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DOI
10.1088/1755-1315/1085/1/012037

Publication date
2022

Document Version
Final published version

Published in
IOP Conference Series: Earth and Environmental Science

IOP Conference Series: Earth and Environmental Science

PAPER • **OPEN ACCESS**

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To cite this article: C Harvey-Scholes *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1085** 012037

A structured approach for governing sustainable heat transitions in building renovation of towns and cities

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Abstract. Pioneer cities have demonstrated a willingness and capability to decarbonise local heat systems, but support is needed to scale up action. Heat decarbonisation is not simply a technical challenge, but also a political and social one; stakeholders must inform decisions about appropriate technological and policy solutions and will, in turn, be affected by them. Taking three dimensions of stakeholders, technology, and policy, a structured approach which centres stakeholders is presented to help local government to collaboratively find appropriate technology and policy solutions, both at the strategic scale across the municipality and in localised pilot projects, and explores how to initialise and support heat decarbonisation in more cities.

1. Introduction

There is broad recognition that decarbonisation of heat in European buildings is an urgent and complex challenge requiring innovative, multi-disciplinary solutions designed for the local context and with appropriate governance[1,2]. Governance of the heat transition must attend to the interactions between stakeholders (e.g. residents and organisations), technologies (for heat, buildings and energy efficiency) and policy (to direct, regulate or incentivise practices) at all levels and stages. Heat transitions present particular socio-technical and socio-political challenges, such as the need for changes in technology and practice within homes and buildings, which present a distributed action problem and political issues of sovereignty; next to technological innovation, social and policy innovation will be essential for establishing a shared agenda for change and governing the speed and outcome of change. Studies indicate that analyses of energy (and specifically heat) system change as a primarily technical or techno-economic problem are inadequate as they fail to attend to social and political realities; a burgeoning literature recognises the thoroughly social and “deeply and unavoidably political” nature of energy transitions[3–5]. Scholarly attention to governance of heat transitions accounting for these three dimensions in a multi-disciplinary way is limited, reflecting a gap in the literature. The literature suggests that developing such an integrated approach would be beneficial as change is triggered more easily when planning for the city is holistic, integrating different sectors at the same time[1]. This paper addresses this gap by proposing a structured approach for further discussion and refinement which centres stakeholder dialogue in the strategic process of determining appropriate technologies and policies within the heat transition and its governance, by responding to the following research question:

How can a multi-disciplinary structured approach address stakeholders, technology, and policy and the interactions between them, support local governance of the heat transition in the current building stock and in what ways is this approach limited?

This paper draws on the experiences of a transdisciplinary research EU project, SHIFFT (Sustainable Heating: Implementation of Fossil Free Technologies), in piloting a tri-dimensional, structured approach to governing heat transitions in towns and cities accompanied by illustrative case studies. This structured approach is designed to provide guidance to inform and empower local actors, provide structure and scope for decision-making processes, (policy) outputs and impacts [6,7]. This paper proceeds as follows: Section 2 provides context. Section 3 summarises the methods. Section 4 describes the structured approach. Section 5 presents case studies and analysis. Section 6 concludes the article.

2. Context

Decarbonising heat in existing buildings is an essential, pressing challenge for cities aiming to achieve zero carbon emissions. In Europe, heat is mostly generated by burning fossil fuels[8], so reducing emissions will require both enhanced energy efficiency and replacement of fossil fuel boilers with zero carbon heat technologies in tens of millions of homes and other buildings. In practice, this often means renovation projects: implementing single or multiple technical measures in large numbers of homes and other buildings to lower energy consumption or replace fossil heating with sustainable alternatives. Alongside reduced carbon emissions, the upgrades to homes and buildings can bring a host of co-benefits including: reduced household energy costs alleviating poverty[9,10], greater comfort and improved living standards[11], higher property valuation[12], health benefits[13,14], reduced exposure to fossil fuel (and other energy) price volatility[15], and potential energy system benefits conveyed by load flexibility[16].

A growing literature supports the view that the heat transition is best managed holistically. To decarbonise the heat system, the literature highlights the value of innovations which are not purely technical or social but multidisciplinary, designed with attention to broad interdependencies and consequences. Yet the literature is replete with incomplete approaches to heat and sustainability system innovation, often neglecting the social and/or political dimensions[5,17]. In addition, the importance of local energy, and particularly heat, realities are increasingly acknowledged – towns and cities are an important locus for developing, governing, and delivering the heat transition due to the spatial and socio-cultural embeddedness of heat consumption[2,18]. Local knowledge of the built environment and neighbourhood architecture, occupants, ownership as well as connections to organisational and trade networks, routes and infrastructure for upskilling, are all relevant to the deployment of heat retrofit. Approaches to socio-political and socio-technical change and innovation at the local level have been widely researched (such as urban transition labs[19]) but have rarely been applied to the heat system specifically. In the role of initiator, facilitator or director of a local heat transition, local government has a range of strengths, such as its connections to local networks of actors (including citizens), processes and infrastructures. However, it is often also constrained in ways that include limited in-house experience of, and capacity for, strategic energy system analysis or power for intervention, restricted financial resources, difficulties in overcoming path dependencies (for example, related to choices of energy carrier or network capacity) or resistant incumbent organisations with local influence. Whilst support from higher up the governance chain is needed, this paper explores an approach local governments can apply to strategise and scope action within their existing powers and capacities.

3. Methods

A structured approach was developed based on a literature review, followed by a process of expert co-creation and validation involving three roundtable workshops with academic and heating sector practitioner partners on the SHIFFT project in January 2019 [20].

Local government officials in four municipalities (Middelburg (NED), Bruges (BEL), Fourmies (FRA), and Mechelen (BEL) have used this approach in the process of developing and implementing a local heat strategy from January 2019 to July 2022. Four case studies are reported below. Collective monthly meetings and one-on-one interviews between researchers and city officials monitored the heat strategy development in each city and identified limitations to the approach. In addition, two cross-border peer review workshops (in January 2021 and March 2022) reflected on the progress and application of the approach with input and advice from external expert stakeholders on modifications.

4. The Structured Approach to the Heat Transition

The approach presented here is structured around three disciplines of stakeholders, technology, and policy which characterise three broad and interlinked dimensions of the transition process ():

Stakeholders: this includes all relevant stakeholder actors (e.g., individuals or organisations), an understanding of social networks, community, and cultural norms. The co-creation approach applied here centres stakeholders in strategy and solution development through information and dialogue.

Technology: this comprises the heat hardware and related data: i.e., infrastructure such as the buildings, the heat generation and distribution systems, energy efficiency measures and materials.

Policy: the toolset or 'policy mix' (a medley of policy instruments) for facilitating, incentivising, planning, enforcing, and accelerating the transition by enabling, influencing, and constraining actors' choices. Local policy depends on the political will, leadership, resources, competences, capacity to act of the local government and on existing policy at higher tiers of government.

Importantly, these three dimensions are interlinked by interdependencies between stakeholders, technologies, and policy instruments. For instance, residents' preferences and attitudes determine the selection and adoption of new technologies (e.g. installing a heat pump). Innovative technologies can, in turn, modify the role of residents from simple consumption to increasingly flexible demand actors. Innovative technologies as well as consumer choices can encourage heating engineers to upskill to deliver these new technologies. Actors must also be encouraged or enabled by policy to adopt technology (e.g., an installation or training grant). Transition strategies must therefore be planned holistically, co-created, and embedded in pilots and neighbourhoods.

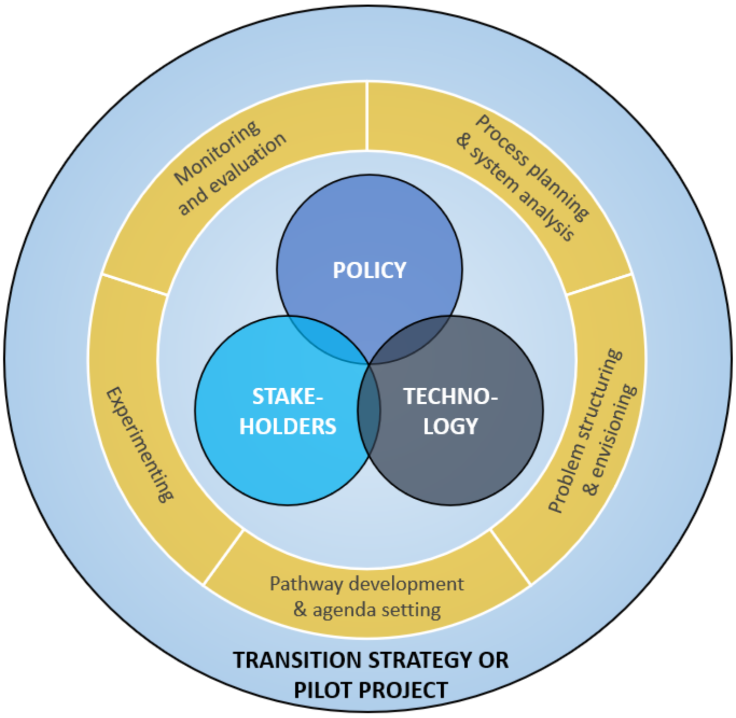

Figure 1. An illustration of the three dimensions at the core of the structured approach in shades of blue, the five cyclical stages of the transition process in yellow and the strategy and pilot project levels of application on the outside in orange.
Source: Authors' own drawing.

These themes are applied on at least two levels: (1) transition strategies (led collaboratively by the municipality) and (2) pilot projects (locally, in city districts).

Transition strategies have a mission and vision, whilst providing high level pathways to reach the set goals from a defined baseline, and usually indicate preferred technologies, cooperation methods, policy instruments, key projects, as well as a global timeline.

Pilot projects are small-scale demonstrations of (transformative) technological, social, or integrated innovations or processes, such as renovating existing buildings. These help to build the case for further deployment by evidencing the economic, technical, social, or political feasibility. Pilot projects combine two or three of the dimensions and further the goals of the municipal transition strategy with ongoing co-design by stakeholders.

The three dimensions are relevant at all stages of every transition project. Drawing on transition literature, we have conceptualised the process as comprising five stages[19]: 1) processes planning and system analysis, 2) problem structuring and envisioning the future system, 3) major pathway development and agenda setting, 4) experimenting, 5) monitoring and evaluation.

5. Results: Case Studies

Four case studies are presented here to illustrate the three dimensions of the structured approach and some of their interactions through a snapshot of their heat strategy development. In each case the city government has recently developed a local heat strategy. The examples have been selected to illustrate the diversity of activities and disciplines and their interactions; they are not an exhaustive exploration.

5.1 Bruges

5.1.1 Challenges. As part of its heat strategy development process, the City of Bruges government carried out a feasibility study for a heat network in the historic city centre which we relay here to demonstrate and explore technology-stakeholders interactions in policy development. In Bruges, efforts to align government departmental responsibilities with the heat transition are embryonic. The Climate Department has sole official responsibility for the heat transition, but relies on effective collaboration with, among others, the departments for Housing, Public Works, Spatial Planning, and Public Estate.

5.1.2 Application. Heat networks were not formally established within any department's responsibilities, but the infrastructure (i.e. pipes) would need to be laid in the public domain and they would potentially connect residential homes and public buildings around the city centre. Coordinated by the heat strategy team within the Climate Department, the technical analysis for the heat network feasibility study was conducted externally by consultants. The departments for Public Works, Housing, Spatial Planning, and Public Estate as well as external stakeholders were contacted throughout the process. A lack of formalised roles and responsibilities among departments regarding heat led to variable engagement: some departments lacked the capacity to engage fully or were otherwise unable to prioritise discussion and progression of the heat network alongside formal responsibilities. In some cases engagement came very late in the process. In contrast, departments with capacity to engage and buy-in to the heat agenda saw easier progress and were proactive in advancing the heat network in their domain.

This case demonstrates the need to strategically engage and align stakeholders, both within as much as outside local government, throughout development (not just delivery). Without aligned roles and responsibilities, municipal departments struggle to find the bandwidth for the objectives of the heat transition and remain occupied by their existing responsibilities and workload. The historically siloed development of sectoral policy frameworks, without consultation or integration across teams, contrasts with the emerging need for coordinated, cross-departmental programs, actions, and policy interventions.

5.2 Fourmies

5.2.1 Challenges. In Fourmies, a high level of (energy) poverty was identified as a major challenge for the heat transition. The reasons for this are multiple and complex: the poor energy performance of many old buildings is compounded by low public awareness of their energy consumption or how it may be reduced. Additionally, many technical energy efficiency measures are unsuitable for old buildings and, for some, they are unaffordable. Poverty is aggravated by technological and social factors, some of which policy may exacerbate (e.g. building conservation rules) or mitigate (e.g. grants or energy advice).

5.2.2 Application. To address the challenge, the city established a one-stop shop - "Guichet Unique Energétique" - as a new initiative to provide expert advice and assistance to the citizens when making technical choices for housing and heating renovations and implementing them, also informing them of the subsidies and support available. Approximately 200 contacts were made between 2019 and 2021 at the one stop counter and about 20 housing thermal scans provided. Through this intervention to provide direct access to technical expertise for householders, the City of Fourmies is empowering citizens to take informed action to reduce their bills and carbon emissions using a range of technical and practice-based solutions. This is particularly interesting to those citizens who own and occupy private homes and consider short-term retrofitting. With the recent high gas and heat prices payback periods have reduced.

5.3 Mechelen

5.3.1 Challenges. Mechelen has no existing district heating network and no high-temperature residual heat source, meaning city-wide district heating was judged 'technically infeasible'. However, economic and regulatory conditions were also unfavourable for the main alternative: heat pumps. The city government identified the renovation of medium to high-rise apartments, a common building type around the city ring road, as one build environment where local heat networks may be viable.

5.3.2 Application. The city has commissioned a study of the built environment around the ring road including mapping energy data, a building typology and relevant existing policy instruments. In parallel, ten households across two buildings were identified to take part in a pilot co-creation exercise and two apartments selected to pilot dwelling-level retrofit technologies. Carrying out all three activities has provided the city with an extremely thorough understanding of this building type and some occupants' preferences. On the other hand, it is unclear if resources will permit this intensive approach to be scaled.

5.4 Middelburg

5.4.1 Challenges. In Middelburg, developing a municipal heat map required engagement across all three dimensions: a province-wide process led to coordinated creation of inter-municipal heat strategies, drawing on technical data and stakeholders' perspectives; the final heat map is a tool for wider neighbourhood engagement and will inform the identification and deployment of policy instruments.

5.4.2 Application. The technical process of heat mapping and zoning quantifies the appropriateness of technological solutions (e.g. collective vs individual heating systems, or heat pumps vs biomass), identifying areas where the optimal solution is clear and others where uncertainty remains. The initial technical methodology of analysing the municipality at the neighbourhood level was proposed nationally in NL and applied by municipalities. In this case, a consultative stakeholder focus group was integrated to the process in order to ensure the accuracy and utility of the assessment and outputs. During the process of consulting the focus group, it was proposed that appropriate technological solutions might be more usefully identified for different building types rather than neighbourhoods as some areas have a variety of building types. The analysis was modified on this basis to add some building-level information and the intention is to incorporate more similar data during implementation; the map will be regularly updated and directly inform strategic policy decisions and residents through neighbourhood engagement processes. Municipalities' experiences across the province led to the inclusion and application of this and other improvements to the initial approach across the wider province.

This example provides three insights for heat governance: first, the involvement of a wide variety of stakeholders throughout the process (even ostensibly technical parts) can contribute novel perspectives,

IOP Conf. Series: Earth and Environmental Science 1085 (2022) 012037 doi:10.1088/1755-1315/1085/1/012037

knowledge, and ideas to improving processes or decision-making. Second, coordination and collaboration between different city districts is beneficial as it can lead to faster learning from distributed action, effective communication, rapid evaluation, and iteration. For example, in one city district ('Dauwendaele') a social housing association decided to opt out from the municipality's district heating plan which it viewed as a burden, slowing down the housing association's strategic asset management actions in a local renovation project. This 'lesson' can be used by the municipality to address social housing associations in other city districts in a different manner. Third, the benefits of process flexibility and innovating locally show the limits to governing centrally: whilst the national mandate mobilised local governments to carry out this analysis, the methodology benefited from local experiences.

5.5 Analysis – Applying the Structured Approach

5.5.1 Stakeholders. An understanding of stakeholders' resources (including ownership of homes or buildings), perspectives, priorities, and problems underpins the design of local heat strategies and projects in order to ensure they are both feasible and acceptable[21]; given the wide-ranging impacts of energy on lives and livelihoods, stakeholder involvement may be considered a right. The future heat system will involve novel roles and actors; identifying and engaging stakeholder actors in consultation or, ideally, in co-creation is fundamental to delivering heat retrofit projects and initiatives that are acceptable and can proceed at the speed required to meet climate goals in the current built environment. In this way, stakeholders are both the starting point for idea conception and design and the target for change. Designing and delivering the heat transition rapidly will combine central coordination with allowing or even empowering actors' autonomy to act independently and collaboratively and allocate resources efficiently – the appropriate blend of autonomy and coordination is context-dependent. A just heat transition will most benefit the least advantaged; but ensuring equity is difficult given the inequitable status quo, the diversity of pathways and technical solutions, and their cost. Policy can assist in addressing this which will likely require action at higher levels of government.

5.5.2 Technology. The heat transition requires technology upgrades at the building level – of the building fabric, heating appliances and any attendant distribution – and at the infrastructure level. A deep technical analysis is central to planning the local heat transition and requires data on a range of heat system and built environment elements to assess current and potential demand and supply; this is enhanced when filtered by stakeholder priorities. For instance, technical analysis of heat supply and demand gains pragmatic reality from information about residents' preferences as well as income and tenancy which, in turn, inform the design of policy to incentivise change. Governance for low carbon heat is heterogeneous: governing uptake of building-level measures (e.g. thermal insulation, heat pumps) is different from system-level infrastructures (e.g. district heat networks). Patterns of investment and ownership, for instance, diverge markedly depending on the technology and wider public policy. Feasible and desirable technology combinations will vary, and experiences like Middelburg show the value of a flexible approach in response to, for instance, stakeholders or energy materialities.

5.5.3 Policy. For the heat system, relevant institutions, regulations, and policy instruments are increasingly diverse and dispersed across, often siloed, departments and political scales. The heat transition will require the alignment of energy policy, welfare, building regulations, spatial planning, market regulation, strategic infrastructure, skills development, and fiscal policy. Coordination is needed to develop and deliver harmonised policy capable of directing cohesive activity across departments and levels of government towards shared objectives. Across the cities reported in this study, local government has limited power and capacity to act over relevant policy areas (e.g. energy policy, building regulation, market regulation, fiscal policy) which are often controlled regionally or nationally. Whilst devolved competences restrict local policy, there is nonetheless scope for leverage, particularly in terms of initiating and enabling action. For instance, the process of developing and publishing a heat strategy can raise the profile of the heat transition on the public agenda, produce initial technical assessments, and direct broader planning and action towards shared objectives. Fundamentally, given buildings' social and spatial embeddedness, local leadership is essential for effective heat decarbonisation and this implies local policy initiatives: this requires greater devolution of power and resources to localities.

5.5.4 Interactions. The heat system is a socio-technical system, the essence of which consists of heating and building technologies and the ways in which people (singly or collectively) decide to adopt them, and then use them; as such, technology and people intersect and interact inextricably in the heat transition. Moreover, if transformative change is to take hold in local and regional heat systems technology and institutions must coevolve, which requires a strategic governance framework (including policy instruments and mixes) that entail the 'right rules' to enable a heterogeneous set of stakeholders to engage in concerted, collective action, whilst acknowledging the polycentric nature of modern society (e.g. multi-level governance, public private partnerships, empowering civil society). In this sense, the structured approach outlines a process in which stakeholder dialogue is central to finding appropriate technological and policy solutions for heat, and these policies then, in turn, enable diverse actors to act, advancing the transition in an iterative cycle. Moreover, to bring about transformative change in the heat system, experimentation must be encouraged (e.g. by 'nurturing' experiments, with intermediary involvement and the use of trans-local networks) to empower sustainable heating innovations while also 'deconstructing' current regime structures and institutions (e.g. 'hindering' legislation) that form substantial barriers to transformative change of heat systems. Importantly, interactions are changing: the modified technical nature of the heat system will alter actors' roles in the system (e.g. more flexible consumption, or gas engineers installing heat pumps) and mean new actors have heat-relevant roles (e.g. Public Estate Department, digital service providers); institutions, policy, and regulation are required to change to govern the transition, reflecting the novel elements (e.g. new roles, technologies, and business models) and complexity (e.g. multi-directional heat flows, cross-vector interaction).

6. Conclusions and Recommendations

This paper has set out a novel multidisciplinary structured approach for local heat transition governance and how centring stakeholder dialogue in developing local heat strategy and experiments can help local governments to navigate the heat transition in an inclusive and context-appropriate manner, while addressing the inherent complexities. We contend that governance of the heat transition requires stakeholder engagement to find technological and policy solutions in order to engender holistic, acceptable, legitimate, and effective solutions which reflect the complexity of the various interlinked dimensions. The intricate web of linkages between actors, technology and policy means that not only the heat transition as a whole but also the isolable challenges and projects within it are complex and benefit from a multi-disciplinary approach. The context of renovating current building stock the heating transition adds even more challenges and complexity to a sector in which projects are already highly complex. The socio-technical challenges are diverse including the need for people to become aware of, develop trust and adopt different technologies as well as for professionals to install novel technologies (with a related need for reskilling). We argue that genuine co-creation can establish stakeholder buy-in to, and the credibility of, the heat transition through meaningful engagement, helping to address the first challenge for municipalities of influencing institutional and individual owners; in addition, based on this common agenda, policy can be designed to incentivise and regulate choices and behaviour.

Piloting the structured approach has underlined the complexity of the challenge, indicating areas the approach needs adjustment or further study. With regard to process, the pilots emphasised the need to interact at different scales simultaneously and from the beginning. Rather than, say, co-designing a heat strategy before engaging with stakeholders, local government actors must engage within smaller communities and broad strategic networks at the same time. The heat strategy is a live document which will need to be revisited as initially uncertain elements crystallise and as the broader vision for the future evolves. At the smaller scale, a local government may find at an early stage, for example, a need to engage closely with a particular government department or explore an opportunity to extend a heat network. One way forward, linking across scales and connecting strategy to realisation, is the formation of a ‘heat coalition’ or partnership of relevant, influential local actors to discuss and agree a shared agenda and identify opportunities for action (similar to a ‘Transition arena’); experimental projects have begun in these cities and further testing and evaluation is needed. Within local government institutions, work areas are often separated with limited horizontal interaction. Given the cross-cutting nature of heat (and climate action in general) involving a range of services (for heat e.g. housing, public works, public estate, energy, welfare, and climate teams) and with the need to harmonise across different strategic objectives, local government organisational structures and processes must be re-engineered to ensure that relevant work is visible to other departments and that communication channels are available.

For local governments, the structured approach is designed to help by providing a framework to guide scoping and planning whilst remaining flexible to local circumstances. This can help to catalyse action in further municipalities by 1) providing guidance and reassurance in a policy area with limited capacity and expertise and 2) scoping the challenge, identifying the key components. We emphasise that a multidisciplinary approach improves the chances of success but does not guarantee it.

This article has sought to elucidate links between the three elements of stakeholders, technology, and policy through examples. Further work is needed to elaborate and systematise our understanding of the interactions within heat transitions, as well as to consider the role of politics in determining decisions, direction, and outcomes.

Acknowledgements
This research is funded by the European Union ERDF Interreg 2 SEAS, with additional co-finance from the Province of South-Holland under reference PZH-2019-683226948 DOS-2019-0000596, and from the Ministry of Economic Affairs and Climate Policy under reference INTER2ZO15.

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