programme, which has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement no 101004509. Open access funding was provided by Lund University.

Data availability

This study uses secondary data exclusively. The data was obtained from publicly available sources which are all in the references.

Declarations

Ethics approval and consent to participate

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 17 October 2025 / Accepted: 31 May 2026

Published online: 10 June 2026

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