Warm and close: an urban design perspective on heat transition in the nebular city

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Short Abstract

Energy infrastructure has historically supported the spatial and social integration of the Flemish territory. The co-evolution between infrastructure and urban development that shaped this landscape, can be read as a typical illustration of the 'modern infrastructural ideal'. But today it becomes increasingly clear that it has also facilitated a very energy-intensive lifestyle and a spatial structure that is fundamentally unsustainable. In the transition towards a more sustainable energy system, new types of heating infrastructure are emerging that raise important questions about spatial morphology and energy governance. This paper focuses on the case of collective heating infrastructure in the city of Roeselare. It explores to what extent the pluralization of heating configurations contributes to 'splintering' dynamics, or has potential to support more energy-efficient urban development and new forms of collective and inclusive governance.

Introduction

Networked infrastructure systems have been a driver, instrument and consequence of urbanization processes and modern social relations since the mid-nineteenth century, and are again playing a key role in urban change (Bulkeley, Castàn Broto, & Maassen, 2014; Coutard & Rutherford, 2016, p. 3). In Flanders, the historical co-evolution of transport and supply networks with urban development, has created a dispersed and energy-intensive landscape. The need to rethink this unsustainable spatial structure has become a central concern for the spatial planning community, and is gaining attention in public debate (Balthazar, 2018; De Meulder, Schreurs, Cock, & Notteboom, 1999; Dehaene, 2015). From that perspective, the debate around collective heating networks in the region, shows how energy infrastructure is becoming "*a key battleground for the direction of social, political and territorial change*" (Coutard & Rutherford, 2016, p. 263). In the transition towards a fossil-free heating system in the Flemish region, crucial questions of urban morphology and energy governance are at stake (Hens, 2017; Juwet & Ryckewaert, 2018; Raeymaekers, 2017).

But contemporary infrastructure transformations have both been criticised as contributing to 'splintering' urbanism, and heralded as processes of 'emancipation' and hope (Coutard, 2008; Coutard & Guy, 2007; Graham & Marvin, 2001; Morris & Jungjohann, 2016; Webb, 2016). This paper explores the case of collective heating systems in the region of Roeselare, a small city in the province of West-Flanders. It aims to understand to what extent the pluralization of heating configurations in the dispersed Flemish landscape contributes to processes of socio-spatial fragmentation and dispersion, and what potentials it holds for spatial rebundling and social emancipation.

1. Infrastructure as fragmentation or emancipation?

The modern network ideology and the Flemish dispersed landscape

The co-evolution between infrastructure and urban development in Flanders since the mid-19th century, can be read as a typical illustration of the 'modern infrastructure ideal'. The result of this process is described by Coutard & Rutherford as "*the socially and spatially ubiquitous provision of, and access to, more or less homogeneous services supplied sometimes on a local and sometimes on a larger scale, by a centrally planned and managed large technological system with exclusive franchise over a given territory which it in turn helped to unify*" (Coutard & Rutherford, 2016, p. 3; Graham & Marvin, 2001). The planning and construction of transport and supply networks in Belgium indeed facilitated the socio-economic and spatial integration of the territory, in support of its industrialization and urbanization (Bruggeman & Dehaene, 2017; Cattoor & De Meulder, 2011; De Block, 2014; Ryckewaert, 2012; Van Acker, 2014). The development of these dense networks was coupled with a housing policy stimulating individual home ownership, mainly in single-family houses often on suburban locations (Bervoets & Heynen, 2013; De Decker, 2011; De Meulder et al., 1999; Ryckewaert, 2002; Winters et al., 2015).

Energy infrastructure, notably the electricity and gas networks, supported and reproduced this urbanization process, and can be associated with the different dimensions of 'integration' as described by Coutard and Rutherford (Coutard & Rutherford, 2016, p. 4). It served the *socio-economic integration* of the territory and became part of a project of welfare provision and socio-economic redistribution (see also (Rutherford, 2008) for a Stockholm example). Ubiquitous energy networks also allowed for the *functional integration* of ever larger areas, which in Flanders lead to a notoriously dispersed form of urbanization. The planning, implementation and financing of these technical networks also supported *political integration* and required collaboration between different levels of local, provincial, regional and national government, as shown for the early development of the electricity network by Bruggeman (Bruggeman & Dehaene, 2017). Lastly, these monopolistic networks facilitated the *metabolic integration* of the territory, through the fine-grained distribution of centrally produced energy based on the appropriation of remote (fossil and nuclear) resources.

The development of spatially ubiquitous distribution networks for gas and electricity, was linked to an increasing centralization of network governance in intermunicipal energy companies, and to what Coutard and Rutherford have called 'network citizenship' (Coutard & Rutherford, 2016). Through his/her network subscription, the individual energy consumer expresses solidarity and contributes to the redistribution mechanism of the network operator's 'public service obligation'. Emancipation was supposed to reside in the connection to the technical network, and was thereby no longer enacted in the urban (public) sphere or at the collective level, but in the domestic sphere, at the individual level (Kaika & Swyngedouw, 2000).

The fundamental unsustainability of the nebular city

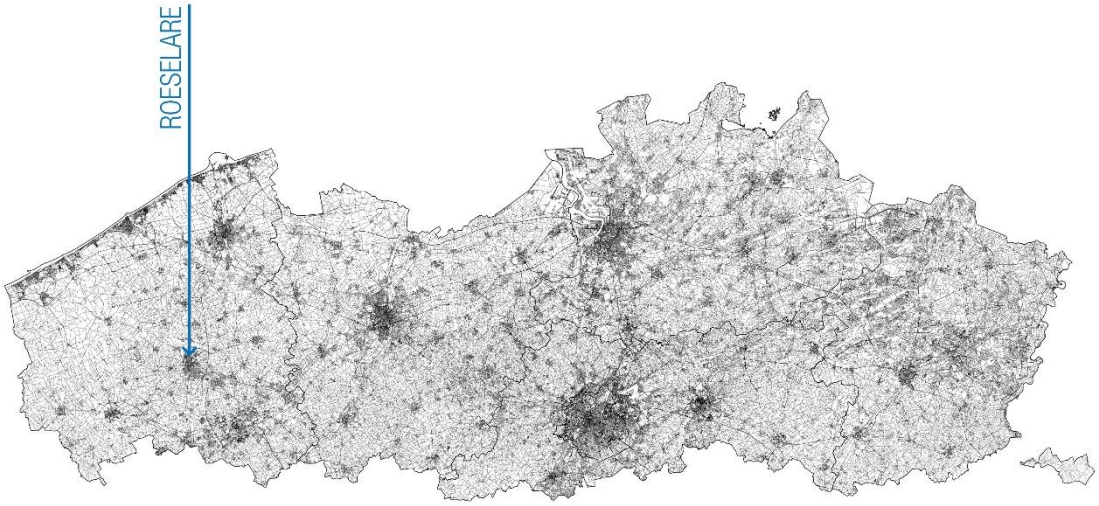

Fig. 1 – Flanders' dispersed spatial structure illustrated through the road network – indicating the location of the Roeselare case study area.

Today, the ecological, spatial, societal and economic consequences of this urbanization process, have started to become clear. Flanders' dispersed spatial structure is unsustainable from many perspectives, ranging from its impact on mobility and water systems, the societal cost of collective services, the fragmentation of open spaces, and its impact on the energy system (Balthazar, 2018; De Decker, 2017). The region's 'nebulous' urbanization translates into a high energy demand for transport (Boussauw & Witlox, 2009). The dominance of relatively old and large single-family homes also leads to a high heating demand (Cyx, 2017; Winters et al., 2015). Transforming this existing building stock is complex and advances slowly due to the individual ownership structure and housing culture. The region's fragmented landscape complicates the spatial integration of large renewable energy production. Its dispersed urbanization also leads to high costs for the implementation and maintenance of gas and electricity supply networks. The integration of the entire territory creates not only social, but also spatial redistribution: as the connection cost to the network is independent of location, urban customers also pay for the connection of more expensive periurban and rural dwellers. As energy production became centralised and infrastructure largely invisible, abundance and availability of energy was taken for granted and consumers' involvement with their daily energy use became limited.
Recently, these relations between the region's spatial structure and its energy system (demand, production and distribution, governance) are becoming an important concern for the Flemish spatial planning community, with energy slowly becoming part of planning research and debate, and of the new spatial policy plan Flanders (Juwet & Ryckewaert, 2018; Raeymaekers, 2017; Wauters, 2017; "Witboek Beleidsplan Ruimte Vlaanderen," 2016).

Contemporary infrastructure transformation: infrastructure as fragmentation or emancipation?

Over the last decades, several dynamics have been observed that show how the 'modern infrastructure ideal' is waning. Both in response to climate change and finite fossil resources, and because of liberalisation and privatisation processes, energy infrastructure is under transformation. Critical accounts of ongoing infrastructure transformations show how uneven power relations and social inequalities can be embedded in the design, governance and functioning of technical networks

(Heynen, 2013; Heynen, Kaika, & Swyngedouw, 2006). Graham and Marvin's 'Splintering Urbanism' thesis vividly illustrates how dynamics of liberalization, unbundling and bypassing can lead to fragmentation and exclusion (Graham & Marvin, 2001). But extreme 'splintering' tendencies (disconnecting households, customer discrimination,...) are relatively limited in the North-West European context and would be socially and politically unacceptable (Rutherford, 2008). Also in Flanders, the liberalised energy market is still strongly regulated, and established welfare and solidarity principles have been inscribed in legislation.

On the other hand, 'counter-stories' emerge from diverse research fields, that show how urban infrastructures in diverse contexts are becoming a site of progressive contestation and are being appropriated by citizens, governed collectively, or remunicipalised (Becker, Naumann, & Moss, 2017; Coutard & Guy, 2007; Coutard & Rutherford, 2016; Morris & Jungjohann, 2016). Particularly the energy transition is then seen as an important opportunity for socio-political change. This broader socio-political agenda was more present in energy debates in the 60s and 70s, but gradually the discourse on sustainable energy shifted towards energy economics, placing quantitative goals and norms of technical success over social values (Byrne & Toly, 2006; Illich, 1974; Lovins & Price, 1975). More recently, transition studies have reframed 'sustainability' as a process of fundamental societal change, recognising that it necessarily includes conflict, contestation, and shifting power relations as the vested interests of regime actors are put into question (Block & Paredis, 2012). Key choices in energy transitions are therefore "*not so much about different fuels or technologies, but between different social, economic and political arrangements built in combination with new energy technologies*" (Miller, Iles, & Jones, 2013, p. 139). These social-political ambitions of the energy transition are often expressed through concepts such as 'energy democracy' (Morris & Jungjohann, 2016; Vansintjan, 2016), 'energy justice' (Miller et al., 2013), a 'right to infrastructure' (Becker et al., 2017), or 'energy as common' (Becker et al., 2017; Byrne, Martinez, & Ruggero, 2009). The commons framework offers an alternative to the traditional state-market dichotomy and stands for a more holistic approach to energy transitions that allows to combine ecological concerns with the aspirations of local communities and economies (Mattei, 2012). These ambitions are operationalized by citizen movements struggling for example for more democratic energy governance and decision-making, financial participation, and affordability of energy prices. Energy infrastructure then serves as a site to question individualism and capitalism and imagine possibilities for emancipation through civil action (Kaika, 2004), to re-imagine the role of the (local) state and of individuals in systems of collective consumption, and to develop new forms of urban citizenship (Webb, 2016).

A pertinent nuance to the 'splintering urbanism' concept, is the need to distinguish between the unbundling and splintering of infrastructure services, and socio-spatial fragmentation or segregation (Coutard, 2008, p. 1818). Moreover, collectively governed energy infrastructures, are not necessarily ecologically and spatially more effective. This paper therefore wants to explore how the pluralization of heating infrastructure configurations in the dispersed territory of Flanders, relates with processes of spatial-metabolic fragmentation or integration, and with socio-political exclusion or emancipation. By exploring this double spatial-metabolic and socio-political dimension of energy infrastructure transformation, it adds crucial perspectives to the dominant understanding of energy transition as a process of mainly technological change. Understanding sustainability transitions as fundamental societal transformations (Frantzeskaki & Loorbach, 2010; Paredis & Block, 2015; Rotmans, 2016), it explores how energy transition in Flanders can include a transformation of existing unsustainable spatial structures, and the development of democratic and inclusive forms of governance. It aims to understand whether spatial selectivity and differentiation in heating technologies, can go hand in hand with a more inclusive and democratic energy system.

Modern infrastructure ideal (Coutard & Rutherford, 2016, p. 4)	**Splintering urbanism** (Graham & Marvin, 2001)	**Heat transition in Roeselare**	**'Integrative' potential to be explored**
Functional integration	'Splintering' or unbundling of infrastructure services + socio-spatial segregation	Spatial-metabolic dimension	> energy-efficiënt spatial structure - spatial rebundling - metabolic integration
Metabolic integration			
Socio-economic integration		Socio-political dimension	> democratic and inclusive energy governance - financial and democratic participation - affordable heat and energy-efficiënt housing
Political integration			

Table 1 – Relation between theoretical concepts with structure of the empirical results

2. The heat transition: spatial-metabolic and socio-political transformation

This paper focuses on the transition towards a fossil-free heating system in Flanders, as a process where the relation between infrastructure configuration, spatial morphology and energy governance is especially relevant. While energy transition debates in Flanders often focus on electricity, energy used in the form of heat is increasingly receiving policy and research attention as a crucial element in building a sustainable energy system (Argus, 2014; Connolly et al., 2014; Cyx, 2017; Raeymaekers, 2017). Heat represents 60% of the end energy use in Flanders, compared to 20% of energy used as electricity and 20% as transport fuel. It is used at low temperatures to heat buildings and supply hot water, and at high temperatures in industrial processes (Argus, 2014). Today heat is mainly produced from imported fossil fuels in the form of natural gas (67,5% of households and increasing) and fuel oil (23% of households and decreasing) (Winters et al., 2015). Only 5,1% of the heat used in the region comes from renewable resources, as opposed to 12,3% for electricity (Jespers, Aernouts, & Wetzels, 2016). There is also no policy consensus about switching to a fossil-free heating system or phasing out gas – as there is in the Netherlands. Sales of gas-boilers still outnumber investments in alternatives. Public investments in the gas network also continue, for example to allow the switch from low-caloric to high-caloric gas once import from the Netherlands will no longer be possible (Hens, 2017). This continues the logic of 'network optimization' rather than investing in fundamental transformation, and illustrates how the gas network represents a crucial factor of obduracy in the Flemish energy transition. Nevertheless, alternatives are slowly emerging, both in the form of 'collective' district heating projects, and 'individual' heating installations such as heat pumps, biomass installations, or solar collectors.

The spatial-metabolic dimension of the heat transition

The heating system is strongly related with the structure of the built environment for several reasons. Heat demand depends on the energy-efficiency of the building stock, which is influenced by aspects on the building scale (building skin, age) and on the urban scale (building orientation and compactness, density, function mix). The transport of heat also requires a relative proximity between source and demand. This means the feasibility of collective heating systems (district heating), more

than for gas or electricity networks, depends on the building density and heat demand of a certain area, often expressed in kWh/m (see also (Guy & Karvonen, 2016)). Flanders' individual housing culture, fragmented ownership structure and dispersed form of urbanization make the integration of collective heating systems particularly difficult.

Knowing how energy supply networks have historically facilitated and reproduced dispersed forms of urbanization in the region, it becomes particularly relevant to understand whether and how the introduction of this new type of energy network might reproduce, or rather challenge, this energy-intensive form of urban development. Revalorising proximity as a guiding principle for both energy systems and urban development, could be a lever for a more energy-efficient Flemish landscape. Synergies can be developed between the integration of collective heating systems, and strategies of densification and structural renovation.

Collective heating introduces an intermediate spatial scale in-between the existing macro and micro dimensions of the energy system. It represents both an up-scaling of individual heating installations, and a decentralisation of the conventional grid (Guy & Karvonen, 2016). The integration of district heating systems, but also the structural renovation of the existing building stock, require interventions on the meso-scales of building block, street, neighbourhood, and city-region.

Energy in the form of heat opens opportunities to reuse energy flows. By 'cascading' heat from functions that need high temperatures (industrial processes) to functions that can work on lower temperatures (heating buildings), a more 'circular' and efficient energy system can be developed (Stremke, van den Dobbelsteen, & Koh, 2011; van den Dobbelsteen et al., 2009).

In the transition towards a fossil-free heating system, both 'collective' solutions (producing heat for more than one building) and 'individual' alternatives (producing heat for one building/entity) are possible choices. But even such 'individual' heat installations often still depend on the public grid for electricity supply and therefore impact the functioning, spatial configuration and societal cost of the public network. There is a tension between the policy focus on individual households for renovation and energy production, which ultimately targets the ideal of maximum self-sufficiency on an individual level, versus the potential of shared heating systems that are usually more effective in denser urban areas. As shown by Späth for passive housing and district heating, such individual vs. collective approaches to energy transition can be mutually interfering strategies (Späth, 2005). In Flanders, subsidizing individual heating installations risks to undermine the feasibility of future collective solutions in areas where these would be more effective. This underlines the need for spatially selective policies and planning strategies, providing a suitable solution for different types of neighbourhoods that balances heat provision with the potential for renovation (Cyx, 2017).

Spatial planners and designers have explored the energy transition as an inherently spatial project, using research-by-design and scenarios to test and visualize potential energy futures (Posad, 3E, Universiteit Gent, Resource Design, 2015; Sijmons, 2014, 2017; Stremke, Koh, Neven, & Boekel, 2012; Stremke, Van Kann, & Koh, 2012). The structuring capacity of collective heating systems based on deep geothermal energy in the Campine Region, was notably explored in the Atelier Diepe Geothermie (51N4E, 2015). But research-by-design would be valuable to explore both the regional and neighbourhood levels in more detail: how could a regional heating strategy contribute to a more energy-efficiënt spatial structure, and how can a heating system on the neighbourhood level also increase local spatial quality?

The socio-political dimension of the heat transition

The heating sector is new within the Flemish energy system, and is not as strictly regulated as the electricity and gas sectors. It therefore raises important questions of governance, social solidarity and inclusion, and might hold opportunities for broader socio-political change. New types of actors and governance configurations start to challenge the existing gas system and its proponents.

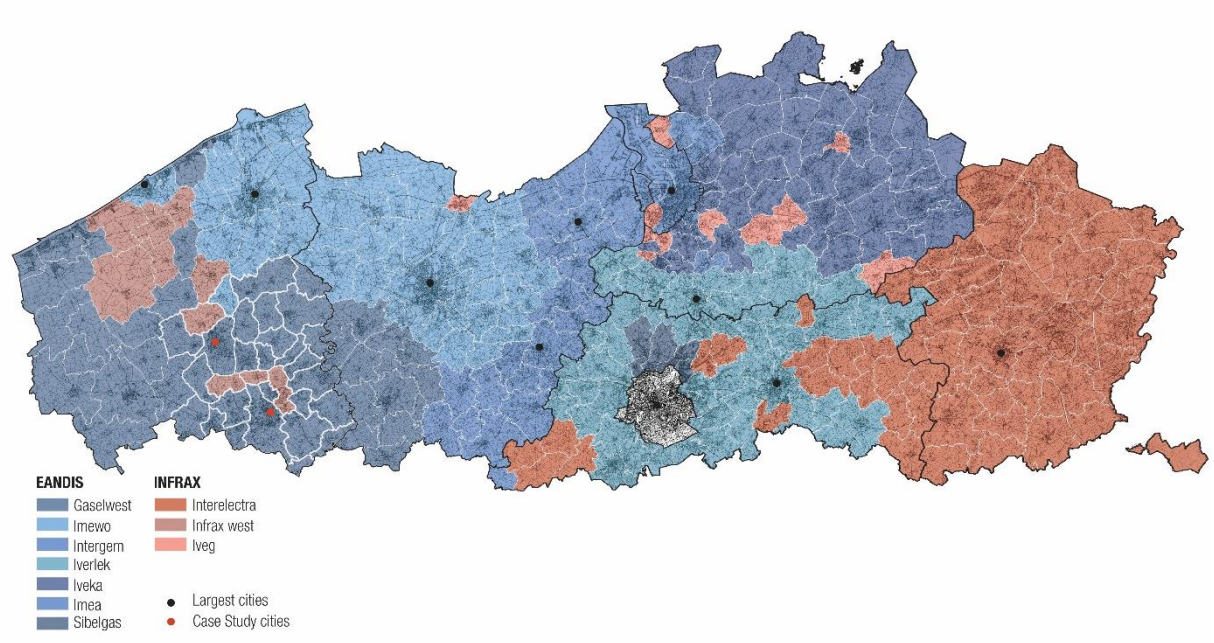

Fig. 2 – Map of the area's of operation of different intermunicipal energy companies – gas distribution network – source: author based on data from Eandis

Intermunicipal energy companies,operating through Eandis and Infrax, have the legal monopoly to manage the electricity and gas distribution networks in the Flemish region [Figure 2]. But as there is no legal monopoly for district heating, diverse types of actors are developing collective heating projects in the region [Figure 3]. Today, these emerging governance forms range from semi-public companies to commercial energy businesses, but alternatives in-between these state- and market-led solutions are also taking shape.

The conventional intermunicipal energy companies, but also intermunicipal waste companies, have been drivers of district heating projects. Some commercial players have built district heating systems, and in particular several B to B projects of heat exchange for industrial processes have been developed. But also more 'commons'-inspired projects are emerging on different scales: citizen energy cooperatives have started to invest in district heating, there are small-scale biomass cooperatives, and shared energy systems have been created as part of co-housing projects.

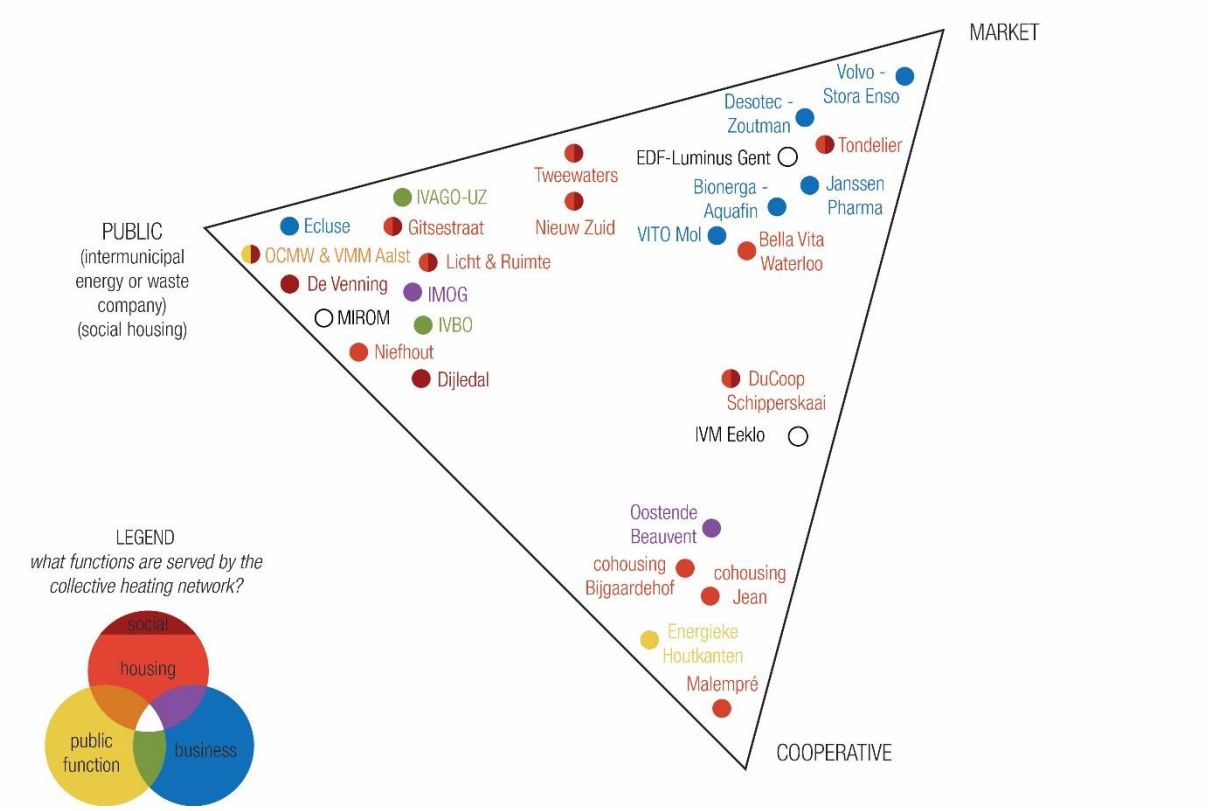

Fig. 3 – Representation of emerging collective heating projects in Flanders – according to type of governance structure (public organisation, commercial actor, cooperative or citizen initiative) and type of functions connected (housing, industry, public functions) – source: author based on desktop research

A crucial question is how different types of governance influence the criteria (social priorities, energy-efficiency and ecology, commercial viability) used in developing district heating, and therefore the spatial configuration, location and scale of collective heating projects. Commons-inspired forms of governance, such as those developed by energy cooperatives, generally aim to combine societal and ecological targets and focus on accessible heating prices, and citizen participation rather than commercial profit. One representative of an energy cooperative stated that "[commercial] *companies expect a rate of return that is not reasonably feasible with district heating*" (presentation April 2018). Such collective forms of governance can take different forms: from struggles for remunicipalisation in cities like Berlin and Hamburg, to the development of district heating by cooperatives in Eeklo and Oostende in Flanders.

However, such collective approaches to energy infrastructure remain exceptions in a region which has no strong tradition of collectivity and is dominated by individual home-ownership and the associated individual heating installations. The political and normative dimensions of the energy transition are rarely made explicit in the public debate, where the focus is on quantitative targets and technical discussions. However, such dimensions are especially relevant in the case of district heating, where the individual customer is dependent on a fixed supplier for heat and commercial objectives need to be balanced against public interest. Moreover, as a technology that needs to be implemented at a meso-scale level, it requires a collective decision and is unlikely to be developed without public support in planning and financing, especially given its long-term impact and investment perspectives (see also (Guy & Karvonen, 2016)).

While the intermunicipal energy companies seem a potentially strong partner for local municipalities to develop district heating, their role in the transition towards a fossil-free heating system is questionable for several reasons. They are semi-public companies with great expertise in implementing and managing underground networks, and have recently developed several district heating projects. But Eandis has been criticised for lacking transparency in its decision-making structure. Representatives of local governments are given limited opportunities to participate in strategic decisions, and often lack the technical knowledge to do so. In 2016 it was revealed that Eandis had wanted to make a deal with the Chinese State Grid Corporation to buy out the shares of Electrabel, according to the requirements of a full unbundling between energy production and distribution. This deal was criticised by civil society as a missed opportunity for 'energy democracy' and a greater involvement of citizens in energy distribution networks (Willems, 2016). In spring 2017, local municipalities (the stakeholders of the intermunicipal energy companies), were asked to vote on a 'transfer of operating rights for the activity heat' to Eandis and Infrax under the guise of 'unburdening' local administrations. But this would also provide the intermunicipal energy companies with a strategic advantage in district heating, and could interfere with the freedom of enterprise of other distric heating developers such as energy cooperatives.

Even more crucially, the intermunicipal energy companies have to deal with conflicting interests as they have large sunk investments in the gas network. This is similar to Guy and Karvonen's observation about the UK situation: "*The six main energy companies in the UK are likely champions of district heating, but they have a significant stake in the gas supply market, a direct competitor with district heating* (quoting Hamkey 2009) (Guy & Karvonen, 2016, p. 86). Or, as one representative of a citizen energy cooperative put it "*They won't cut off the branch they are sitting on*" (presentation 26th of May 2018). So far, these intermunicipal energy companies have only developed heating networks in new neighbourhoods where no gas network was present, and don't seem likely to invest in district heating in places where it competes with an existing gas network or is economically less interesting than gas, even if collective heating would be the most sustainable solution on the long term.

Because heat demand is so closely linked with the energy efficiency of a building, it is also connected with housing quality and the issue of energy poverty. In Flanders, around ¾ of a household's energy budget goes to heating, and aroudn 15 to 20% of households struggle with energy poverty (B. Delbeke, Verbeeck, & Oosterlynck, 2013; Bart Delbeke & Coene, 2017). This means they spend a proportionally large part of their monthly budget on energy, or use less energy than needed to satisfy daily needs (B. Delbeke et al., 2013). For electricity and gas, a federal framework prescribes a 'social maximum price' for certain target groups and imposes strict conditions for disconnecting an indebted customer (B. Delbeke et al., 2013). This social redistribution mechanism is financed through fees on electricity that fund the 'social service obligation' of intermunicipal energy companies, the federal and Flemish energy funds, and the green energy certificates. Intermunicipal energy company Eandis uses the argument that as more households or areas would become independent of the electricity network (for example producing energy locally or exchanging with neighbouring functions), this could undermine the overall affordability of the energy system.
Such a redistribution system or 'social tariff' is not in place yet for heating at the federal or Flemish level. Some district heating projects organise it at the project scale through internal solidarity mechanisms or with funding from local government. A more general policy framework for heat is under development, but the emergence of new types of individual and collective heating systems raises the question how and on what scale solidarity and redistribution can be organised fairly and sustainably.

Disadvantaged families more often live in low quality housing and are confronted with different barriers to invest in energy efficiency, which depend on their housing status as social renter, renter on the private market or (emergency) home owner (Vanhille, Verbist, & Goedemé, 2017). But current energy efficiency policies often have a Matthew effect: they proportionally more often benefit high- or middle-income households, as they focus on home owners and usually require pre-financing by the beneficiary (Bart Delbeke & Coene, 2017). 'Ecological' and 'social' goals often create conflicting incentives: proposed ecological policy measures such as a carbon tax, could disproportionally affect lower-income households that use fossil fuels but don't have the means to invest in alternatives. On the other hand, small-scale pilot projects in cities like Ghent, Kortrijk and Oostende have tested innovative approaches that focus on specific target groups and develop alternative financing schemes for renovation (Vanhille et al., 2017)

3. The case of Roeselare through participatory observation

This paper will further focus on the case of heating transition in the region of Roeselare. It is part of a PhD project that explores the spatially and socially transformative potential of the energy transition in Flanders. It ties in with the need for more context-specific and practice-based case studies to develop a better understanding of the spatial and socio-political dimensions of energy transitions (Faller, 2016).

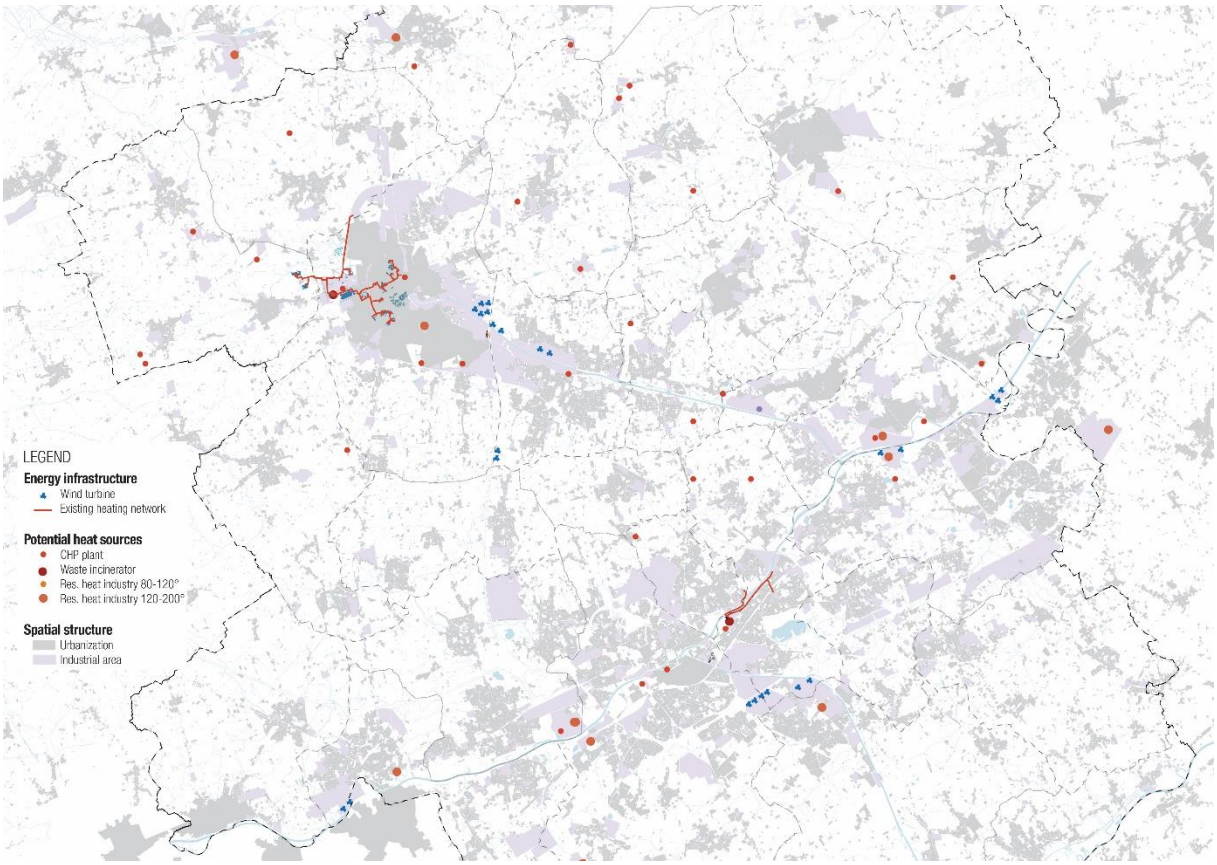

Fig. 4 – Regional spatial structure of the regions around Roeselare and Kortrijk (Mid-West-Flanders and South-West-Flanders), indicating existing collective heating networks and potential heat sources – source: author based on data from Geopunt, Province of West-Flanders, Leiedal, MIROM, POM West-Flanders.

Roeselare is a relatively small city of 61 000 inhabitants in West-Flanders, and is quite representative in terms of the governance challenges and spatial conditions of other places in the Flemish region. It has a limited administrative (spatial planning) capacity compared to larger cities like Antwerp and Ghent, and has several characteristic low-density residential neighbourhoods surrounding its historical urban centre.

At the same time, Roeselare's spatial and economic context also presents interesting challenges and opportunities from an energy transition perspective. The 'Midwest' region has a large agri- and horticultural sector, including a strong pig and cattle farming industry and a number of large 'frozen vegetables' companies. Its economy is further characterised by many small and medium enterprises and has a very low unemployment rate.
Urbanisation in the Midwest and South-West-Flanders is concentrated along the water- and rail infrastructures of the Mandel and Leie valleys, and residential and industrial areas are strongly intertwined [figure 4]. The region is one of the most dispersedly urbanised areas in Flanders, and connects with the Leie valley which has repeatedly been studied as a typical example of Flanders' 'wild' urbanization and layering of diverse infrastructure networks (Cattoor & De Meulder, 2011; De Block, 2014). Roeselare has a larger demographic growth than comparable cities in Flanders (Statistiek Vlaanderen), and its built surface rapidly increased over the last decades: from 30% of the municipal territory in 1983 to 49% in 2015 (Stad Roeselare, FOD Economie). This urbanization increases pressure on existing infrastructures, and in particular on the natural water system of the Mandel valley. Over the last years, the city has experienced regular floods and periods of drought that strongly affected local agriculture but also increased inhabitants' awareness about the challenges of the local water system. But this spatial and economic context also offers opportunities to exchange heat between different types of activities, and develop a more circular economy based on synergies between the flows of heat, electricity, fuels, (organic) materials and water, as explored by a scenario exercise about the Flemish energy landscape in 2014 (Posad, 3E, Universiteit Gent, Resource Design, 2015).

While district heating is relatively new in Flanders, Roeselare was one of the pioneers in developing a heating network in the 1980s. The local intermunicipal waste company MIROM decided to valorise residual heat from its waste incinerator to produce electricity and power an urban heating network that supplies heat to the hospital campus, the regional vegetable auction, several schools, and the swimming pool. The network has expanded considerably since 2012, with another hospital campus, public buildings and several residential development projects (Rabaut, 2018). These extensions were based on emerging opportunities and facilitated by a close cooperation between MIROM and the urban administration.

In 2017 the municipality of Roeselare set up a participatory process to formulate a Climate+plan as part of its Covenant of Mayors engagement for 2030. The aim is to involve different city departments and local stakeholders in a dynamic transition process to formulate climate ambitions and actions. The regional food industry and potential further expansion of the district heating network have emerged as important opportunities for the city, while the dominance of car mobility and the need to rehabilitate the natural blue-green structure are crucial challenges. As part of this process, the 'CityZen Roadshow' (element of the European CityZen project coordinated by VITO) visited Roeselare. During this week-long urban design workshop, international energy and sustainable urbanism experts collaborated with local stakeholders to visualise the energy challenge for Roeselare, and to design strategies that connect energy transition with broader urban transformation opportunities in the domains of water, food, mobility local economy, and spatial quality.

The case study research combines several qualitative and designerly research methods. A first element is participatory observation during the process of developing Roeselare's Climate+plan, including workshops with external experts, civil servants, and local stakeholders. This gives contextual insight in the regional spatial context and the network of actors engaging with climate and energy questions. The second is a visual mapping of Roeselare's spatial structure and the regional energy system. It allows to understand and visualize the region's topography and water system, built environment and energy demand, existing heat infrastructures and sources, and opportunities linked with planned urban projects. The third line of inquiry is a desktop research on existing collective heating projects in Flanders, combined with a series of semi-structured interviews with relevant actors in the heating sector. Civil servants, representatives of energy cooperatives, and technical and legal experts were interviewed about the spatial and social dimensions of new (collective) heating infrastructures. This provides an understanding of the state of art of (collective) heating in Flanders, and the spatial and social questions emerging around this new type of infrastructure.

These parallel approaches will form the basis for the next step in the case study. Different scenarios for Roeselare's future heating system will be explored in design workshops with stakeholders. Scenarios are widely used in different fields to interrogate the future in situations of uncertainty, and can be particularly interesting in a transition context. Imagining the transformation of the heating system has to deal with uncertainties on many levels: future technological evolution and policy decisions are unknown, and there is no consensus about the desired heating technologies or forms of governance, nor a clear understanding of the spatial and socio-economic consequences of different possible choices.

In urban design, scenarios often use research-by-design to understand the spatial consequences of certain trends or hypothetical actions (Schreurs & Kuhk, 2011; Viganò, 2016). Scenario exercises have particularly become important in the context of environmental questions, for example in the context of regional energy transitions by Stremke et.al. in the Netherlands (Stremke, Koh, et al., 2012; Stremke, Van Kann, et al., 2012). But they are also used as a tool to understand new forms of dispersed urbanization (Viganò, 2016). Both these dimensions of environment and urbanization come together in this research about the heat transition in the 'nebular' region of Roeselare.

The planned scenario workshops will build on the work and findings of the Climate+plan so far, and address some of the questions that remain unanswered. As argued by Dirk Sijmons, research-by-design should allow to go beyond technical questions and use its potential to visualize and spatialize the fundamental societal impact of a transition towards sustainable energy systems (Sijmons, 2017, p. 120). The aim of the scenario workshops in Roeselare is to generate a discussion about the spatial consequences of certain technological choices (eg. in terms of spatial selectivity for collective infrastructures), and to make the socio-political and governance questions (eg. in relation to heat accessibility and citizen involvement in different governance forms) explicit.

4. Preliminary findings – a dual evolution

The first findings from the analysis of ongoing evolutions in Roeselare's heating system and its Climate+plan trajectory, are documented in the following paragraphs. They will be structured according to the distinction between 'spatial-metabolic' and 'socio-political' dimensions used in the theoretical section before. The case illustrates both the risks and opportunities present in the pluralisation of heating technologies and governance systems in the Roeselare region.

The spatial-metabolic dimension: the need for spatially selective heating strategies

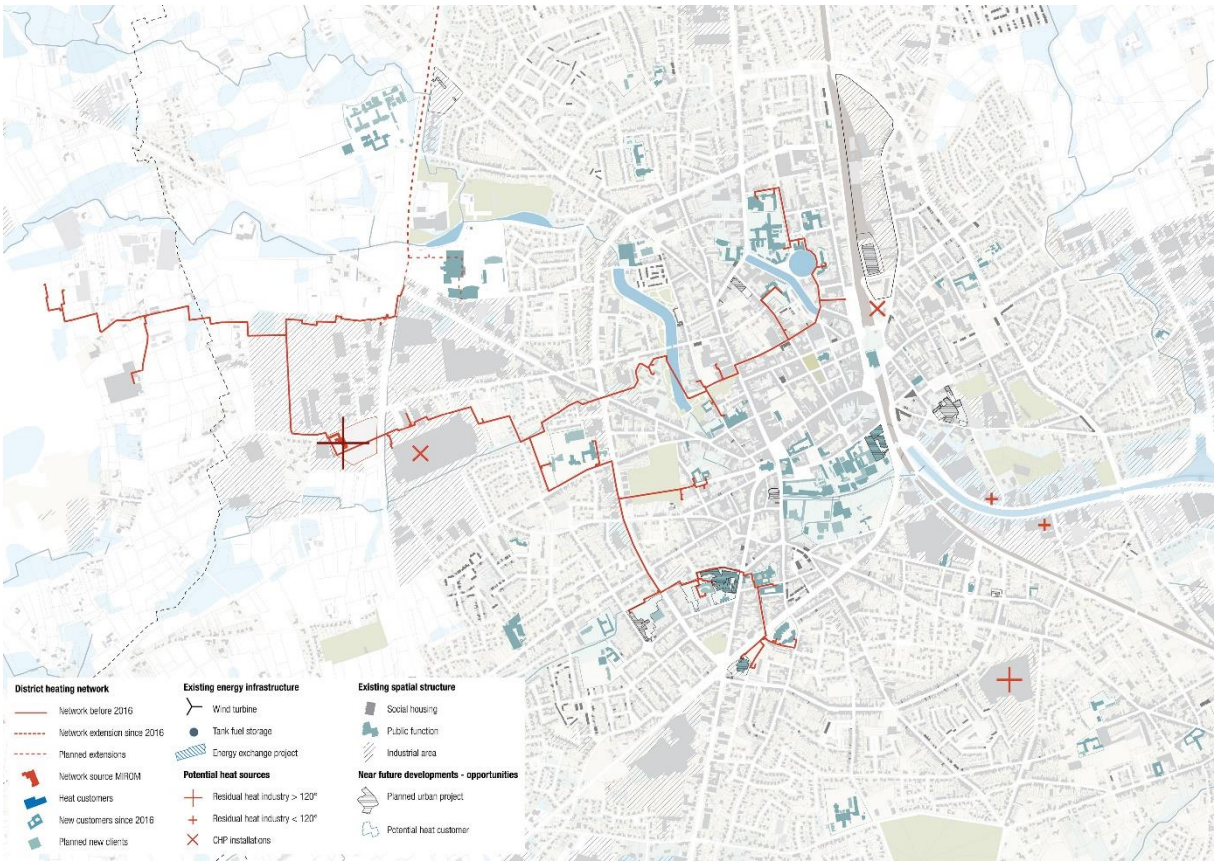

Fig. 5 – Visualisation of existing district heating network in Roeselare, and potential stepping stones for its expansion (public buildings, residual heat sources, local heat production, planned urban projects) – source: author, based on material from Geopunt, Stad Roeselare, MIROM.

Untill today, the MIROM heating network in Roeselare developed in a rather opportunistic way, its spatial structure being the result of an expansion towards interested customers. But as new heating projects are being developed, the urban administration feels the need for a more long-term vision about the future heating system. "*We have realised a lot through voluntaristic and ad-hoc work this policy period, but we have reached the limits of such a development. We need a framework now.*" (conversation with city administration, December 2017). This framework is a necessary tool for the administration to respond to ad-hoc questions from project developers. But a long-term heating strategy for the city(-region) would also allow to develop a suitable heating strategy for different types of neighbourhoods. Or, as one workshop participant put it "*We are not going to make the same mistake as we did with gas, are we? We can't roll out district heating everywhere. Nor can we strengthen the electricity grid for every household that wants to install a heat pump*". A suitable solution for each neighbourhood would then find a realistic balance between the renovation potential of the area, the local heat source opportunities, and the aspirations and socio-economic profile of its inhabitants. Moreover, a long-term framework would allow to phase the implementation of collective heating networks in synergy with other planned infrastructure works (bikelanes, sewage system transformations, ...), and improve the spatial quality of existing car-dominated and impermeable street profiles.

Another recurring question relates to the need to 'green' the heat source on the long term. Today the district heating network is fueled by the waste incinerator, but while the percentage of recycling is already relatively high in Flanders, the need for household waste incineration will ideally decrease in a more circular economy. More diverse heat sources (residual heat from companies, solar collectors and heat pumps, local biomass) can then be integrated in the network over time.

The workshops in the frame of the Climate+plan have made clear that Roeselare's urban centre would require a high-temperature collective heating system, while mid- and low-temperature systems could be used in more peripheral areas. A structural renovation of the existing urban tissue is especially difficult, as much of the housing stock in Roeselare dates back to the post-WWI-period and is in a relatively bad state in terms of energy efficiency (workshop with local architects, 27 March 2018). At the same time, several green- and brownfield projects are being developed at the urban fringe which increase the housing offer and further reduce the incentive to invest in the renovation of the existing urban tissue. Some of these new developments are also connected to the district heating network, but connecting existing housing remains too expensive so far.

Another spatial dimension that took central stage during the design workshop, was how a spatially selective implementation of collective heating systems can be linked to strategies for more energy-efficiënt spatial development. Collective heating networks can support densification in suitable places, while in other areas investment in energy infrastructure could be limited to reduce urban development on the long term, for example to create more space for wind energy production or the natural creeks of the Mandel valley. Here the link between energy transition, mobility, blue-green structure and urban morphology became very concrete. The discussion also revealed the potential of the area in-between the inner and outer ringroad of Roeselare, to densify urban morphology and strengthen open spaces, to integrate energy production and storage (for example in industrial areas), and to develop diverse forms of urban agriculture. While many participants understood the need for such a radically 'restructuring' approach, the social and financial implications, and political acceptability raised much concern. This debate illustrates that if the potential of the heat transition to contribute to a more sustainable spatial structure is to be realised, a more holistic and supported long-term vision will be necessary. The need for a spatially selective solution also raises crucial questions about social inclusion: how can equal access to sustainable heating systems be ensured, but solved with different technological configurations depending on the spatial characteristics of each area?

These discussions at city level also revealed how the transformation of the heating system depends on developments at many different governance levels. Cities are seen as important arenas of infrastructure transformation and as nexus between different governance levels and domains (Rohracher & Späth, 2014). But these are high expectations for a small city like Roeselare, especially in a pre-election period when political support for long-term changes and difficult choices is low (local elections are planned for October 2018). At the same time the smaller scale of a city like Roeselare might reduce spatial and governance complexity, and increase the options to 'colour outside the lines' (conversation with local stakeholders, April 2018). The fragmentation of energy and spatial planning competences at federal and Flemish level and between different government departments definitely doesn't help. The decision at federal level to phase out nuclear energy by 2025 could offer opportunities to integrate decentral gas-powered CHP plants on suitable locations to power local heating networks. A consensus about phasing out the ubiquitous gas network (as in the Netherlands) could provide a clear policy direction. But such decisions clearly transcend the local level. Moreover, the workshops at city level have showed the need for a reflection at the city-regional scale, for example to explore suitable locations for wind turbines, but also to develop a

regional heating strategy. Several heating networks are emerging in the region, illustrating a pluralisation of heating technologies and an ambition of local stakeholders to invest in collective heating solutions. A reflection about a regional heating strategy connecting Roeselare with the Leie valley, was initiated by the neighbouring region of Leiedal beginning this year (conversation with Leiedal, January 2018). Such a regional heating network would also require a suitable governance structure or partnership at the (inter-)regional level.

The socio-political dimension: a pluralisation of heating governance

The district heating network in Roeselare was historically developed by the intermunicipal waste management company MIROM. Its main activity being waste management, this public company started to produce electricity and heat as a side activity but has expanded the heating network considerably over the last years. Today, the future governance structure for the district heating system is coming under discussion as other actors start to develop district heating projects in the city. Several industries in the region have started to exchange heat for industrial processes, thereby setting up local heat networks between them. Moreover, planned residential developments in the fringe of Roeselare will include separate district heating systems managed by either commercial actors, or the intermunicipal energy company Eandis. Discussions about future developments of the existing MIROM-network involve the connection of more functions and more types of heat sources and storage, which would require an appropriate govenance solution.

Throughout the Climate+plan trajectory, ideas about setting up a commons-inspired alternative organisation, be it a citizen energy cooperative or a public heat company in the spirit of the German Stadtwerke, have emerged. But while energy cooperatives are active in other Flemish cities, Roeselare's civil society so far hasn't organised around the issue of 'energy democracy' or 'energy as a common', and most of the initiative comes from the public administration.
When Eandis asked to be granted the operating rights for heat in 2017, Roeselare was one of the cities that didn't adopt this proposal. The public administration doesn't want to foreclose the possibilities for other heat network developers. It has consulted legal advice to better understand and employ possible instruments, procedures and criteria for granting access to its public domain for the construction and operation of district heating infrastructure (interview with urban administration February 2018).

Another socio-political question is related to the 'right to a social tariff' for heat, which de facto doesn't exist by lack of a general framework that regulates social solidarity. Some inhabitants of social housing in Roeselare are customers of the district heating network and raised this issue to the social housing company De Mandel. The urban administration is now considering to 'fund the difference', which is feasible as only a few households would be entitled to this tariff (conversation with urban administration, March 2018). The social housing company is also confronted with the challenge to deal with billing and malpayment, as MIROM doesn't invoice to the end customer but to the building owner or manager. This means an extra concern for the social housing company and a reason to reconsider collective heating for new projects.
Beyond the heat price itself, the accessibility of sustainable (collective) heating solutions also depends on the type of housing that is equiped with these alternative technologies. So far both commercial developments and social housing have been connected to the district heating network, but connecting existing housing is still both a spatial and an important social and financial challenge.

The Climate+plan energy workshops visualised that it will be very challenging, if not impossible within current legal and practical limitations, to produce enough energy within the city's boundaries.

This raised a discussion about the value of locally produced (renewable) energy versus import from other, potentially more suitable, locations. While some stakeholders argued for exchanges with neighbouring countries or an expansion of Flanders' offshore windparks, others stressed the potential benefits of local energy production for Roeselare's economy. Reducing the city's dependence on imported fossil fuels (Roeselare's households spend around 36 million euros each year on natural gas (urban administration, January 2018)), and a stronger embeddedness of local industries through energy exchange projects were raised as important dimensions in the energy transition.

Energy policy in Flanders still operates along the traditional lines of large-scale energy production, and individual energy consumers that are stimulated towards energy production and efficiency. But the emergence of district heating introduces a collective scale of governance and requires adapted public support to be developed. As one architect in Roeselare remarked: "*individual solutions will always be there, but as a city you need to create a framework to support solutions at a collective level.*" (discussion 27th March 2018). But by subsidizing individual heat installations and investments in energy efficiency, Flemish policy still aproaches individuals as consumers rather than supporting them to develop collective solutions as citizens. The high investment cost for district heating, and its long-term spatial and social impact, notably require a long-term perspective. But the large number of small and medium enterprises in Roeselare, or even large companies that are part of a broader group, often don't have the expertise of the long-term security to commit to energy exchange opportunities or district heating.

5. Conclusions and reflection

The case of (collective) heating in the region of Roeselare reveals both opportunities for spatial rebundling and socio-political inclusion and emancipation, and risks of spatial fragmentation and increasing inequalities.

On the one hand the implementation of district heating holds potential for a stronger spatial integration or rebundling, and for social emancipation. It raises the question of proximity and could offer opportunities to support densification in suitable locations, while reducing development elsewhere. That would require thoughtful design and long-term planning. The design workshops have also showed how imagining a sustainable energy system can link heating to other policy domains such as mobility, water, food and industry. Collective heating networks can also be interpreted as tools for metabolic integration: they are not an aim in themselves but a way to cascade heat flows, connect different temperature regimes and types of heat sources, that can become 'greener' over time. Connecting industries with residual heat can further embed local companies in the urban economy. The challenge of renewable energy production, but particularly of district heating, has also revealed the need for (inter-)regional collaboration between Roeselare and neighbouring municipalities and city-regions. Depending on the type of governance structure, district heating could offer opportunities for a stronger citizen involvement in the energy system, but so far no strong civil society has emerged in Roeselare.

On the other hand, a pluralisation of heating technologies and types of actors can be observed in the region, resulting in a spatial differentiation of heating configurations and potential embedding of inequalities. In terms of solidarity and redistribution, no general policy framework or regulations are in place. While solidarity and 'public service obligations' were traditionally organised through the intermunicipal energy companies, today a diverse range of actors is active in the heating sector. Energy poverty and energy justice are absent from the local, but also from the Flemish-level debate,

although heat demand is strongly connected with housing quality and poverty. The ad-hoc responses at local level don't provide a structural solution. Both social housing projects and more high-end residential developments are connected to district heating today, but renovation and sustainable heating provision for the existing building stock remains a challenge. The affordability and degree of participation in collective heating strongly depends on the governance structure of specific projects, but accessibility also depends on the type of housing that is connected. One of the risks remains that commercial developers cherry-pick the most profitable projects, leaving more high-risk or less profitable projects for cooperative or public developers. The fragmentation and division of competences at Flemish and urban level between energy and climate, waste and (circular) economy and spatial planning is an important barrier for a spatially strategic implementation of new energy (production) infrastructures. Also the difficult collaboration between the urban administration and the intermunicipal energy company hinders better energy solutions for new urban projects.

Overall, what emerges is the challenge to reconcile a spatially diversified and context-specific heating solution, with the need for a socially inclusive and democratic heat transition. While spatial selectivity is a necessary condition for a spatially and ecologically sustainable energy system and urbanization structure, it also poses serious challenges to the development of an inclusive and redistributive heating system. On the one hand a long-term strategy should imagine a spatially selective – individual or collective - solution for each neighbourhood that responds to its spatial morphology, local heat sources, and the ambitions of its inhabitants. At the same time it needs to ensure that each inhabitant has equal acces to a fair level of heating comfort and might even increase opportunities for democratic and financial participation in the heating system. A spatially selective energy strategy includes the support of collective or individual solutions in particular neighbourhoods. But it also implies the difficult choice to discourage people from decisions that negatively impact the collective system, such as renovating badly located housing or investing in an individual heat pump where a collective network would be more effective.

Put differently: is it possible to shape the transition towards a fossil-free heating system in a way that avoids the pluralisation of heating configurations to create socio-spatial inequalities and fragmentation, but rather explores and realises its potential to restructure the Flemish landscape in an energy-efficient way and to support new forms of citizen engagement?

An important question that remains to be studied further, is how the criteria used to develop (collective) heating systems differ according to different forms of governance (public, commercial, citizen organisations), and how this influences their spatial configuration. If district heating is to be developed not only in new residential neighbourhoods, or in places where it is already competitive with gas, but strategically in areas where it is the most sustainable solution, this requires a combination of financial, social, spatial and ecological factors to be taken into account.

The case study illustrates how the challenge of developing a fossil-free heating system becomes very concrete at city level, and makes clear that local governments have a key role to play in valorising the social and spatial potential of the heat transition. But this is a high expectation for small cities like Roeselare. A stronger connection will need to be built between the actors and policy domains dealing with energy, waste, mobility and spatial planning. It wil also require coalitions or governance structures for (inter-)city-regional collaboration, and a better alignment between local, provincial, Flemish and federal policy levels.

The experiences with research-by-design and scenario building in this case study, but also in other cases in the Netherlands and Flanders (51N4E, 2015; Posad, 3E, Universiteit Gent, Resource Design, 2015; Sijmons, 2017; Stremke, Koh, et al., 2012; Stremke, Van Kann, et al., 2012) are promising to

explore the energy transition as an ambitious spatial project. More in-depth planning and design processes can help to build public support for long-term energy strategies, particularly at neighbourhood-, city- and regional level. But what has been missing so far is an explicit debate about the imagined, or desired socio-political outcome and governance structure for such future energy systems. How can design workshops and visioning processes connect spatial and technological strategies with questions about citizen engagement and the inclusion of disadvantaged groups? The scenario workshops in the next phase of this research project aim to address this question.

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