

Locally-led governance of residential heat transitions: Emerging experience of and lessons from the Dutch approach

Anna Devenish¹, Matthew Lockwood^{*}

Science Policy Research Unit, University of Sussex Business School, Jubilee Building, Falmer, Brighton BN1 9SN, UK

ARTICLE INFO

Keywords:

Heat
Decarbonisation
Governance
Netherlands

ABSTRACT

Decarbonising heat is especially difficult in the Netherlands, as it is the country in Europe most heavily dependent on natural gas for residential heating. However, the Dutch government aims to phase out the use of gas by 2050, and has adopted a local government-led process for heat decarbonisation visions and plans for neighbourhoods. This article examines the evolution of this new governance approach drawing on documentary evidence and interviews with participants in and observers of the Dutch residential heat transition. The Dutch approach has a number of strengths, building on the closeness of local government to residents and sophisticated mechanisms for technical support and knowledge sharing. However, there a number of challenges have also emerged, in policy coherence and instrument consistency, the capacity of municipalities to deliver, problematic regional coordination, vulnerability to an incumbent pro-gas coalition, and in some cases poor engagement leading to backlash from the public. The Dutch experience has useful lessons for other gas-dependent countries, such as the UK, seeking to decarbonise residential heat.

1. Introduction

Heat demand is a significant source of emissions in many high-emitting countries, meaning that the decarbonisation of heat is essential for meeting climate goals (IEA, 2022). In Europe, the largest single source of energy for residential heating is natural gas (Bertelsen and Mathiesen, 2020; IEA, 2022), so phasing out its use in favour of more sustainable energy sources is a central challenge.

This is especially so for the Netherlands, as it is the country most heavily dependent on gas for residential heating in Europe (CBS, 2021). However, in 2018, following a series of earthquakes in the gas producing region of Groningen, it was decided to stop extraction by 2022 (Dutch Government, 2020) and phase out gas use in residential heating (Beckman and van den Beukel, 2019; Tigchelaar et al., 2019). This effort was given new impetus by the adoption of a Climate Agreement in 2019 that set out targets and a strategy for decarbonising residential heat completely by 2050.

In the Agreement, the lead role for creating visions and strategies for gas-free districts across the Netherlands was given to municipalities, i.e. local government. This approach is of particular importance because it is

often argued that cutting emissions from residential heat will require a high degree of direct engagement with households (Vringer et al., 2021), with local government often seen as the tier of the state closest to the public.

In this article we examine how this governance approach has evolved within the wider institutional and political context, and against the backdrop of the major energy shock following Russia's invasion of Ukraine in 2022. The study is based on a range of documentary sources, 29 semi-structured interviews with participants in and close observers of the Dutch heat transition process, a number of municipal case studies and a UK-Dutch workshop held in September 2022. Our analysis covers the period from the adoption of the Climate Agreement in 2019 to late 2023.

We show that the creation of a new mandate for municipal leadership was layered on top of existing multi-level energy governance structures. In some areas, this has been done in a relatively coherent way, but in others this layering has led to tensions and uncertainties, which are also reflected in the resulting 'policy mix' (Rogge and Reichardt, 2016) for the heat transition. As the new approach was implemented, experiences from the construction of district visions and

^{*} Corresponding author.

E-mail address: m.lockwood@sussex.ac.uk (M. Lockwood).

¹ Eindhoven University of Technology, Industrial Engineering and Innovation Sciences, Technology, Innovation & Society Group, PO Box 513, 5600 MB Eindhoven, the Netherlands.

plans within the evolving policy mix, along with the positioning of actors in the gas lobby, have fed back into changes in original policy goals, reflecting the complex politics of residential heat decarbonisation. However, the transition has been surprisingly robust to the huge increase in prices following the Ukraine crisis.

The article contributes to the emerging literature on the Dutch municipal-led heat transition (e.g. [Herreras Martínez et al., 2022](#)), by assessing the wider governance context within which local actors are working. Our analysis has implications not only for the Dutch strategy looking ahead, but also for other countries with a similar high dependence on gas for heating, such as the UK.

The rest of the article is structured as follows. In the next section we lay out an analytical approach for the analysis of the Dutch approach. Section 3 describes the methodology and sources of evidence. Section 4 presents results on the evolution of the governance framework and aspects of coherence and tension at the levels of governance and policy, dynamics within the politics of heat transition, and the effects of the gas crisis. Section 5 concludes and draws out some lessons.

2. Analytical approach

We start by laying out a simple analytical approach, which considers the coherence of elements at the levels of governance and the policy mix, and feedback processes and exogenous shocks within the politics of the heat transition.

It is now widely recognised that socio-technical transitions to low-carbon systems require purposeful steering, especially if they are to happen rapidly ([Scrase and Smith, 2009](#); [Kuzemko et al., 2020](#); [Frank et al., 2022](#)). In this sense of steering, the nature of governance ([Kooiman, 2004](#); [van Popering-Verkerk et al., 2022](#)) is central to the speed and effectiveness of transitions. Our focus here is on the key governance innovation in the Dutch context, i.e. the new role for municipalities in leading visions and plans for moving away from gas at the district level (see Section 4.2).

This development raises the question of how this new role interacts with existing frameworks for the governance of heat and heat decarbonisation. In the Dutch case, with most heat provided by gas to individual households or via district heating, existing heat governance included liberalised markets for gas supply, regulation of gas distribution and heat networks by an independent agency, and central government policy making in areas such as tax and support for low-income households (see Section 4.3). Existing heat decarbonisation governance was centred on central government, through instruments such as subsidies for insulation, and R&D and deployment for low-carbon technologies, such as heat pumps. Much of this governance landscape was established through frameworks set at the EU level.

New roles for municipalities have not displaced existing roles in the governance framework, and so are effectively layered on top ([Mahoney and Thelen, 2010](#)). This then raises the question of how consistent the resulting *policy instrument mix* arising from these different governance roles actually is, and how coherent the processes for aligning the policy mix are. While consistency and coherence in policy mixes for sustainability transitions are a theoretical ideal ([Rogge and Reichardt, 2016](#)), it is widely recognised that a degree of incoherence and inconsistency is inevitable in situations of rapid innovation and institutional change ([Kern and Howlett, 2009](#); [Frank et al., 2020](#)). We should therefore expect to find areas of tension between municipal visions and plans on the one hand and existing policy and regulation on the other.

A second question is how far municipalities actually have the *governance capacities* required to play their new roles effectively, including powers and authority, financial resources and technical expertise ([Kuzemko and Britton, 2020](#)). These capacities will be strongly shaped by municipalities' position within wider Dutch multi-level governance structures ([Hooghe and Marks, 2001](#)). The Netherlands is seen as a decentralised unitary state ([Toonen, 1990](#)), which should in principle work in favour of municipalities having the capacities to play

an effective leadership role ([Ehnert et al., 2018](#)). However, while the Dutch idea of decentralisation has deep historical roots it has in practice fluctuated over time ([Bos, 2013](#)), not least in the funding settlement between central and local government. Privatisation and liberalisation, along with the rise of regulatory agencies, has also made the Dutch government system less state-centric, as elsewhere in the EU ([Thatcher and Sweet, 2002](#)). There are thus reasons to expect that municipal capacity may be an issue for delivering the governance model.

A final dimension for analysing Dutch heat transition governance is that of the *politics of transition*, especially how far the approach can mobilise actors for collective action and allocate resources in ways that build and maintain legitimacy ([Pierre and Peters, 2021](#)). The Netherlands is usually seen as having a political culture of cooperation and consensus-building ([Lijphart, 1968](#); [Lijphart, 2012](#)). These aspects can be seen in the process of reaching the Climate Agreement, which provided the mandate for municipalities in heat decarbonisation ([Kooistra, 2021](#)). However, the Agreement represents consensus reached at the elite level, while the experience of developing visions and producing plans has been unfolding at the local level. We can expect that this experience provides a more realistic sense of how these plans, as well as the targets in the Agreement and the wider goal of getting rid of gas, are seen by the public and other actors, not least incumbents in the gas heating regime ([Lowes, 2019](#)). A question of interest is therefore whether there has been a degree of early policy feedback ([Béland et al., 2022](#)), and what this implies both for municipal strategies, and for the wider governance and politics of heat decarbonisation.

We would also expect the politics of heat decarbonisation to be affected by external shocks. Over the last 20 years, energy markets in the Netherlands as elsewhere in Europe have been relatively stable. This situation changed radically with the major energy crisis sparked by the invasion of Ukraine in February 2022, with gas prices consequently spiking to extremely high levels ([StatLine, 2023](#)). The account here does not provide a full analysis of the gas crisis on Dutch energy policy, but rather focuses on its effects on the municipal planning process and heat decarbonisation politics. Of particular interest is whether the price surge accelerated the shift away from gas, or was so disruptive that it slowed progress.

3. Methodology

The focus of this study is innovation in heat transition governance, i.e. a complex, multi-dimensional process, for which a case study methodology ([Yin, 2018](#)) is the most appropriate. The Netherlands was selected as the critical case ([Flyvbjerg, 2006](#)), i.e. the most gas dependent country in Europe.

In developing the evidence base for the study, we drew on a wide range of data sources including: policy and legislation documentation; secondary research; grey literature; discussions in an online workshop with about 50 Dutch and British policymakers and project leaders in the area of heat transition held by the research team in September 2022, and 29 semi-structured interviews with participants and observers of the Dutch heat transition. These interviews were collected as part of a wider study of heat transitions in the Netherlands and Great Britain. All interviews were conducted between December 2021 and September 2022, with some face-to-face and others on-line. Interviewees were initially identified through the networks of the research team and through snowballing. We then deliberately sought to recruit interviewees representing a wide range of stakeholder groups, including representatives of central, provincial and local governments, business associations, civil society organisations, consultancies, local energy co-operatives, and academic and research organisations (see details in the Appendix).

Interviews varied in length but were mostly of the order of 1 h long. The majority of the interviews were recorded and transcribed verbatim, and the transcripts then thematically analysed.

In addition, we examined a small number of case studies of municipal visioning and planning processes and outcomes in Amsterdam,

Hoogeveen, Pekela and Tilburg. These cases were chosen to reflect a range of contexts from a large city through to a rural area, geographical diversity across the Netherlands and a range of different technological approaches, including a high reliance on heat networks in Tilburg, hydrogen in Hoogeveen (Erflanden), green gas and the use of heat pumps and solar panels in Pekela and a mix of approaches in Amsterdam. Case study locations were visited between March and September 2022.

4. Results

The new role of municipalities in heat transition governance in the 2019 Climate Agreement was an innovation in the governance of the heat transition in the Netherlands. As discussed in Section 2, this development raises a number of questions. First, is the approach delivering a coherent and consistent policy mix? Second, given multi-level governance relationships, do municipalities have sufficient capacity to play this role? Third, how far has the governance strategy underpinned the political sustainability of heat decarbonisation?

In this section we explore each of these questions in turn to build up an understanding of how the municipal-led approach is evolving. First, however, we provide some context with a brief account of the residential heating regime at the start of the transition, and describe the development of the municipal approach in the 2019 Climate Agreement.

4.1. Historical context

The Netherlands has the most gas dependent heating system in Europe. Up until the 1950s, municipalities had developed town gas production facilities, and extensive distribution networks, but these were fragmented and used different technical standards (Bertelsen et al., 2021). After the discovery of natural gas in Groningen in 1959, the Netherlands became a major producer, and by the 1970s distribution networks had been integrated into a single national system. In 2019, 92% of homes had access to the gas grid (CBS, 2021), 82% of which had individual boilers (in 2022) (CBS, 2023a).

As a response to the 1970s energy crisis and the increased focus on energy efficiency, the 1980s saw the major development of district heat networks, mostly using residual heat as a source (Herrerias Martínez et al., 2023). These networks were originally constructed by municipalities, but 90% are now owned by private companies (e.g. Vattenfall, Eneco, Ennatuurlijk). Heat networks served around 7% of heat demand in 2022 (CBS, 2023a). Some heat networks are associated with housing associations, which own 29% of all dwellings (CBS, 2023b).

The role of natural gas in the Netherlands began to change in the 2010s. The gas field in Groningen had long been subject to seismic activity, but after a major earthquake in 2013 the Dutch government began restricting the volume of gas extracted (Tigchelaar et al., 2019; Lowes, 2019; CBS, 2019). In 2017, emerging concern about climate change under a new government led to an agreement to phase out connections to the gas grid for new buildings, and start moving existing houses away from gas heating with an ultimate goal of all housing in the Netherlands being made sustainable by 2050 (Beckman & van den Beukel, 2019). Mandatory emission heat standards were also introduced (Rijksdienst voor Ondernemend Nederland (RVO), 2021). In 2018, the Netherlands became a net gas importer for the first time (CBS, 2023a). Following more earthquakes, the Dutch government announced a decision in 2018 to phase out extraction in Groningen. Gas extraction in Groningen stopped in October 2023.²

² <https://www.rijksoverheid.nl/actueel/nieuws/2023/06/23/gaswinning-groningen-stopt-per-1-oktober-2023#:~:text=Per%201%20oktober%20dit%20jaar,de%20gaswinning%20uit%20het%20Groningenveld.>

4.2. The Climate Agreement and the new role for municipalities

The move away from gas was given fresh impetus in 2019. The Netherlands brokered a Climate Agreement that established a goal of 95% reduction in greenhouse gas emissions from 1990 levels by 2050. The Agreement also specified targets and a governance framework for decarbonising five sectors of the economy, including the built environment. By 2050, all Dutch homes – excluding 10% of homes that are already natural gas-free – should have switched to low-carbon heating and natural gas should be phased out. As an interim goal, 1.5 million homes – or roughly 20% of all homes – should be made ‘more sustainable’ by 2030 (Climate Agreement, 2019).

The cornerstone of the governance framework for the heat transition was a locally-oriented strategy based on the approximately 14,000 districts (neighbourhoods) in the country, each containing around 500 homes. The Netherlands’ 342 municipalities were given the key responsibility for planning and implementing heat transitions (Herrerias Martínez et al., 2022). Each municipality was required to adopt a vision for heat transition by the end of 2021. These were to comprise: i) a timeframe specifying the number of homes (by district) that will be insulated and will switch to sustainable heating solutions between 2022 and 2030, and ii) an indication of sustainable heating approaches with the lowest social and end-user costs to be adopted by each district in the municipality (e.g. all-electric, district heating). They also specify where work will start on heat transitions before 2030, and which after 2030. Subsequent district-level implementation plans provide detailed plans of action for each district. An overview of visions, differentiated by the dominant technology, is shown in Fig. 1.

4.3. Consistency and coherence in the policy mix

As noted in section 2 above, municipal visioning and planning at district level was layered onto an existing governance landscape for heat and heat transition policy making, in which national government played the central role.

The Dutch gas market, which evolved under European Directives and national laws, is liberalised and unbundled. An independent regulator regulates the state-owned national transmission system operator and the

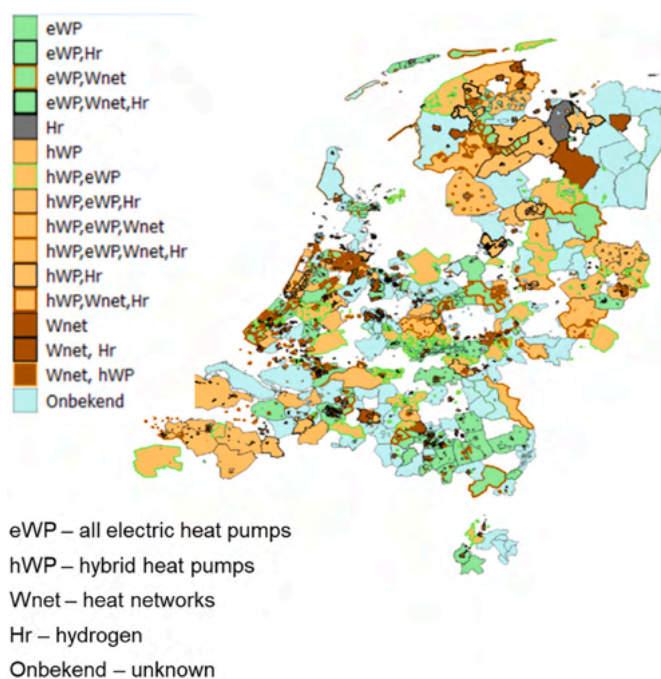


Fig. 1. Municipal heat visions. Source: Heat Expertise Centre, 2022

distribution system operators. District heat networks have been mostly privately owned since the 2000s and were unregulated until 2014, since when tariffs have been linked to gas prices to protect consumers (Herreras Martínez et al., 2023). The main focus of Dutch heat policy until recently was a market transformation programme for the rollout of higher efficiency condensing boilers in the 1990s (Weber et al., 2002), and improving the energy efficiency of housing. Energy efficiency policy has again been driven by EU Directives transposed into national programmes and targets, with all new buildings required to be nearly zero-energy from 2021 and proposals for fully decarbonising the building stock by 2050 (European Commission, n. d.). With over 80% of Dutch housing built in the post-war period (CBS, 2023c), progress on energy efficiency has been relatively good and around 85% of the housing stock has full roof insulation and double glazing, and around 75% has wall insulation (Dutch Government, 2020). Carbon emissions from housing have been in a slow decline from a peak in the mid-1990s (Fig. 2).

The government has also adopted a range of new or expanded instruments to meet Climate Agreement targets. To shift costs from electricity to gas, taxes on gas were increased significantly in 2023 (Tax and Customs Administration, n. d.). A subsidy scheme (ISDE)³ for insulation measures, heat pump installation, and heat network connections was already in place, but budgets have been scaled up with €325 m available in 2022 and €350 m available in 2023 (RVO, 2023a). The budget for the main renewable energy support programme (SDE++),⁴ which includes sustainable heat sources, was increased from €5 billion in 2020 to €13 billion in 2022 (RVO, 2021a).

A National Insulation Programme was also announced in 2022, allocating €4bn to insulate a total of 2.5 million homes (about 30% of all homes) by 2030, with a focus on those with poorest thermal performance (Dutch Government, 2022b). In the rental sector, there is a ban from 2030 on renting out properties with E, F, or G energy labels, i.e., those with the worst thermal performance (Dutch Government, 2022a). A subsidy scheme for rental properties (SAH⁵) incentivises connection to heat networks. From 2023, the landlord levy reduction scheme lifts the landlord levy for social housing associations in exchange for insulating the least efficient homes (Dutch Government, 2022c).

As the process of introducing municipal governance for heat decarbonisation into this policy landscape has unfolded, a number of questions about consistency and coherence in the policy mix have arisen. The

most obvious issue is how the municipally-led planning process fits with instruments that are based on market incentives, since while planning occurs at the collective level, market incentives are aimed at individual households, and market outcomes may or may not be consistent with plans.

The heat transition vision concept accepts the principle that building owners are free to choose any sustainable heating solutions, but emphasises that there is a preferred solution for a specific area. Municipalities can try to steer households to adopt the preferred solution in their district identified by the vision. For example, within pilot projects (see below) residents can get a larger subsidy if they opt in for the preferred heating approach (PBL, 2022). However, municipalities currently do not have the resources to do this at scale.

In technology terms, this issue can be framed as consistency between low-carbon heat network planning and individual dwelling heat pumps. While municipalities can indicate in a district plan that a heat network approach is most suitable, if large numbers of households install individual heat pumps before a network is constructed, then the plan makes less sense. To some extent this risk is mitigated by planning by housing density, but ideally a coherent approach ensuring a consistent instrument mix would be to coordinate the roll out of heat networks and individual heat pumps.

In practice this is not the case. Heat network development is largely stalled, with the percentage of heat delivered virtually unchanged at 6–7% since 2019 (CBS, 2023a). This is not least because a new Collective Heat Supply Act (*Wet Collectieve Warmtevoorziening*) (Dutch Government, 2022d) has become mired in controversy in Parliament. After more than two years of heated debates regarding market structure, in October 2022 the Dutch government proposed that public entities will have a majority share in district heat networks (Herreras Martínez et al., 2023). The bill awaits approval by the Dutch Parliament. But even when the Act is eventually passed, detailed planning and construction of heat networks takes 6–7 years, so significant growth is not expected until 2030 at the earliest.

In the meantime, many municipalities rely on the willingness of private network owners to cooperate with plans. For example, in Tilburg, which has a relatively high proportion of heat produced through district heating at 28% of homes (CBS, 2023a), options for the northwest of the municipality are to lower the temperature of the Amer heat network and replacing the power plant that provides the heat with geothermal energy. However, the municipality has no direct control over the network and cannot implement any of these changes itself.

By contrast, individual heat pump installations are expanding rapidly, more than doubling between 2021 and 2023, with over 600,000 heat pumps installed cumulatively to the end of that year (Fig. 3).

There has been a sharp increase in applications for ISDE subsidies driven by the 43% budget increase in 2022 (RVO, 2023a). In spite of the increased budget, however, subsidies do not cover 100% of costs,

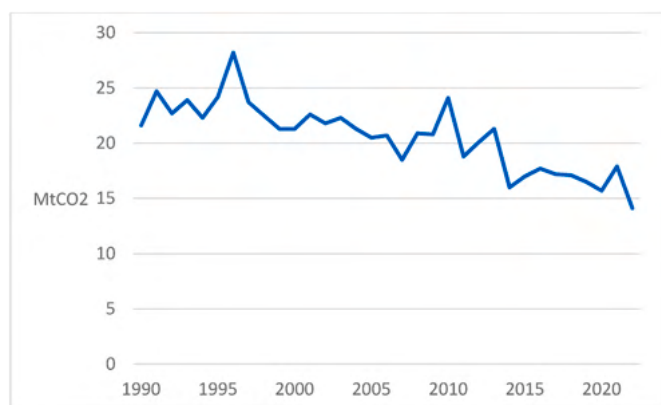


Fig. 2. GHG emissions from households 1990–2022.

Source: <https://www.cbs.nl/nl-nl/dossier/dossier-broeiassgassen/welke-sectoren-stoten-broeiassgassen-uit>

³ Investeringsubsidie Duurzame Energie en Energiebesparing

⁴ Stimulering Duurzame Energieproductie en Klimaattransitie

⁵ Stimuleringsregeling Aardgasvrije Huurwoningen

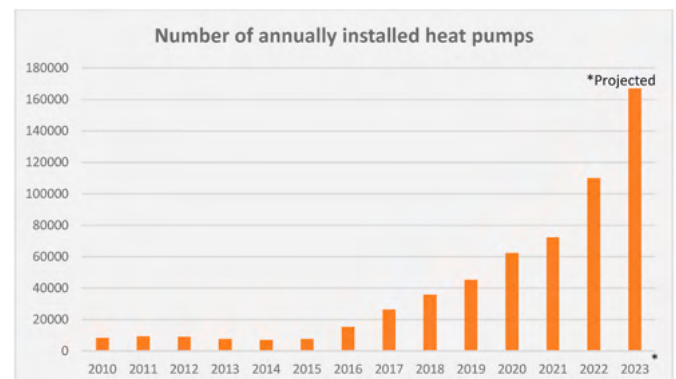


Fig. 3. Number of annually installed heat pumps in the Netherlands.

Source: Vereniging *Warmtepompen*, 2023a.

meaning that most installations are undertaken by wealthier households (Interviews 18, 19, 20, 32), as reported by the Dutch heat pump association (Vereniging [Warmtepompen](#), 2023b). Growth has also been strongly driven by the ban on new buildings having gas connections, with over 90% of new builds compliant in 2021 ([Netbeheer Nederland](#), 2023). Of the 100,000 installations in 2022, 70,000 have been installed in new buildings. Thus while municipal plans are signalled as playing the lead role in the heat transition in the Climate Agreement, currently the most dynamic drivers of heat decarbonisation are central government subsidy policies and regulations for new build.

There are similar coherence issues with 'green' gases, i.e. hydrogen, biomethane and biogas. For example, the municipality of Pekela, in north-eastern Netherlands, has made a tentative plan to adopt green gas ([ECW](#), 2022). The Amsterdam municipality has made initial plans for districts in the historic centre expected to remain on the gas network and be supplied with sustainable gas (biogas or green hydrogen) ([Amsterdam Municipality](#), 2020). However, the availability of green gas depends on central government decisions, yet to be made, about the role of hydrogen and the repurposing of the existing gas network. There are various government initiatives aimed at cost-discovery and technological development for green gases, such as the Integral Knowledge and Innovation Agenda (IKIA) and part of the SDE++ programme ([RVO](#), 2023b). However, hydrogen is not expected to be used in the built environment until 2030, with the exception of pilots ([Nationaal Waterstof Programma](#), n. d.) The use of biogas at scale will require major expansion of gasification and digestion plants, again dependent on central government support ([Winquist et al.](#), 2021).

By contrast, the policy mix for energy efficiency has become more coherent. Municipal visions and plans typically include improvements in thermal performance of existing buildings to try to minimise heat demand. Energy efficiency policy has historically been based on central government subsidy instruments (ISDE, SEEH), along with regulations for thermal performance, including for the rental sector, driven by the EU Energy Performance of Buildings Directive. Municipal governments have not historically been involved in these instruments. However, the new National Insulation Programme is now linked to the district approach to the heat transition – municipalities will receive funding to insulate 750,000 homes in the districts scheduled to become natural gas-free in the next several years. The programme also aims to insulate one million rental properties (both owned by private landlords and housing associations).

Because municipalities are working in an environment in which they do not control important policy instruments, as well as wider uncertainty about future technology costs, visions and plans in many cases do not specify heating options for each district in detail. For example, while Tilburg has a goal of phasing out natural gas and decarbonising residential heat by 2045, and divides the city into four zones based on the age of the building stock, building density and existing infrastructure, the vision does not specify technological solutions for each district within the zones. Indeed, visions and plans are expected to be frequently reviewed. As a result, in the words of one municipal official, *'Most of the [municipal] plans are vague ... And this is on purpose'* (Interview 14). Such an approach provides flexibility, but also means that municipal instruments may not be not immediately implementable, and also less effective at coordinating other actors, for example gas and electricity network operators, which need to make investment decisions based on stable expectations of demand growth or decline. This is particularly important given the growing levels of congestion on electricity distribution networks (e.g. [Edwardes-Evans](#), 2023).

4.4. Capacities of municipalities

The Climate Agreement not only created new roles for municipalities but also established a framework for coordination and support across governance levels. Actors across different governance areas were to form partnerships to perform specific tasks (e.g. to develop building

regulations, prepare technical guidance, or establish a pilot programme), relying on network governance and collaborative efforts that are characteristic of Dutch political culture. However, as decarbonisation vision exercises and plans have progressed, some challenges have emerged.

One issue concerns the powers available to local governments. Several interviewees expressed concern that local governments do not have the necessary instruments for their role in the Dutch heat transition (Interviews 1, 3, 9, 14, 22, 28, 32, 33) and compared them to 'toothless tigers'. There was concern that central government had 'dropped' the task of heat transitions on municipalities without due preparation and resources (Interviews 1, 8). As one municipal official put it: *'Local authorities get responsibility to organise things very quickly, very early in the process, without a good national package of rules and regulations'* (Interview 25). Another highlighted the lack of enforcement powers:

'We don't have the means and the power [in the heat transition]. It's all up to the people – if they want to do it and if they want to pay for it. It's a really strange position we have as a municipality. We have the [task of] coordination of the heat transition, but we don't have the means' (Interview 33).

A draft of the Municipal Instruments for the Heat Transition Act (*Wet Gemeentelijke Instrumenten Warmtetransitie*), was submitted to the House of Representatives in June 2023. One of the most contentious provisions in the bill is a potential municipal authority to designate areas with existing homes to be disconnected from the gas grid ([Volkshuisvesting Nederland](#), 2023). However, the passage of the Act through the Dutch Parliament is uncertain, and many local authorities may be averse to actually using such strong powers.

A second area is financial resources. Over the past decade the Netherlands has seen a trend in central government delegating new tasks to municipalities (e.g. youth care, spatial planning) without accompanying increased resources ([Groenleer and Hendriks](#), 2020). Indeed, financial resources have been squeezed as local budgets were cut proportionately with government spending under austerity policies adopted in the first half of the 2010s ([Weske et al.](#), 2014; [Rozmainsky et al.](#), 2022). Since 2013 municipal budget deficits have also been capped under the requirements of the EU Stability and Growth Pact. There is significant variation in the resources and staff available to municipalities to produce the visions and implementation plans (Interviews 11, 15, 19, 20, 22, 23, 28, 33). Smaller municipalities with limited personnel and financial resources face challenges in leading heat transitions ([Herreras Martínez et al.](#), 2022).

The difficulties that some local governments face in their new heat transition governance role have been recognised. The Dutch government initially allocated €2.6bn across the period 2022 to 2026 to local authorities and other actors for planning and implementation activities across climate sectors ([Dutch Government](#), 2022b). However, in 2023 a further €5.38bn was added for the period to 2030 to help municipal and provincial governments cover the costs of additional capacity for implementing energy transition in the built environment, electricity, mobility, and industry, either through hiring officials or paying for external expertise ([VNG](#), 2023).

A third area is knowledge and expertise. Overall, our case studies showed low in-house municipal expertise for planning and implementing heat transitions. This situation is partly a consequence of the liberalisation and privatisation of the energy sector in the 1990s. As one municipal official put it:

'Energy companies were at first owned by the municipalities, and we had the knowledge, but we sold them. Now we're just shareholders, so all the knowledge is gone. The only knowledge we have as policymakers and project leaders, is all about gathering parties to collaborate. We hire consultants [to perform other tasks]' (Interview 9).

Central government has provided some technical support. The *Planbureau voor de Leefomgeving* (PBL), i.e. the Dutch environmental

assessment agency, created an open-source spatial modelling tool (Vesta MAIS) to assess the technical feasibility, costs, and emission reductions of different heating technologies for each district. However, the approach has limitations – for example, [Herrerias Martínez et al. \(2021\)](#) point out that cost calculations are made only at the system level, which while useful for municipal actors, does not provide insight into how costs are spread among building owners and stakeholders in the heat supply chain.

Established under the Climate Agreement, the Heat Expertise Centre (HEC) supports municipalities with expert knowledge on the technical, legal, and financial aspects of the heat transition. The HEC also developed guidance on how to include local data in the PBL's model, a step-by-step guide for developing heat transition visions, frameworks for how a municipality defines its heat transition tasks based on local context, and guides detailing the role of network operators, and assessing heat networks' technical feasibility and business cases.

Despite these measures, municipalities often hire external consultants to conduct data modelling and techno-economic analyses, design citizen participation and communication approaches, and develop finance plans. They also rely on external consultants to navigate the PBL model outputs, or bring them in because the model is not aligned with local needs ([Herrerias Martínez et al., 2022](#)). One interviewee raised concern over this dependence:

'Municipalities with much less capacity need to buy that capacity ... So if [external consultants] go, also a lot of the expertise and the knowledge gained in this process leaves the municipality' (Interview 15).

Some municipalities have also relied heavily on housing associations, which are an important partner in planning and implementing heat transitions. They share relevant data with municipalities and work with them to align multi-year maintenance plans with heat transition plans to save costs and reduce nuisance for residents. In the heat transition visions, municipalities (for example Amsterdam) have often prioritised districts where housing associations have renovation plans in the near future. Because regular agreements are made between the government and housing associations, it is somewhat easier to enforce heat decarbonisation measures in that housing segment ([Herrerias Martínez et al., 2022](#)).

The PBL and HEC also provide mechanisms for knowledge sharing ([ECW, 2022](#)). Municipalities have been able to trial heat transition approaches through a pilot programme for establishing natural gas-free districts (*Programma Aardgasvrije Wijken* (PAW)) that was set up in 2018. Sixty-four municipalities have received PAW grants with a total of €400 m in funding. The pilots examined the use of low-carbon heating technologies, effective citizen engagement strategies, opportunities for cost reduction, management and administration issues, and the role of existing laws and regulations (Interviews 3, 7, 11, 13).

The programme has been important for what interviewees characterised as a learning-by-doing approach (Interviews 1, 11, 15, 16). A national Knowledge and Learning Programme supports sharing the knowledge gained through the PAW pilots. Evidence on challenges and barriers from pilots is collated, and then solutions are suggested or issues are referred to central government to assess whether any policy or regulatory changes are needed ([PBL, 2022](#)). A PBL analysis of PAW pilots argues that learning follows an S-curve with many unexpected issues arising initially, leading to an accelerated transition later on. However, the analysis also notes that some challenges are context-specific and cannot be resolved on the basis of existing precedents, or generate knowledge relevant to other contexts ([PBL, 2022](#)).

The approach to assisting municipalities has changed over time. In the first phase, the Heat Expertise Centre and the PAW worked with frontrunner municipalities. They examined their experience and prepared guidelines for other municipalities to use. In 2023, the PAW and the Heat Expertise Centre merged into a National Programme for Local Heat Transitions (*Nationaal Programma Lokale Warmtetransitie*, NPLW) to extend support to all municipalities.

A final area concerns coordination between local and regional governance structures. In addition to the municipal role, the 2019 Climate Agreement also established regional cooperation by requiring government at different levels to work with businesses, community groups, and network operators to develop and implement Regional Energy Strategies (RES). Thirty strategies were developed between 2019 and 2020. Their primary purpose was to contribute to the reaching of a national target of 35 TWh of large-scale wind and solar electricity production ([Anfinson et al., 2023](#)). As part of a RES, a Regional Heat Structure maps heat demand, available sustainable heat sources, and heat infrastructure for the region. The Structures focus primarily on supra-municipal heat sources, especially important for collective heating solutions, including residual heat, geothermal energy, aquathermal energy, biomass, solar thermal energy, green gas, hydrogen and heat storage ([NPRES, 2021](#)).

However, in practice the RES approach has been problematic for a number of reasons. The 'energy regions' do not align with existing subnational administrative structures in the Netherlands meaning that they do not have legal decision-making authority. This makes municipalities the primary actors with official decision-making power in energy regions ([Anfinson et al., 2023](#)), including with respect to preferred heating options in each district. One of the main reasons for creating the RES approach was to involve local actors in decision-making and build local support, but to date development has often relied on a technocratic spatial planning approach with limited citizen engagement (*ibid*). The intended coordination function of the RESs has therefore not functioned well ([Van Dijk et al., 2022](#)). Our interviewees were concerned that municipalities might prioritise their needs over the needs of the region (e.g. Interview 8). As one municipal official put it:

'I'm not such a fan of the regions because that's not in our DNA, as we've worked a long time together with the central government and the province, so we've got all kinds of structures for consultations, and then there's the region, but we don't know how to communicate with them. So that's a new dynamic' (Interview 9).

4.5. The politics of the heat transition

The rationale in the Climate Agreement for giving municipalities a leading role in the governance of the heat transition was that citizens engage more closely with local than central government:

It's about people ... Heating grids or renovation projects will be organised locally, at district level. Case studies so far have shown that this is more successful, as local residents collaborate more with one another and with the relevant local government authority (Climate Agreement, 2019, p. 16).

The view that municipalities have the best understanding of the local context could also be found amongst interviewees:

'One of the reasons why the local governments have such a big role in this transition, because they can make the translation between this general support for these climate goals and the specific things that have to be done in people's homes. ... The main task is national but the way it has to be implemented is really something of the local government, and the local government can make their own priorities which districts are going first' (Interview 11).

The Climate Agreement negotiations followed a consensus-building approach characteristic of Dutch politics. They took over a year and, in addition to expert input, included about 150 parties representing the interests of employers and labour, business associations, environmental and civil society organisations, the government at the local, provincial, and central levels, and the Dutch Parliament.

However, as noted in section 2 above, the Agreement negotiations represented consensus reached at an elite, rather than mass political level. As one interviewee put it:

'The sector is much more unified than the populace ... [The Climate Agreement] is probably an agreement between the different organisations in the sectors and the government, but that doesn't mean that there aren't any opponents' (Interview 2).

This assessment is echoed in other studies. Hendriks (2008, p. 1009) found that Dutch energy transition governance is 'dominated by industry and government elites, at the expense of broader democratic engagement' (see also Lelieveldt and Schram, 2023). The challenge is not one of awareness – in 2021, 89% of Dutch residents knew about the goal to phase out natural gas for domestic heating (RVO, 2023c) – but rather one of participation and consent.

In principle, the municipal visioning and planning process is designed to deliver these. Public participation is widely seen as built into the development of municipal heat transition visions and district-level plans (Interviews 9, 14, 16, 29). Making methodologies for choosing low-carbon heating solutions for a specific district helps promote transparency. Including residents in the analysis increases support for the chosen solution. In some districts, residents have developed their own initiatives for low-carbon heating. The Participation Coalition, a collaborative initiative of five civil society organisations, worked with residents' initiatives and helped incorporate them into some municipal plans (Interview 17). Independent energy advisors and members of the community sharing their experience of decarbonising heat in their homes help residents to make decisions on heating alternatives and increase public trust. According to an interviewee from a central government agency: *'It's people they already know and already trust, and they can go into their houses and see it's not such a big change'* (Interview 15).

The PAW pilots also tested strategies for citizen engagement that were then shared with all municipalities. However, variation in municipal capacity has in practice meant differences in approaches to and the extent of citizen engagement, ranging from simple online surveys to convening citizen assemblies. The PAW case studies suggest that if municipalities do not conduct proper public engagement strategies and fully consider residents' interests, there can be resistance (for example Van der Pekbuurt in Amsterdam, and Erflanden in Hoogeveen). One interviewee reflecting on the experience of Overvecht in Utrecht, observed that:

'[The district-based approach] has been applied in a pretty strong top-down-oriented way, and it has generated a lot of opposition: the municipality deciding what needs to happen, and then the citizens – the tenants, the owners – not being able to voice their concerns and their own wishes, and then [starting towards] implementation' (Interview 2).

Participation and engagement are also sometimes in tension with other elements of the planning approach. The Climate Agreement specifies that municipalities must choose low-carbon heating solutions with the lowest costs, as calculated through techno-economic analyses, but these are not always those preferred by residents. For example, modelling in Van der Pekbuurt, Amsterdam showed that connecting homes to an existing high-temperature heat network owned by a private company and fed by a waste incinerator was the most efficient solution for that district. That approach, however, received resistance from residents over concerns about the sustainability of the heat source and high tariffs from a monopoly heat provider. Municipal officials therefore need to balance choosing heating options based on residents' preferences and steering residents toward the most efficient solution (PBL, 2022).

Recognition of the need to bring residents along with the decarbonisation process (PBL, 2022) has fed back into a major policy shift in 2022 at the national level. It has been accepted that the initial approach of making entire districts gas-free one-by-one faced challenges. The assumption was that because a district consists of similar homes, tackling heat decarbonisation in all homes would bring economies of scale. It has now been recognised that differences inside homes and in residents' circumstances require much greater customisation.

The direction of the strategy has also been affected by the politics of

the gas lobby. The natural gas industry, gas network operators, and boiler manufacturers might be seen as losers from the switch to low-carbon heating. There are a number of reasons why gas incumbents in the Netherlands might be expected to have only a limited influence on policy. Gas network operators are state-owned, not privately owned. Distribution network operators operate both electricity and gas networks, so decline in one business area would be offset by gains in the other. In addition, concerns over climate change and the Groningen earthquakes reduced support for the use of gas among the Dutch public, in principle weakening the position of the lobby (Lowes, 2019). However, while these factors may have mitigated the power of the pro-gas coalition, they have not eliminated it. A number of interviewees saw the gas lobby as influencing the Dutch heat transition strategy (e.g. Interviews 9, 18, 19, 22, 28, 34).

The pro-gas coalition has advocated for policies that would allow the continued use of the gas network infrastructure by switching to hydrogen and biomethane, and the continued use of gas boilers. In May 2022, the Dutch government issued a Hybrid Heat Pump Plan, making the installation of a hybrid heat pump compulsory when a gas boiler is replaced from 2026 onward. Such hybrid heat pumps combined with boilers can save up to 50–70% on gas consumption and were seen by interviewees as an important interim solution (Interviews 15, 32, 16, 18, 22). But the policy also allows for the continued installation of gas boilers, which benefits the pro-gas coalition. The Hybrid Coalition, which includes the association of boiler installation companies, the association of network operators, and the environmental organisation Natuur & Milieu, lobbied for the policy. At a wider level, the overall Dutch strategy has thus shifted from a focus on *phasing out* natural gas at the district level to one of *reducing* gas consumption.

A final issue to consider is the impact of the energy crisis following Russia's invasion of Ukraine on the Dutch heat decarbonisation strategy. Russian imports accounted for around 15% of Dutch gas consumption in 2022 (Meijerink et al., 2022). The crisis had a huge impact on gas prices for Dutch households, jumping by almost 200% in October 2022 (CBS StatLine, 2023), although the shock was cushioned by a package of measures including a one-off energy subsidy for households on benefits and a cut in VAT rates for gas, electricity and district heating.⁶

The Dutch government responded partly by pivoting away from Russian gas. There were attempts to slow the decline of gas production in the North Sea,⁷ while existing liquid natural gas (LNG) import capacity was increased and a second terminal was commissioned at Eemshaven.⁸ However, at the same time the transition from gas was reasserted.⁹ The goal of phasing out domestic gas production in Groningen remained unchanged, although the date was pushed back. Reducing energy demand was prioritised, with the new National Insulation Programme. The government also proposed accelerating the development of green gas, hydrogen, renewable energy, electrification, and the adoption of hybrid heat pumps. This approach was underpinned by a shift in public opinion following Russia's invasion of Ukraine. A poll in August 2022 showed increased support for insulation (44% in 2022 compared with 13% in 2021), and a move away from use of natural gas becoming one of the top three priorities for respondents (Motivaction, 2022).

⁶ <https://www.government.nl/ministries/ministry-of-economic-affairs-and-climate-policy/news/2022/03/21/measures-to-cushion-impact-of-rising-energy-prices-and-inflation>.

⁷ <https://www.rijksoverheid.nl/actueel/nieuws/2022/07/15/versnellin-g-gaswinning-op-de-noordzee>.

⁸ See, for example, <https://www.kpler.com/blog/netherlands-plans-to-boost-lng-import-capacity-could-allow-it-to-fully-replace-russian-gas>.

⁹ <https://www.rijksoverheid.nl/onderwerpen/gas/documenten/kamerstukken/2022/03/14/brief-over-gasleveringszekerheid-komende-winter-en-verder>.

5. Conclusion and policy implications

In this article we have examined the evolution of the Dutch approach to the governance of residential heat decarbonisation. Through the 2019 Climate Agreement this approach has in principle given a lead role to municipalities in creating visions and plans at district level for moving homes off the use of gas. We assess the implications of this innovative approach across a number of areas.

The Dutch approach has a number of strengths. There are many advantages to placing municipalities at the centre of transition governance, especially understanding of local context and citizen engagement. At both the elite level, in the Climate Agreement process, and in the district heat transition visions and planning processes, the approach has been consensus oriented and paid attention to inclusion of stakeholders. The Dutch approach has also created mechanisms for coordination between actors at the local level, and across levels (i.e. municipal, regional and national).

The PAW pilot programme has sought to build responsiveness, and public trust through mechanisms for citizen engagement, supporting local heat decarbonisation initiatives by groups of residents, the use of independent energy advisors and residents sharing their experience with the neighbours. The programme has also developed strong knowledge-sharing frameworks.

However, as the new governance approach has unfolded, it has revealed some tensions and challenges. One is the challenge of ensuring consistency of the policy mix within a multi-level governance framework, especially between (municipal-led) planning instruments and (largely central government-led) market incentive and regulatory instruments. Coherence of approach has been achieved in some areas, such as the new National Insulation Programme, but there are questions in others, such as the fit between heat network expansion and individual heat pump rollout.

A second area concerns the capacity of municipalities to deliver the governance tasks allotted to them in the Climate Agreement. There are concerns about a lack of appropriate and effective powers, and whether financial resources are adequate against the backdrop of austerity in 2010s and unevenness across municipalities. Some aspects of knowledge sharing and expertise are well-developed, with technical support from the central PBL agency and learning processes within the pilot programme. However, limited technical capacity within municipalities means that reliance on consultants is still commonplace. While coordination mechanisms with the regional level existing, there are questions about how effective these are in practice.

A third area concerns the politics of the heat transition. The overarching framework in the Climate Agreement was agreed only at the elite level, and concerns about pushback on the ground remain, especially where engagement efforts have been poor. Some municipalities are wrestling with achieving a balance between maintaining public trust and choice and ensuring economic and technological efficiency.

This challenge is related to the balance between tailoring and scaling up heat transition approaches. One of the arguments for adopting a district-based approach was that it would help achieve economies of scale. However, the pilot programme revealed significant heterogeneity within districts, requiring understanding of the specifics of buildings and residents' circumstances. Developing such tailor-made solutions consumes time and resources and does not allow for the assumed economies of scale and expansion to other districts. At the same time, the gas lobby in the Netherlands has been effective in lobbying for interim technological solutions, such as hybrid heat pumps. These factors have shifted the overall strategy away from a focus on phasing out natural gas at the district level to reducing gas consumption.

The experience of the Dutch approach is relevant for other countries, especially those, such as England, with a high dependence on gas and where the role for local government in heat decarbonisation has yet to be defined (CCC, 2020; NAO, 2021; Wade et al., 2021). Lessons arise directly out of the Dutch experience. It is important to coordinate the timing and interaction of policy instruments such as heat network planning, market incentives for individual home technologies and energy efficiency interventions from the outset of the transition, and then as it unfolds. Giving local government a lead role in the governance of heat transition only makes sense if they have the powers, financial resources and staff expertise to deliver that role effectively. In the UK's highly centralised state this is a particularly important lesson. Giving participation and inclusion in local vision and planning processes as much attention as techno-economic considerations is crucial for making the politics of transition work on the ground. Keeping the gas lobby in check as the transition unfolds is important for maintaining momentum. These are again important points for the UK which has a top-down, technocratic approach to climate governance and a powerful gas lobby (Lowes et al., 2020).

Overall, the Dutch approach to heat transition governance is one of the most systematic and locally-led in Europe. It is still at a comparatively early stage, and through the process of its piloting and development various challenges have emerged, as well as a number of trade-offs between governance goals. However, one of the strengths of the approach is that it is adaptive, and if it can address these challenges and manage the trade-offs, it could offer a strong model for other countries to learn from and adapt.

Funding

This research was undertaken as part of the UK Energy Research Centre research programme. Funded by the UK Research and Innovation Energy Programme under grant number EP/S029575/1.

CRediT authorship contribution statement

Anna Devenish: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization.
Matthew Lockwood: Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

The authors would like to acknowledge the major input into the research underlying this article from Dr Niall Kerr, University of Edinburgh, as part of the project team. We would also like to thank those who agreed to be interviewed, and to advice and comments from Casper Tigchelaar, Geert Verbong and Robert Kint. Responsibility for any errors of fact or interpretation remain with the authors.

Appendix

The research project team conducted 42 interviews with 46 people in the Netherlands and the UK between December 2021 and September 2022. The interviews were semi-structured, using a list of questions (available on request) that differed between interviewees but for Dutch interviewees covered the main issues discussed in Section 4 of this paper. The average interview duration was 1 h. Table A.1 presents a list of interviewees.

Table A.1
Interviews

Number	Anonymised interviewee description	Date
1	Academic working on heat transitions in the residential sector at Dutch university	December 21, 2021
2	Academic working on sustainability transitions at Dutch university	January 12, 2022
3	Senior researcher working on heat transitions at Dutch research organisation	January 18, 2022
4	Academic working on sustainability transitions at Dutch university	January 19, 2022
5	Academic working on heat transitions in the residential sector at Dutch university	January 24, 2022
6	Researcher working on citizen participation in energy transitions at Dutch university	January 31, 2022
7	Dutch government senior policy officer	February 11, 2022
8	Academic working on socio-technical transitions at Dutch university	February 21, 2022
9	Policy officer at Dutch municipality	March 4, 2022
10	Researcher in regulation of energy markets at Dutch research organisation	March 9, 2022
11	Dutch government official and Project leader at Dutch subnational government association	March 14, 2022
12	Representative of the Dutch Climate Agreement's built environment table	March 15, 2022
13	Senior policy adviser at Dutch government	March 31, 2022
14	Heat transition adviser at Dutch municipality	April 7, 2022
15	Research officer at Dutch government	April 20, 2022
16	Treasurer at local Dutch citizen sustainability initiative	April 21, 2022
17	Knowledge and innovation specialist at Dutch consultancy working on energy transition	April 25, 2022
18	Board member at Dutch consultancy working on energy transition	May 03, 2022
19	Programme manager for sustainable heating technologies at Dutch innovation centre focusing on energy decarbonisation	May 04, 2022
20	Chairman at Dutch business association	May 05, 2022
21	Planning officer at Scottish local authority	May 11, 2022
22	Heat transition strategist at Dutch province	May 13, 2022
23	Programme manager at Dutch innovation centre focusing on heat transitions in the built environment	May 23, 2022
24	Academic researching public governance at Dutch university	May 23, 2022
25	Coordinator working on heat decarbonisation in the built environment at Dutch municipality	May 24, 2022
26	Scottish government official	May 30, 2022
27	1. Senior sustainability officer at Scottish local authority 2. Project officer at Scottish local authority	May 31, 2022
28	Energy transition programme manager at Dutch business association	June 7, 2022
29	Academic working on energy policy at a Scottish university	June 10, 2022
30	Scottish government official	June 17, 2022
31	Local energy planning consultant in England	June 22, 2022
32	Senior adviser at Dutch expert knowledge centre	June 27, 2022
33	Project manager working on heat transitions at Dutch municipality	June 27, 2022
34	Dutch government official working on heat transitions	June 29, 2022
35	Adviser on area approach at Dutch municipality	July 28, 2022
36	Academic researching local authority energy policies at a Scottish university	August 01, 2022
37	Regional net zero lead at English combined authority	August 01, 2022
38	Welsh local authority representative working on heat decarbonisation	August 12, 2022
39	Energy and climate lead at English local authority	August 22, 2022
40	Welsh Government official working on heat decarbonisation	September 14, 2022
41	Welsh Government official working on heat decarbonisation	September 14, 2022
42	Sustainability project managers at English local authority and Manager at English environmental consultancy	September 28, 2022

References

- Amsterdam Municipality, 2020. Transitievisie Warmte – versie voor inspraak. Online: <https://overmorgen.nl/wp-content/uploads/2020/04/Transitievisie-Warmte-Amsterdammers-versie-inspraak.pdf>.
- Anfinson, K., Laes, E., Bombaerts, G., Standal, K., Krug, M., Di Nucci, M.R., Schwarz, L., 2023. Does polycentrism deliver? A case study of energy community governance in Europe. *Energy Res. Social Sci.* 100, 103093.
- Beckman, K., van den Beukel, J., 2019. The great Dutch gas transition. In: *Oxford Energy Insight*, vol. 54. Oxford Institute for Energy Studies. Online: <https://www.oxfordenergy.org/wp-content/uploads/2019/07/The-great-Dutch-gas-transition-54.pdf>.
- Béland, D., Campbell, A.L., Weaver, R.K., 2022. *Policy feedback: How policies shape politics*. Cambridge University Press.
- Bertelsen, N., Mathiesen, B.V., 2020. EU-28 residential heat supply and consumption: historical development and status. *Energies* 13 (8), 1894.
- Bertelsen, N., Paardekooper, S., Mathiesen, B.V., 2021. Implementing large-scale heating infrastructures: experiences from successful planning of district heating and natural gas grids in Denmark, the United Kingdom, and The Netherlands. *Energy Efficiency* 14 (7), 64.
- Bos, F., 2013. Economic theory and four centuries of fiscal decentralisation in the Netherlands. *OECD Journal on Budgeting* 12 (2), 9–60.
- CBS, 2023a. Woningen; hoofdverwarmingsinstallaties, wijken en buurten, 2022. Online: <https://www.cbs.nl/nl-nl/cijfers/detail/85677NED>.
- CBS, 2023b. Voorraad woningen; eigendom, type verhuurder, bewoning, regio. Online: <https://opendata.cbs.nl/#/CBS/nl/dataset/82900NED/table?ts=1669807561475>.
- CBS, 2023c. Voorraad woningen; gemiddeld oppervlak; woningtype, bouwjaar, regio. Online: <https://opendata.cbs.nl/#/CBS/nl/dataset/82550NED/table?ts=1669808291523>.
- Centraal Bureau voor de Statistiek (CBS), 2021. 92 Procent Woningen Op Aardgas Begin 2019. Online: <https://www.cbs.nl/nl-nl/nieuws/2021/07/92-procent-woningen-op-aardgas-begin-2019>.
- Expertise Centrum Warmte (ECW), 2022. Database transitievisie warmte. Online: <https://www.expertisecentrumwarmte.nl/themas/regie+en+organisatie/database+transitievisie+warmte/default.aspx>.
- Climate Agreement, 2019. Online: <https://www.government.nl/documents/reports/2019/06/28/climate-agreement>.
- Climate Change Committee (CCC), 2020. Local authorities and the sixth carbon budget. Online: <https://www.thecc.org.uk/publication/local-authorities-and-the-sixth-carbon-budget/>.
- Dutch Government, 2020. Definitief einde gaswinning Groningen wettelijk geregeld. Online: <https://www.rijksoverheid.nl/actueel/nieuws/2020/11/24/definitief-einde-gaswinning-groningen-wettelijk-geregeld>.

- Dutch Government, 2022a. Duurzaam wonen voor iedereen. Online: <https://www.rijks-overheid.nl/regering/bewindspersonen/hugo-de-jonge/nieuws/2022/06/01/duurzaam-wonen-voor-iedereen>.
- Dutch Government, 2022b. Kabinet start landelijke Energiebesparingscampagne en komt met Nationaal Isolatieprogramma om 2,5 miljoen woningen snel te isoleren. Online: <https://www.rijksoverheid.nl/ministeries/ministerie-van-binnenlandse-zaken-en-ko-ninkrijksrelaties/nieuws/2022/04/02/kabinet-start-landelijke-energiebesparings-campagne-en-komt-met-nationaal-isolatieprogramma-om-2.5-miljoen-woningen-snel-te-isoleren>.
- Dutch Government, 2022c. Meer nieuwbouw, verduurzaming en lagere woonlasten voor sociale huur door afschaffing verhuurderheffing. Online: <https://www.rijksoverheid.nl/actueel/nieuws/2022/10/07/meer-nieuwbouw-verduurzaming-en-lagere-woonlasten-voor-sociale-huur-door-afschaffing-verhuurderheffing>.
- Dutch Government, 2022d. Kamerbrief besluit infrastructuur collectieve warmtevoorziening in publieke handen. Online: <https://www.rijksoverheid.nl/documenten/kamerstukken/2022/10/21/wet-collectieve-warmtevoorziening-besluit-infrastructuur-in-publieke-handen>.
- Edwardes-Evans, H., 2023. Dutch government acts as power networks near peak overload. Online: <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/102023-dutch-government-acts-as-power-networks-near-peak-overload#:~:text=Power%20networks%20in%20Utrecht%20Gelderland,Jetten%20said%20in%20an%20Oct>.
- Ehnert, F., Kern, F., Borgström, S., Gorissen, L., Maschmeyer, S., Egermann, M., 2018. Urban sustainability transitions in a context of multi-level governance: a comparison of four European states. *Environ. Innov. Soc. Transit.* 26, 101–116.
- European Commission, n.d. Energy Performance of Buildings Directive. Online: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en.
- Flyvbjerg, B., 2006. Five misunderstandings about case-study research. *Qual. Inq.* 12 (2), 219–245.
- Frank, L., et al., 2022. Transforming or tinkering at the margins? Assessing policy strategies for heating decarbonisation in Germany and the United Kingdom. *Energy Res. Social Sci.* 67, 101513.
- Frank, L., Jacob, K., Quitzow, R., 2020. Transforming or tinkering at the margins? Assessing policy strategies for heating decarbonisation in Germany and the United Kingdom. *Energy Res. Social Sci.* 67, 101513.
- Groenleer, M., Hendriks, F., 2020. Subnational mobilization and the reconfiguration of central-local relations in the shadow of Europe: the case of the Dutch decentralized unitary state. *Reg. Fed. Stud.* 30 (2), 195–217.
- Hendriks, C.M., 2008. On inclusion and network governance: the democratic disconnect of Dutch energy transitions. *Publ. Adm.* 86 (4), 1009–1031.
- Herreras Martínez, S., Uytewaal, M., Liu, W., Harmsen, R., 2021. Exploring sustainable heating solutions for buildings at the district level. *Energy Efficiency* 14 (8), 93.
- Herreras Martínez, S., Harmsen, R., Menkveld, M., Faaij, A., Kramer, G.J., 2022. Municipalities as key actors in the heat transition to decarbonise buildings: experiences from local planning and implementation in a learning context. *Energy Pol.* 169, 113169.
- Herreras Martínez, S., Harmsen, R., Menkveld, M., Kramer, G.J., Faaij, A., 2023. Why go public? Public configurations and the supportive and divergent views towards public district heating in The Netherlands. *Frontiers in Sustainable Cities* 5.
- Hooghe, L., Marks, G., 2001. Types of multi-level governance. *Eur. Integrat. Online Pap.* 5 (11).
- International Energy Agency (IEA), 2022. Heating. Online: <https://www.iea.org/report/heating>.
- Kern, F., Howlett, M., 2009. Implementing transition management as policy reforms: a case study of the Dutch energy sector. *Pol. Sci.* 42, 391–408.
- Kooiman, J., 2004. Governing as governance. *Int. Publ. Manag. J.* 7 (3), 439–442.
- Kooistra, G., 2021. Climate Policy and Democracy. MSc dissertation, Radboud University.
- Kuzemko, C., Britton, J., 2020. Policy, politics and materiality across scales: a framework for understanding local government sustainable energy capacity applied in England. *Energy Res. Social Sci.* 62, 101367.
- Lielieveldt, H., Schram, W., 2023. Where are the citizens? Unravelling the lopsided nature of stakeholder participation in the Dutch regional energy transition. *Energy Res. Social Sci.* 96, 102925.
- Lijphart, A., 1968. *The Politics of Accommodation: Pluralism and Democracy in the Netherlands*. University of California Press.
- Lijphart, A., 2012. *Patterns of Democracy: Government Forms and Performance in Thirty-Six Countries*. Yale University Press. Second Edition.
- Lowes, R., 2019. Power and Heat Transformation Policy: Actor Influence on the Development of the UK's Heat Strategy and the GB Renewable Heat Incentive with a Comparative Dutch Case Study. PhD Thesis. University of Exeter.
- Lowes, R., Woodman, B., Speirs, J., 2020. Heating in Great Britain: an incumbent discourse coalition resists an electrifying future. *Environ. Innov. Soc. Transit.* 37, 1–17.
- Mahoney, J., Thelen, K., 2010. A theory of gradual institutional change. In: *Explaining Institutional Change: Ambiguity, Agency, and Power*. Cambridge University Press, pp. 1–37.
- Meijerink, G., Freeman, D., Tuelings, R., Van 't Riet, M., 2022. Analysis of International Trade Sanctions against Russia. CPB Netherlands Bureau for Economic Policy Analysis, p. 23. March 2022. Online: <https://www.cpb.nl/en/node/160824>.
- Motivaction, 2022. *Opinieonderzoek: burgers positiever over energietransitie door oorlog Oekraïne*. Online: <https://www.motivaction.nl/actualiteiten/nieuwsberichten/opinie-onderzoek-burgers-positiever-over-energietransitie-door-oorlog-oe-kraïne>.
- Nationaal Programma Lokale Warmtetransitie gestart (NPLW), 2023. Nationaal Programma Lokale Warmtetransitie Gestart. Online: <https://nplw.nl/nplw/nieuw-s-nplw/2393576.aspx?t=Nationaal-Programma-Lokale-Warmtetransitie-gestart>.
- Nationaal Programma Regionale Energiestrategie (NPRES), 2021. Achtergrondinformatie per warmtebron. Online: <https://www.regionale-energiestrategie.nl/energiesysteem/warmte/1654091.aspx?t=NP-RES-Factsheet-Warmte>.
- Nationaal Waterstof Programma, n.d. Gebouwde omgeving. Online: <https://nationaalwaterstofprogramma.nl/themas/thema+gebouwde+omgeving/default.aspx#:~:text=Tot%202030%20speelt%20het%20gebruik,meer%20installaties%2C%20materiale%20en%20transport>.
- National Audit Office (NAO), 2021. Local government and net zero in England. NAO UK. Online: <https://www.nao.org.uk/report/local-government-and-net-zero-in-england/>.
- Nederland, Volkshuisvesting, 2023. Wetsvoorstel Wet gemeentelijke instrumenten warmtetransitie (Gwiv) ingediend. Online: <https://www.volkshuisvestingnederland.nl/actueel/nieuws/2023/06/28/wetsvoorstel-wet-gemeentelijke-instrumenten-warmtetransitie-gwiv-ingediend>.
- PBL, 2022. Tussen uitvoering en beleid in de warmtetransitie: Over de omgang met knelpunten in de gemeentelijke uitvoering van het Programma Aardgasvrije Wijken.
- Pierre, J., Peters, B.G., 2021. *Advanced Introduction to Governance*. Edward Elgar Publishing Limited.
- Planbureau voor de Leefomgeving (PBL), 2021. Warmtetransitie in de praktijk.
- Rijksdienst voor Ondernemend Nederland (RVO), 2021a. Energieprestatie indicatoren – beng. Online: <https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/wetten-en-regels/nieuwbouw/energieprestatie-beng/indicatoren>.
- Rogge, K.S., Reichardt, K., 2016. Policy mixes for sustainability transitions: an extended concept and framework for analysis. *Res. Pol.* 45 (8), 1620–1635.
- Rozmainsky, I., Kovezina, Y., Klimenko, A., 2022. An empirical application of the financial instability hypothesis based on data from the Dutch non-financial private sector. *J. Post Keynes. Econ.* 45 (2), 281–300.
- RVO, 2023a. Aanvragen subsidie voor energiebesparing woningeigenaren geopend. Online: <https://www.rvo.nl/nieuws/aanvragen-isd-geopend>.
- RVO, 2023b. Ruim € 16 miljard SDE++-subsidie aangevraagd voor energie-opwek en CO2-vermindering. Online: <https://www.rvo.nl/nieuws/ruim-16-miljard-subsidie-aangevraagd-sde>.
- RVO, 2021a. Stimulering Duurzame Energieproductie en Klimaattransitie (SDE++). Online: <https://www.rvo.nl/subsidies-financiering/sde>.
- RVO, 2023c. Aardgasvrij. Online: <https://energiecijfers.databank.nl/dashboard/dashboardaardgasvrij>.
- CBS StatLine, 2023. Consumentenprijzen. Online: <https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83131NED/table?dl=30680>.
- Tax and Customs Administration, n.d. Tabellen tarieven milieubelastingen. Online: http://www.belastingdienst.nl/wps/wcm/connect/bldcontentnl/belastingdienst/zakelij/overige_belastingen/belastingen_op_milieugrondslag/tarieven_milieubelastingen/tabelen_tarieven_milieubelastingen?projectId=6750bae7%2D383b%2D4c97%2Dbc7a%2D802790bd1110.
- Scrase, I., Smith, A., 2009. The (non-) politics of managing low carbon socio-technical transitions. *Environ. Polit.* 18 (5), 707–726.
- Thatcher, M., Sweet, A.S., 2002. Theory and practice of delegation to non-majoritarian institutions. *W. Eur. Polit.* 25 (1), 1–22.
- Tigchelaar, C., van Lidth de Jeude, M., Niessink, R.J.M., Kooger, R., de Koning, N.M., Paradijs, G.L., 2019. How earthquakes shook up Dutch energy policy: an overview on who should do what, when and how to renovate 99% of all Dutch houses in the next 30 years. *Proceedings ECEEE Summer Study on Energy Efficiency 1167*. Online: https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2019/7-make-buildings-policies-great-again/how-earthquakes-shook-up-dutch-energy-policy-an-overview-on-who-should-do-what-when-and-how-to-renovate-99-of-all-dutch-houses-in-the-next-30-years/.
- Toonen, T.A., 1990. The unitary state as a system of co-governance: The case of the Netherlands. *Publ. Adm.* 68 (3), 281–296.
- Van Dijk, J., Wiecek, A.J., Ligtvoet, A., 2022. Regional capacity to govern the energy transition: the case of two Dutch energy regions. *Environ. Innov. Soc. Transit.* 44, 92–109.
- Van Popering-Verkerk, J., et al., 2022. A framework for governance capacity: a broad perspective on steering efforts in society. *Adm. Soc.* 54 (9), 1767–1794.
- Vereniging Van Nederlandse Gemeenten (Vng), 2023. Vanaf 3 april: uitkering uitvoeringskosten klimaat aanvragen. Online: <https://vng.nl/nieuws/vanaf-3-april-uitkering-uitvoeringskosten-klimaat-aanvragen#:~:text=In%20het%20coalitieakkoord%20is%20voor,28%20april%20aanvragen%20bij%20RVO>.
- Vringer, K., de Vries, R., Visser, H., 2021. Measuring governing capacity for the energy transition of Dutch municipalities. *Energy Pol.* 149, 112002.
- Wade, F., Webb, J., Tingey, M., 2021. Local heat and energy efficiency policy: England and Scotland. In: Webb, Janette, Wade, Faye, Tingey, M. (Eds.), *Research Handbook on Energy and Society*. Edward Elgar.
- Warmtepompen, Vereniging, 2023a. Nationaal Warmtepomp Trendrapport 2024.
- Warmtepompen, Vereniging, 2023b. 110.000 Warmtepompen Erbij in 2022, Maar Vooral Onder Lage Inkomens Valt Nog Een Wereld Te Winnen. Online: <https://warmtepompen.nl/110-000-warmtepompen-erbij-in-2022-maar-vooral-onder-lage-in-komens-valt-nog-een-wereld-te-winnen/>.
- Weber, C., Gebhardt, B., Fahl, U., 2002. Market transformation for energy efficient technologies—success factors and empirical evidence for gas condensing boilers. *Energy* 27 (3), 287–315.
- Weske, U., Leisink, P., Knies, E., 2014. Local government austerity policies in The Netherlands: the effectiveness of social dialogue in preserving public service employment. *Transfer: European Review of Labour and Research* 20 (3), 403–416.

Winqvist, E., Van Galen, M., Zielonka, S., Rikkonen, P., Oudendag, D., Zhou, L., Greijdanus, A., 2021. Expert views on the future development of biogas business branch in Germany, The Netherlands, and Finland until 2030. *Sustainability* 13 (3), 1148.

Yin, R.K., 2018. *Case Study Research: Design and Methods*. Sage.
CBS StatLine, 2023. Consumentenprijzen. Online: <https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83131NED/table?di=30680>.