Energy transition as a catalyst for spatial and socio-political transformation

Exploring the role of planning and design in the dispersed urban context of Flanders

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Dissertation submitted in fulfilment of the requirements for the degree of Doctor in Sciences.

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Acknowledgements

It was around six years ago that I first got hold of a copy of the book 'Landschap en energie' by Dutch landscape architect Dirk Sijmons. As I flipped through the pages, I was struck by the beautiful drawings that visualized the spatial impact of energy systems and possible strategies for a sustainable energy transition on different scales. It inspired me to choose this relation between energy and space as the starting point for my research project when I applied to become a teaching assistant for STeR*, the urban planning and design programme at VUB. Working on the energy transition from a spatial design perspective, seemed an interesting way to combine some of my interests and skills. A background in engineering-architecture gave me a basic capacity to understand the technicalities of energy systems. At the same time, having grown up around several engineers, I was curious to understand energy transitions as much more than a mere technical challenge. During the landscape urbanism studios in my urban design studies I had really enjoyed developing territorial mapping and design strategies. But more fundamentally, choosing this topic was a way to explore an almost existential question: how could I, as a spatial designer, contribute to a more sustainable world?

Little did I know, and perhaps for the better, that I had embarked on a journey that was going to be as challenging as it would be rewarding. I ended up in Cosmopolis, a research group that brings together researchers with many different backgrounds, from financial geography to migration studies and housing research, but having in common an engaged and critical attitude. I soon realized how lucky I was to have met colleagues that were both inspiring researchers and extremely kind people that were always there to put in perspective the seriousness of academia. Having little research experience, it was at times also an intimidating environment. I found it especially hard to discover and claim my own position as a designer exploring concrete future alternatives when so many colleagues were often skeptical of urban planning and design processes and proposals. Working among these critical voices definitely pushed me to engage more with the social and political dimensions of urban energy transitions.

Navigating between different research fields such as transition studies, urban metabolism studies, and spatial planning and design, I also struggled to find my 'tribe' beyond the research group, or the relevant networks and settings to present and discuss my research. During a transitions conference I had to justify why I was interested in spatial morphology, while in urban planning settings I often struggled with the broad and imprecise use of the concept 'transition'. But along the way I encountered many inspiring scholars whose diverse approaches stimulated me to find my own path and believe in its value. At the same time, I was often left wondering whether and how all this research effort would have a real impact on the ground.

From the start I had contacted practitioners 'in the field' to understand what they were working on and what challenges they encountered. It is how I met the wonderful people in the administration of Roeselare, intermunicipal company Leiedal and the Province of East-Flanders. Working with them was an incredibly valuable but also humbling experience, and made me realize how much more they knew about the messy reality of urban energy transitions. I hope this work reflects some of the knowledge they so generously shared with me during our collaborations.

Looking back on these almost 6 years, it feels as if I'm finally starting to understand something about what research is and can be, about how the academic world works but also for whom it works and doesn't work, and about how complex it really is to imagine and realize an inclusive energy transition. Having started without much of a plan, I learned these things by doing, and I would probably do things very differently, knowing what I do now. Perhaps what I consider most challenging is to find a better balance between practice and reflection, between action and research, and the different types of knowledge and output they each call for.

Although at times it felt like a very lonely endeavour, many people have contributed to this research trajectory in their own meaningful ways and I would like to express my sincere gratitude ...

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To all my other STeR*, Cosmopolis and Geography colleagues, for welcoming me into this stimulating research environment, for the ever-critical conversations, the seminars, and the coffee moments. Unfortunately we had to go digital for the last couple of years, but I'm happy to pick up these inspiring interactions in real life again.

To all the people I met along the way, in the AGORA editorial board, the transitions community, the AESOP summer school, the Urbanism and Urbanization network, the TRANS-PED consortium, it is reassuring to know there are so many dedicated researchers and practitioners out there.

To Ellen, our paths keep crossing in and out of academia and I don't think that is a coincidence at all. Your candid voice and clear visuals are a great addition for spatial research.

To the friends that have been there for me since long before I undertook this adventure. Elisabeth, Eveline, Ruth, Veerle and Joke, Marjolein, Ellen, Lise, Maaike, Julie, Jo and Sanne, Evert and Elke thank you for the welcome distraction, the love and support all these years.

To anyone I might have forgotten unintentionally, please do not interpret the flaws of my memory as a lack of appreciation.

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To Christof, to help me remember whenever necessary, that everything would be fine in the end. To Thea, for reminding me every day about what really matters in life. I look forward to welcoming another bright girl in our home soon, and I can't imagine any stronger motivation for my research and practice than my concern about your futures on this planet.

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Summary

Flanders' dispersed urbanization patterns were facilitated and reproduced by ubiquitous and isotropic networks for electricity and gas distribution. Today this energy-intensive landscape is running into its spatial, ecological and societal limits. Meanwhile, the transition to more sustainable energy systems introduces potentially transformative logics, as energy configurations and governance models become more spatially selective and diverse. Proximity between source and demand, density and function mix become relevant again, while individual energy consumership and centralized governance can be replaced with more collective energy arrangements. In this research I use Flanders' particular territorial context to investigate this spatially and socio-politically transformative potential of energy transitions. I explore how spatial planning and design can contribute to energy transitions that activate more qualitative spatial development and more inclusive forms of energy governance.

Drawing from transition theory, urban metabolism studies, and planning and design literature, I propose a conceptual framework to describe the relations between energy system transformation, territorial morphology and energy governance. Three empirical chapters illustrate how the spatial and political implications of energy transitions play out on different scales and in different energy domains. They are based on a combination of qualitative and designerly research methods, including spatial mapping and scenario workshops, in-depth interviews, document analysis and participant observation. First, I zoom in on the city of Roeselare to explore the ambiguous socio-spatial potential of collective heating systems at the neighbourhood and city scale. While design can identify strategic opportunities to realize collective spatial and social benefits, without spatial planning collective heating systems risk to reproduce undesirable spatial patterns or socio-spatial inequalities. Second, I investigate how regional energy planning initiatives address the politics of transitions, as they translate generic climate ambitions into context-specific spatial strategies. Studying spatial energy planning in the regions of Denderland, Leiedal, Pajottenland and Waasland, it becomes clear how contestation around the location of wind energy production leads to different planning outcomes depending on the regional landscape, institutional setting and planning approach. Third, I unravel the implicit socio-spatial rationalities underlying energy distribution governance at the Flemish scale. This case reveals how inherently political questions around solidarity, redistribution and access to carbon-free energy solutions tend to be depoliticized because of Fluvius' operational positioning and a technocratic regulatory system.

I conclude that planning and design have a key role to play, to imagine, visualize and facilitate collective energy strategies, that connect technical energy solutions with other territorial and societal challenges. At the same time, I expose how a serious governance deficit at the Flemish level hinders the implementation of promising transformative energy strategies at the scale of neighbourhoods and supra-local regions.

Samenvatting

De verspreide verstedelijkingspatronen in Vlaanderen werden mogelijk gemaakt en gereproduceerd door alomtegenwoordige en isotrope netwerken voor elektriciteits- en gasdistributie. Vandaag botst dit energie-intensieve landschap tegen zijn ruimtelijke, ecologische en maatschappelijke grenzen. Ondertussen introduceert de transitie naar duurzamere energiesystemen potentieel transformatieve logica's, omdat energieoplossingen en beheersmodellen ruimtelijk selectiever en diverser worden. Nabijheid tussen productie en gebruik, dichtheid en functiemix worden opnieuw relevant, terwijl individuele energieconsumptie en gecentraliseerd beheer vervangen kunnen worden door meer collectieve energie-configuraties. In dit onderzoek gebruik ik de specifieke territoriale context van Vlaanderen om dit ruimtelijk en sociaal-politiek transformatieve potentieel van energietransities te verkennen. Ik onderzoek hoe ruimtelijke planning en ontwerp kunnen bijdragen aan energietransities die meer kwalitatieve ruimtelijke ontwikkeling en meer inclusieve vormen van energiebeheer activeren.

Op basis van transitietheorie, stedelijk metabolismestudies en plannings- en ontwerpliteratuur, stel ik een conceptueel kader voor om de relaties tussen de transformatie van het energiesysteem, ruimtelijke morfologie en energiebeheer te beschrijven. Drie empirische hoofdstukken illustreren hoe de ruimtelijke en politieke implicaties van energietransities zich op verschillende schalen en in verschillende energiedomeinen manifesteren. Ze zijn gebaseerd op een combinatie van kwalitatieve en ontwerpmatige onderzoeksmethoden, waaronder ruimtelijke mapping en scenarioworkshops, diepte-interviews, documentanalyse en participerende observatie. Eerst zoom ik in op Roeselare om het ambigue sociaal-ruimtelijke potentieel van collectieve warmtesystemen op buurt- en stadsschaal te verkennen. Hoewel ontwerp strategische mogelijkheden kan identificeren om collectieve ruimtelijke en sociale voordelen te realiseren, bestaat ook het risico dat zonder ruimtelijke planning, collectieve warmtesystemen ongewenste ruimtelijke patronen of sociaal-ruimtelijke ongelijkheid reproduceren. Ten tweede onderzoek ik hoe regionale energieplanningsinitiatieven omgaan met het politieke karakter van energietransities, wanneer ze generieke klimaatambities vertalen in contextspecifieke ruimtelijke strategieën. Door ruimtelijke energieplanning in de regio's Denderland, Leiedal, Pajottenland en Waasland te bestuderen, wordt duidelijk hoe spanningen over de locatie van windenergieproductie tot verschillende planningsresultaten leiden, afhankelijk van het regionale landschap, de institutionele setting en de planningsaanpak. Ten derde ontrafel ik de impliciete sociaal-ruimtelijke logica's in het bestuur van het energiedistributiesysteem op schaal van Vlaanderen. Deze case laat zien hoe inherent politieke vraagstukken rond solidariteit, herverdeling en toegang tot koolstofvrije energieoplossingen gedepolitiseerd worden door de operationele positionering van Fluvius en een technocratische regulering.

Ik concludeer dat planning en ontwerp een sleutelrol te spelen hebben bij het bedenken, visualiseren en faciliteren van collectieve energiestrategieën, die technische energieoplossingen verbinden met andere territoriale en maatschappelijke uitdagingen. Tegelijkertijd toon ik aan hoe het gebrek aan ambitieus beleid op Vlaams niveau de implementatie van veelbelovende transformatieve energiestrategieën op de schaal van de buurt en de regio belemmert.

Introduction

Energy transition as a catalyst for spatial and socio-political transformation

"We are all talking about CO_2, energy and climate change. But even if the planet wasn't heating up, it would be destroyed if we keep using so much land. We are focusing on energy and if we're not careful, we'll find the most climate-neutral way to build up the entire world."

Leo Van Broeck (former Flemish state architect)
City of tomorrow, a Glimpse of where we're going, STAM Gent, November 2016.

1. THE URGENCY OF A FUNDAMENTAL ENERGY SYSTEM TRANSFORMATION

Human society has created unprecedented and rapid changes in the global climate system, which are already affecting weather and climate events accross the planet. Unless deep reductions in greenhouse gas emissions occur in the coming decades, global warming of 1.5°C and 2°C will be exceeded during the 21st century, with far-reaching consequences for life on earth (Masson-Delmotte et al., 2021). Deep emission reductions require rapid and far-reaching transitions in energy, land, urban, infrastructure and industrial systems (*IPCC Global warming of 1,5°*, 2018). As the energy sector represents around three quarters of global greenhouse gas emissions, a transition towards fossil-free energy systems is key to averting the worst effects of climate change (*Net Zero by 2050: A Roadmap for the Global Energy Sector*, 2021). Meanwhile, over 785 million people, mostly in sub-Saharan Africa, still have no access to electricity, and 2.6 billion people do not have access to clean cooking solutions (*Net Zero by 2050: A Roadmap for the Global Energy Sector*, 2021). Underscoring the global challenge of access to clean energy and the importance of a global policy agenda on energy, the United Nations have named 'Clean and affordable energy' as the seventh Sustainable Development Goal.

Since the industrial revolution and the acceleration of capitalism, the use of energy from fossil fuels has permeated every aspect of society and supported rising living standards in large parts of the world (Haberl et al., 2011; Moore, 2000; Sijmons et al., 2014). Especially after WWII, energy use per capita increased substantially as car-based transport, modern household appliances and single-use consumption became widespread (Sijmons et al., 2014). Until recently, moving up the housing ladder often meant moving to less energy-efficient building forms (Owens, 1986). In most developed countries, the infrastructure systems necessary to process and supply energy became an almost invisible part of urban landscapes (Kaika and Swyngedouw, 2000; Star, 1999). During this short but intense fossil fuel era, the availability of cheap energy sources was considered self-evident unless their seemingly limitless flow was interrupted or threatened, for example due to international conflicts such as the 1973 oil crisis, or with the 1977 New York black-out. More recently and more closeby, the 2014 nuclear power plant failures in Belgium and the circulation of a 'power outage plan', the power disruptions caused by the flooding in the Meuse river basin in summer 2021, or the recent surge in energy prices have eroded the perception of energy as a cheap and abundant resource.

The development of this globalized and fossil-fuel based energy system co-evolved with a transformation of the scale and form of urbanization around the world. The democratization of car-based mobility coincided with the emergence of dispersed urbanization patterns based on an energy-intensive housing model of low-density, single-family houses (Sijmons et al., 2014). Along with the Dutch Randstad, the Italian Veneto or the German Rein-Ruhr region, the Belgian 'nevelstad' or nebular city is one of the notable examples of how such horizontal urbanization took shape in Europe (Dehaene, 2015). Meanwhile, a global network of coal, petroleum and gas supply chains fuels the worlds' cities and economies. This has been explained as a characteristic of planetary urbanization, the condition whereby even remote areas have become entangled in globalized and uneven urbanization processes through complex flows of extraction and consumption (Brenner and Schmidt, 2012; Ibanez and Katsikis, 2014). In this context it's significant that Belgium depends for over 90% of its primary energy sources on resource extraction in countries such as Russia or Qatar, and even in the Norwegian North Sea to power its electricity and gas networks.

Because energy is so deeply intertwined with most aspects of society, transitions towards more sustainable energy systems are complex and multidimensional processes of socio-technical change. A transition can be defined as a fundamental, deep transformation in the basic systems of society, such as the energy, mobility, food, housing or care system. Socio-technical transitions often take place over several generations, and include changes in practices and behaviour, values and patterns of thinking, regulations and institutions, infrastructure and built environment, actors and power relations (Block and Paredis, 2012; Geels, 2002; Rotmans, 2016; Rotmans et al., 2001). In the context of energy transitions, policies often focus on reducing energy demand, transforming and optimising networks and energy flows, and producing energy from fossil-free and renewable sources. However, within this focus on emission reduction, energy efficiency and energy production targets, it remains unclear how, where, by and for whom energy system transformations should be realized. Although energy transitions involve fundamental territorial and societal change, they are often treated as technological challenges while their spatial, social and political dimensions remain out of view.

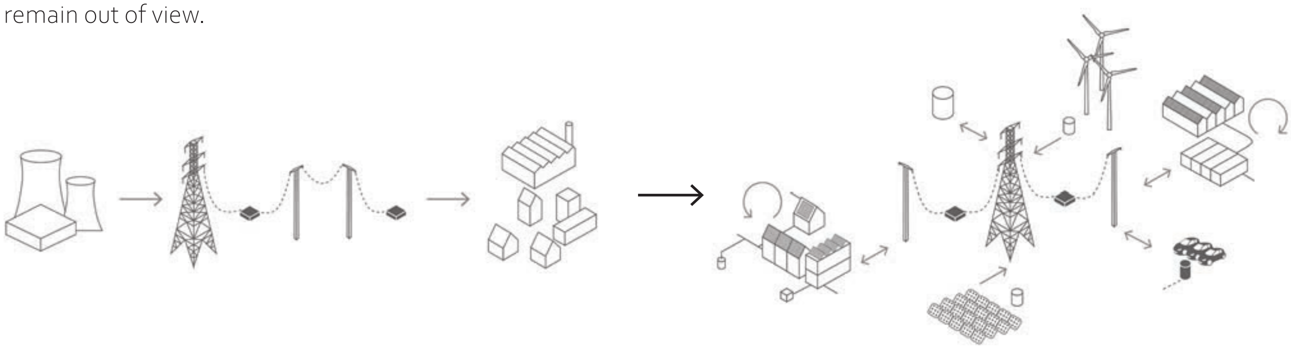


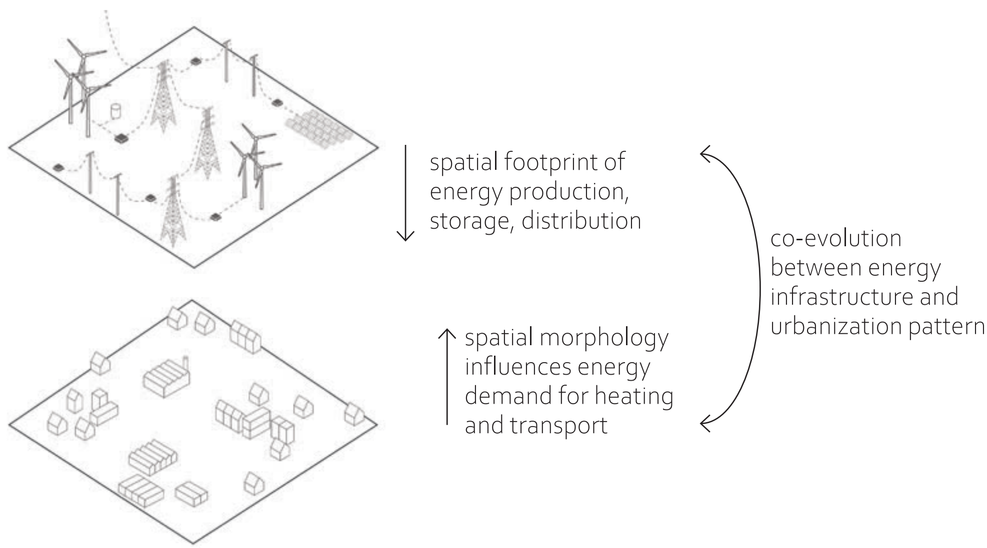
Figure 0.1. Schematic representation of energy system transformation. Source: author.

This research therefore explores how spatial and socio-political aspects of energy transitions matter, by focusing on the specific context of Flanders' dispersedly urbanized territory. This condition of horizontal urbanization provides a remarkable case to study the complex relations between energy system transformation, urbanization patterns and energy governance. Historically, throughout the emergence of Flanders' dispersed urban landscape, infrastructure planning and urbanization strongly impacted one another (Ryckewaert, 2011; Van Acker, 2014). This resulted in a particularly energy-intensive spatial morphology sustained by ubiquitous energy distribution networks, and an energy system combining centralized production with individualized energy consumption. A transition towards fossil-free and sustainable energy solutions fundamentally challenges these core characteristics as alternative social and spatial arrangements are needed that are based on collectivity, proximity and solidarity.

2. RECOGNIZING THE SPATIAL, SOCIAL AND POLITICAL DIMENSIONS OF ENERGY TRANSITIONS

Energy and space have a complex and reciprocal relationship. On the one hand, specific forms of spatial development and urbanization require certain amounts of energy and particular types of energy production and supply systems, and on the other hand, the production and distribution of energy has a particular spatial footprint and the spatial characteristics of an area shape its energy production potential (Asarpota and Nadin, 2020; Owens, 1986; Sijmons et al., 2014). Therefore, a transition towards more sustainable energy systems is an inherently spatial question.

Figure 0.2. Relations between energy system and spatial morphology. Source: author.



Embedded in the context of the Flemish nebular territory, this research also introduces another layer by exploring the interrelations between energy infrastructure transformation and urbanization patterns. It builds on a body of research that has aimed to unravel the rationalities behind the dispersed urbanization of Belgium, and which has often focused on the role infrastructure networks have played in the industrialization, modernization and urbanization of the nation (De Block, 2014, 2021; De Block and Polasky, 2011; Ryckewaert, 2012; Van Acker, 2014). In that tradition, recent work by Bruggeman showed how the development of the electricity system in the first half of the 20th century, emerging in rural as well as urban areas, facilitated and reproduced dispersed patterns of urbanization (Bruggeman, 2019). Other scholars showed how the often implicit spatial logics of policies in domains such as housing or economic planning also shaped Belgian urbanization (De Meulder et al., 1999; Ryckewaert, 2002, 2011). While most of this work has retroactively analysed the rationalities that shaped the Flemish landscape, some designers have also explored through research-by-design how this territory could be re-imagined in relation to transitions in domains like mobility, water or circular economy. Blondia investigated the potential of public transport infrastructures to (re-)structure mobility and urbanization patterns in Flanders (Blondia, 2014), and Nolf explored the redesign of water systems as a basis for spatial transformation (Nolf and De Meulder, 2013). Marin studied how urban landscape design can contribute to a spatially transformative circular economy transition (Marin, 2019). In a similar vein, in this research I explore how the introduction of alternative energy infrastructures in Flanders' dispersed landscape might have a spatially restructuring capacity, for example by supporting logics of densification or concentration.

Energy systems are not only embedded in particular spatial conditions, but also in a specific socio-political context. Rethinking them raises questions about governance, actors and power relations, about socio-economic inequalities and justice, and about the roles of citizens in energy transitions (Bulkeley et al., 2014; Nader, 1980; Shove and Walker, 2007; Szulecki, 2018; Vansintjan, 2016). Energy transitions are then not only, or even not most importantly, about technologies and fuels, but about the social, economic and political arrangements and dynamics that they shape and are shaped by (Miller et al., 2013; Rutherford and Coutard, 2014). In the sense that the energy transition is about (re-)organizing such collective arrangements, or forms of collective consumption, it is also inherently an urban question (Dehaene et al., 2015; Merrifield, 2014). Throughout this research I aimed to draw attention to these social and political energy transition dimensions and addres them in relation to the spatial reconfiguration of energy systems.

Flanders' nebulous territory is often framed as a planning failure, "*an ecological disaster that is, due to a lack of planning, now difficult to plan for*" (Dehaene, 2013, p. 72). However, as mentioned above, scholars have shown how the Flemish landscape is not merely "*the chaotic result of thousands upon thousands of individual decisions*"(De Meulder et al., 1999). Its urbanization was shaped by policies and investment strategies in domains like infrastructure planning, housing and economic development. At the same time, traditional spatial planning policies such as the Gewestplannen (1970s) or the Spatial Structure Plan (1990s) were indeed rather unsuccesful in redirecting dispersed urbanization processes (Voets et al., 2010). The Flemish landscape therefore urges the planner to be modest, but also requires spatial imagination to work with and within its territorial reality. "*The dispersed urbanized landscape ridicules the overly ambitious urban designer. Overall change is not an option. At the same time, however, the absence of an apparent and legible order is the source of endless possibilities of recombination and modification.*" (Dehaene, 2013: 59–60). How can one meaningfully plan and design for a sustainable energy transition in this context? Dehaene calls for a 'gardening' approach to urban design, a careful reading of existing horizontal urbanization patterns as a basis for recombination and intensification, to create and rethink collective arrangements and qualities. This does not imply an acceptance of the dispersed consumption of the territory, nor does it give up the possibility of radical change. Rather, Dehaene acknowledges the social and ecological crises caused by dispersed urbanization, while recognizing at the same time the potential qualities of this landscape in terms of resilience and infrastructural overcapacity. Indeed, Flanders' energy distribution grid, for example, has proven to be a very robust network. Building on the work of sociologist Jean Remy, Dehaene draws attention to the collective value accumulated in the urbanization process of Belgium, and to the radically transformative potential of collective socio-spatial arrangements in different 'urban questions' around housing, mobility or food. This research explores how that lens can inspire a design approach to the energy transition in Flanders and a critical alternative to current energy policy and spatial development. It investigates how planning and design can harness the energy transition as a catalyst to create spatial and societal added value on different collective scales, from the street or the building block, to the neighbourhood, the city and the supralocal region to the scale of Flanders.

3. DIVING INTO THE SOCIO-SPATIAL CHARACTERISTICS AND GOVERNANCE CONTEXT OF THE FLEMISH ENERGY SYSTEM

The spatial and socio-political conditions of the Flemish territory are then key to understand the specific challenges of a transition towards more sustainable energy systems in Flanders. The following paragraphs trace how these spatial and social conditions matter in relation to the different elements of the energy flow, from energy demand, over transport, to energy production. They also provide an outline of the governance context for energy and spatial planning in Flanders. Keeping up with the rapidly changing energy policy context was a continuous challenge throughout this PhD research process. This section represents the situation at the time of writing during fall-winter 2021-2022.

Concerning energy demand, Belgium can be considered an energy-intensive country and has a higher energy use per capita than its neighbours France, Germany, the Netherlands and the UK (Corens, 2021). Three forms of energy 'end use' can be distinguished, with energy being used in the form of heat, electricity and transport fuel. Although much energy transition effort focuses on renewable electricity production through wind turbines or solar panels, heating constitutes the largest energy end use and represents around half of the total global energy consumption (*IEA*, n.d.). In Flanders, energy used in the form of heat (heating buildings, hot water and powering industrial processes) accounted for 58,3% of final energy use in 2019, while electricity took up 17,9% and transport 23,7% (Energiebalans 2019) [Figure 4]. Renovating the existing building stock is therefore key to reduce energy demand, along with optimising industrial processes and reducing (carbon-based) car mobility. However, precisely the characteristics of the Flemish building fabric make this a tough challenge. Heating demand in Flanders is relatively high compared to other Western-European countries with similar climates. In 2013, energy consumption for residential buildings was on average 263 kWh/m² in Belgium, while the European average is 180 kWh/m², and the average is 152 kWh/m² in the Netherlands, 190 kWh/m² in France and 199 kWh/m² in Germany (*EU Buildings Factsheets*, 2016) [Figure 5]. The ambition of the Flemish government is to reach an average of 100 kWh/m² (EPC score 100) by 2050. Compared to most neighbouring countries, Flanders has a higher share of single family homes with relatively large footprints, and the building stock is relatively older and has a lower energy performance (Corens, 2021; Van Noordt and Bieseman, 2018). Together with the UK, the Belgian housing stock has the highest share of houses constructed before 1945 or between 1945 and 1969. Similar to the UK and the Netherlands, Belgium also has a high share of single-family housing units (73%), but unlike those neighbouring countries, many of those homes are located in low- or intermediately urbanized areas (*EU Buildings Factsheets*, 2016), which has a negative impact on energy demand for transport. Whereas in the UK and the Netherlands, respectively 55,9% and 46,8% of the population lives in densely populated areas, this is only 29,4% in Belgium (*EU Buildings Factsheets*, 2016). Indeed, only 26% of households live in one of the regions' 11 larger cities (Heylen and Vanderstraeten, 2019). More than 50% of the single-family homes are underused (for example because children have moved out) and there is a growing mismatch between the current housing offer and the increasing demand for smaller units in more central locations (Bervoets and Heynen, 2013). Given the current state of the housing patrimony, around 57% of housing units need to be repaired or renovated to comply with minimal housing quality norms, and almost 95% of all houses require investments to reach the energy

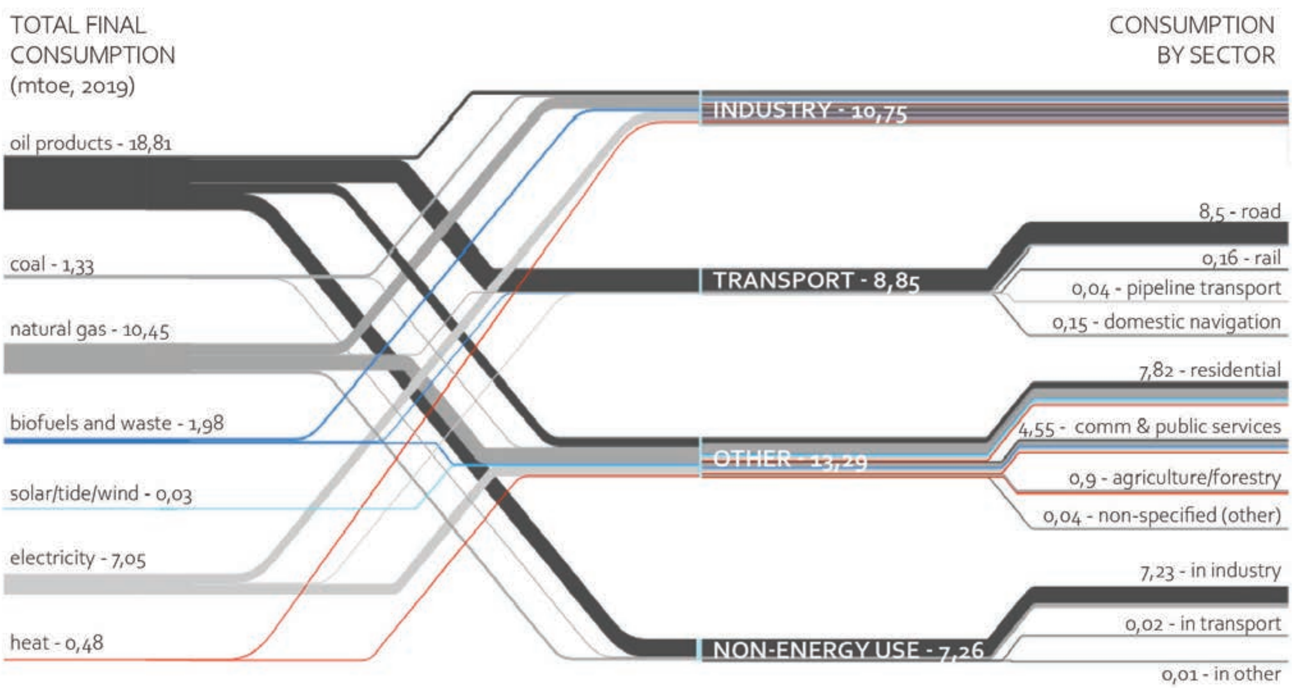


Figure 0.3. Final energy consumption - Belgium (in million tonnes oil equivalent, 2019).
Source: IEA Sankey diagram.

Figure 0.4. Final energy use - Flanders.
Source: Energiebalans 2019.

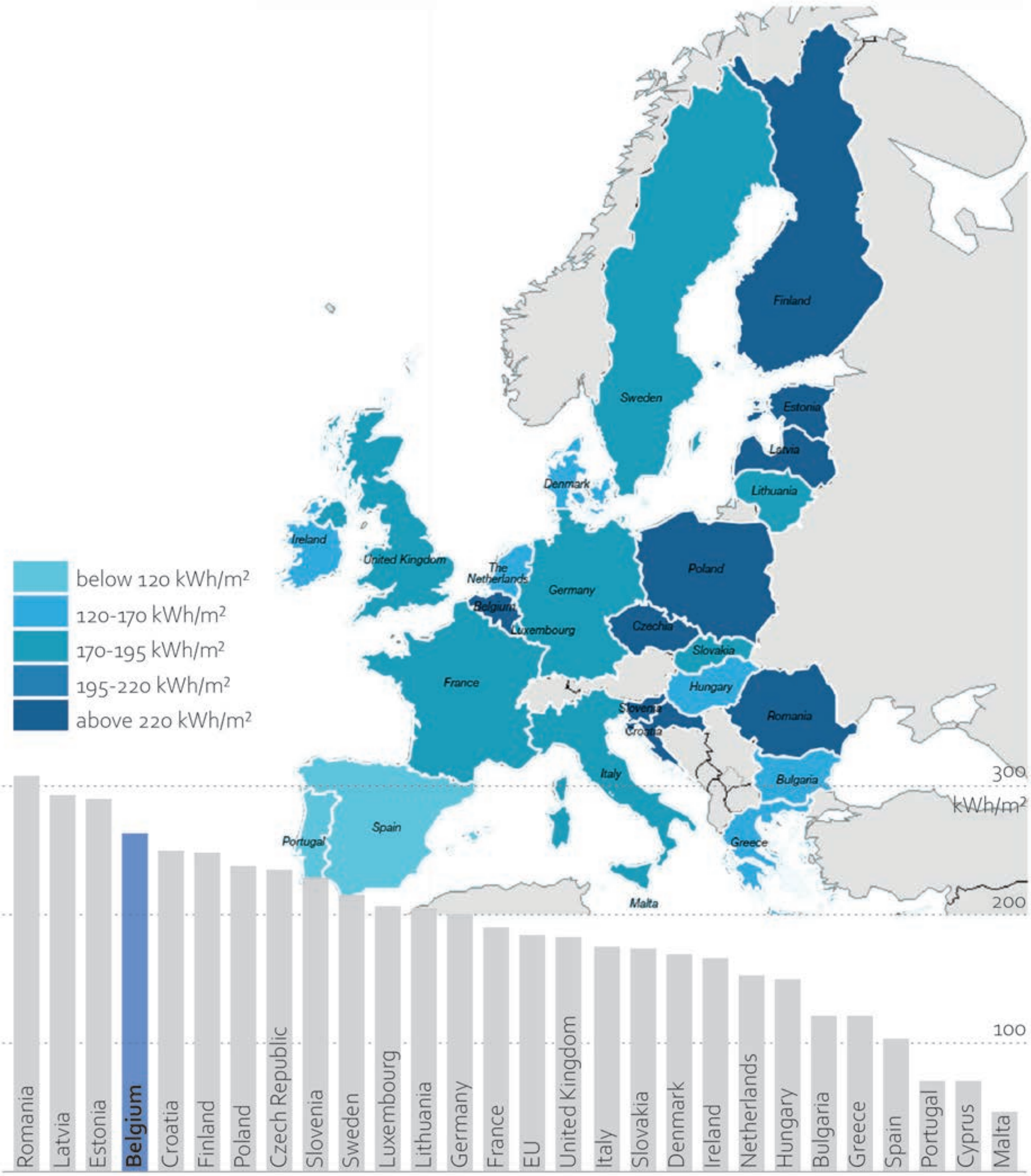


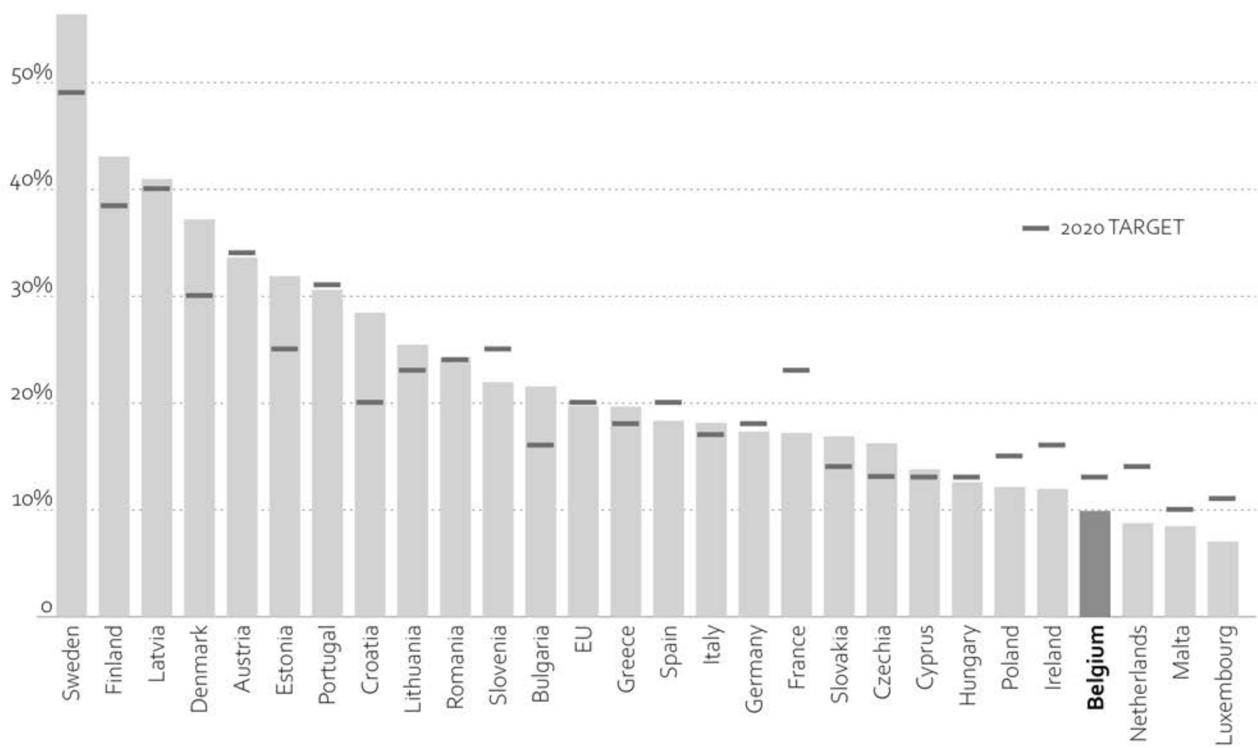
Figure 0.5. Energy consumption of residential buildings (in kWh/m², in normal climate, 2013).
Source: EU Building Stock Observatory.

goals of the Flemish 'Renovatiepact 2050', which would cost around 40-43.000 euro on average (Ryckewaert et al., 2018). However, the renovation of this existing housing patrimony progresses slowly at a rate of around 1% a year (*Argusrapport*, 2014), because of the region's fragmented ownership structure: 71,6% of households are owner-occupants (Heylen and Vanderstraeten, 2019). Low-quality housing patrimony tends to impact vulnerable households most strongly. More than 1 in 5 Belgian households (15,1% in Flanders) faces a form of energy poverty, with social renters being the most vulnerable group (Meyer and Coene, 2021). In addition, expected renovation costs are the highest for the most vulnerable groups, with lowest housing quality and energy performance among renters, single parent- and single person households, meaning those underprivileged households cannot afford the necessary renovation cost to reach climate goals (Ryckewaert et al., 2018). Nevertheless, approximately 97% of energy subsidies (e.g. for renovation) are awarded to non-vulnerable households (Steunpunt Armoede, 2019). Low-income households meeting specific criteria are entitled to a social tariff that corresponds with the lowest rates in the market. This tariff is an important buffer to protect the most vulnerable households from energy poverty, for example in the context of soaring gas and electricity prices in fall-winter 2021-2022. However, households that fall just outside of this category often struggle to pay commercial rates and end up with the network operator as a 'social supplier'. This operator charges a 'discouraging tariff' that is among the highest energy rates in Europe and aims to stimulate consumers to re-enter the commercial energy market (Pauwels, 2021). Flanders' dispersed urbanization and spatial fragmentation also lead to a relatively high energy demand for road transport: on average, Flemish inhabitants, in particular rural dwellers, yearly drive 1000km more than other Europeans (Corens, 2021). Moreover, while energy demand in the residential sector is decreasing, energy demand for transport still increases (increase of 31,1% compared to 1990) (Corens, 2021).

In terms of energy networks and infrastructures, Flanders is equipped with extensive electricity and gas networks. The integration of decentralized, renewable energy sources requires the transformation of the electricity grid to allow for a bidirectional flow of electricity, and to cope with the intermittent production of solar and wind energy. At the transmission level, network operator Elia is investing in strategic high-voltage interconnections with neighbouring countries, to allow for the exchange of energy across national borders and contributing to Europe's ambition of an integrated energy market. The company also realizes the integration of offshore wind energy production (Elia, n.d.). The LNG terminal in Zeebrugge is a key hub for natural gas transmission in Europe. It is managed by Fluxys, which also operates gas transmission infrastructure in Flanders, Europe and Brazil (About Fluxys, n.d.). Distribution networks for gas and electricity are operated by public network operator Fluvius. The operator needs to adapt and strengthen the electricity distribution grid to accommodate the increasing electrification of heating (heat pumps) and transport, and to integrate local renewable electricity production (solar photovoltaic, wind) and charging infrastructure for electric vehicles. Moreover, balancing energy production and demand involves a proces of digitization, for example through the introduction of 'smart meters', and the integration of energy storage and buffering capacity. Regarding gas distribution, Fluvius has to deal with a legacy of public investment in an extensive natural gas network. Part of this network distributes low-caloric gas imported from the Netherlands and is currently being adapted to transport high-caloric gas as the Netherlands have decided to phase out gas extraction by 2030 (Corens, 2021). Meanwhile, district heating systems are emerging both as collective heating solutions in newly-developed residential projects, and as systems to cascade residual heat between industries in industrial areas. Since district heating is a relatively new energy sector, there is no regulated network monopoly and both commercial, cooperative and public companies are involved in heat production, distribution and supply. Investments in hydrogen infrastructure are also receiving increasing interest. Flanders' dispersed spatial structure leads to high societal costs to develop and maintain utility networks for water, electricity, gas and sewage. Although the yearly cost per meter is 30% higher in urban than in dispersed areas, infrastructure length per building is up to 9,5 times higher in dispersed areas, leading to overall supply infrastructure costs that are 7 times higher per building in dispersed, than in urban areas (Vermeiren et al., 2019). The yearly cost of electricity infrastructure per building is around three times higher in urban than in dispersed areas (Vermeiren et al., 2019).

Regarding energy production, the Belgian system strongly depends on the import of petroleum and natural gas. Electricity is mainly produced in gas power stations and a number of nuclear installations located in Doel and Tihange. The latter were constructed in the 1970s and 1980s, and have already remained in operation for ten more years than originally planned for. An increasing number of households uses natural gas for heating (68% in 2019), while 16% use petroleum as main source (Maes et al., 2019). 14,60% of electricity, and only 5,60% of heat is produced from

Figure 0.6. Share of energy from renewable sources - EU (in % of gross final energy consumption, 2019).
Source: Eurostat.



renewable sources. Biomass makes up 75,4% of renewable energy in Flanders and is mostly used for heating and as biofuel. Since Flanders doesn't have the large surfaces available that are necessary to produce energy crops, most biomass is imported, which raises questions about its sustainability (Corens, 2021). Solar and wind energy are dominant in renewable electricity production. In Flanders' urbanized landscape, most opportunity for solar is on roofs, but only around 4% of this potential has been realized up to date (Van Esch et al., 2016), with most solar installations (51%) being installed in rural areas (Corens, 2021), and on single-family rather than on multi-family houses (Heylen and Vanderstraeten, 2019). 21% of home owners have invested in renewable energy, whereas only 3% of renter households live in homes equipped with renewable energy (Heylen and Vanderstraeten, 2019). Finding suitable locations for onshore wind turbines is extremely complicated in Flanders' fragmented landscape, and the region counted 560 wind turbines in 2020, mostly in rural and peri-urban areas (Corens, 2021). Although large commercial energy companies like Engie, Luminus and Eneco retain the major share of the energy supply market (VREG, 2021), the number of energy cooperatives in Belgium is steadily growing and there are currently around 36 cooperations, 20 of which are active in Flanders with in total around 80 000 cooperants (REScoop Vlaanderen, n.d.; Vansintjan, 2021). Nevertheless, this means that only around 1% of citizens are a member of an energy cooperative today (energy cooperative, 2021). The high amount of savings in Belgian bank accounts (250 billion) suggests a strong capacity for financial citizen participation and is regularly cited by energy cooperatives as an interesting potential to mobilize citizens as key actors in the energy transition. However, at the same time 67,7% of households struggle to regularly set aside some money (Testaankoop, cited in Van Broeck and van Ypersele, 2019), indicating that the capacity to invest in sustainable energy solutions is distributed very unevenly among Flemish households. In that sense, citizens are still rather positioned as individual energy consumers rather than active participants in the energy market. The implementation of the EU legislation on Citizen and Renewable Energy Communities could potentially mean a shift in this respect, but the current transposition into Flemish legislation seems to remain relatively conservative and will be implemented in phases from January 2022 onwards.

The governance of energy systems in Flanders needs to be understood within the context of broader EU energy and climate policy, and within the structure of Belgium as a federal state where competences on energy and spatial planning are distributed between the federal, regional ('*gewestelijk*' – regions of Flanders, Brussels and Wallonia), and local level[1]. The EU is often at the forefront of international climate policy and defines climate targets for its member states. Since 2021, it strives towards a reduction of carbon emissions with 55% compared to 2005 for non-ETS sectors by 2030 ('Fit for 55' package).

1 Throughout the dissertation, it is important to distinguish the different governance levels, as a confusion of terms could arise between the 'Flemish region' (*Vlaams Gewest*) and the supra-local or intermunicipal 'region'. Where possible, I've used the term 'Flanders' or 'Flemish level' for the Flemish region, although in chapter 4 about the energy distribution system, I also use the terms 'region' and 'regional' to refer to the Flemish scale. In chapter 3 on regional energy planning, the term 'region' refers to the supra-local level.

Regarding energy policy in Belgium, the federal government is responsible for offshore wind production, nuclear energy and the transmission grid, while the Flemish region *('Vlaams Gewest')* is competent for renewable energy, energy efficiency, energy distribution and district heating. Flanders also has the main authority on spatial planning and environment, except for marine spatial planning which is a federal competence. Dialogue between the federal and Flemish governments on energy matters is organized via the platforms ENOVER (energy) and NKC (National Climate Commission). The CREG ('*Commissie voor de Regulering van de Elektriciteit en het Gas*') at national level, and the VREG ('*Vlaamse Regulator van de Elektriciteits- en Gasmarkt')* at Flemish level, are the independent regulators of the energy market. Consultation with civil society actors is organized through the platforms of *Minaraad* ('*Milieu- en Natuurraad van Vlaanderen'* – Environment and Nature Council) and SERV *('Sociaal-Economische Raad van Vlaanderen'* - Socio-Economic Council). This institutional fragmentation hinders the development of ambitious climate and energy policy in Belgium. For example, it took the Flemish, Brussels and Walloon regions until 2018 to reach an agreement about the 'burden sharing' of climate and energy goals for the period 2013-2020 (*Klimaat* | *Climat*, n.d.). Formulating an integrated National Energy and Climate Plan, as introduced by the EU's Clean energy for all Europeans package (Regulation on the governance of the energy union and climate action (EU/2018/1999)), also proved to be a difficult task, since each region first had to develop and approve its own Energy and Climate Plan. In its evaluation of Belgium's National Energy and Climate Plan 2021-2030, the European Commission called the plan lacking in coherence, the measures to reduce carbon emissions insufficient to reach the EU ambitions, and the renewable energy and energy efficiency goals lacking in ambition (Klimaat.be, no date). This weak climate and energy policy was also denounced by a large group of Belgian citizens who took legal action and prosecuted the Belgian governments in court through the '*Klimaatzaak'*. This case resulted in the recent conviction by the Brussels' court of the collective Belgian federal and regional governments for their negligent climate policies, because they violate legal duties of care and essential human rights (Klimaatzaak, 2021). The EU's 'Fit for 55' ambition reinforces Belgian climate objectives from -35% emission reductions by 2030, to -47%, an objective that might be technically feasible but requires ambitious policy measures (Bollen and Matheys, 2021). In its recent update of the Flemish Energy and Climate Plan, the Flemish government slightly increased its efforts from a reduction of emissions by -35% to -40%, which still remains below the necessary effort (*Visienota aan de Vlaamse regering. Bijkomende maatregelen klimaat*, 2021).

Provinces and municipalities also have important spatial planning competences, and take up responsibilities in terms of energy and climate policy, for example through provincial climate plans or municipal Sustainable Energy (and Climate) Action Plans (SEAP/SECAP) within the Covenant of Mayors framework (van Noordt, 2019). Municipalities regularly collaborate in different intermunicipal structures, such as intermunicipal development companies which offer support in terms of spatial planning, and intermunicipal energy companies, which are the shareholders of the Flemish energy distribution company Fluvius.

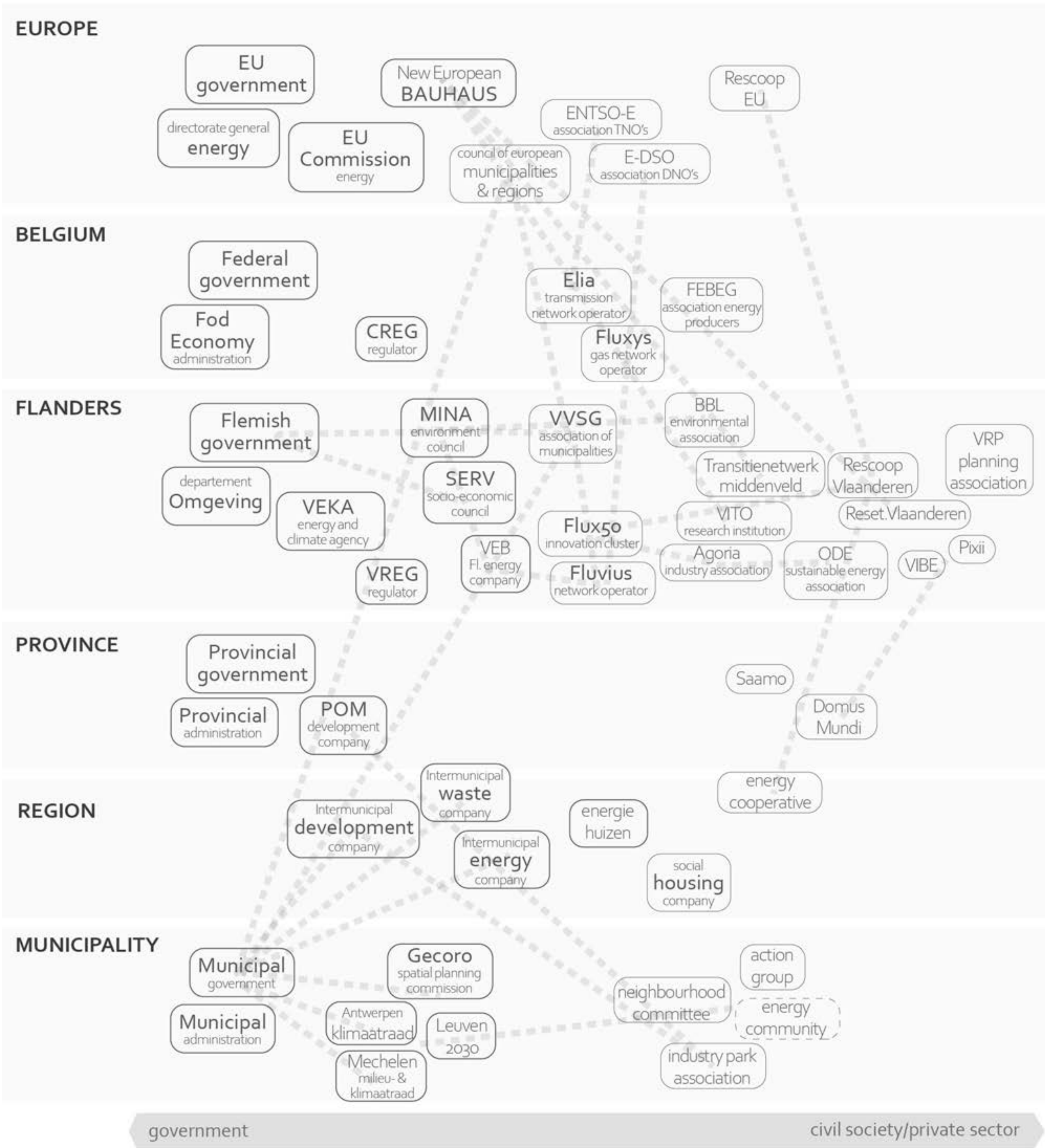


Figure 0.7. Governance - actor scheme.
Source: author.

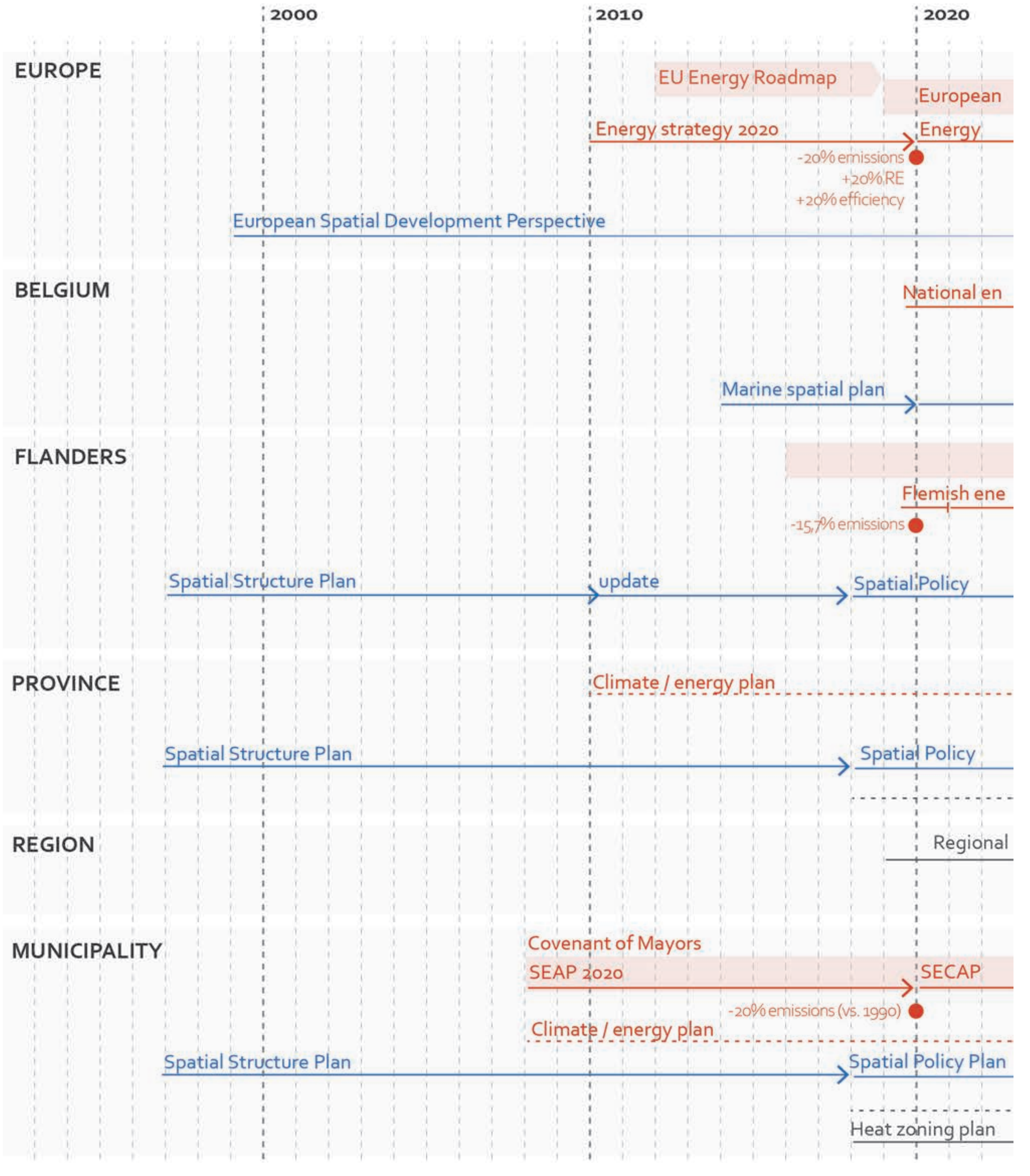
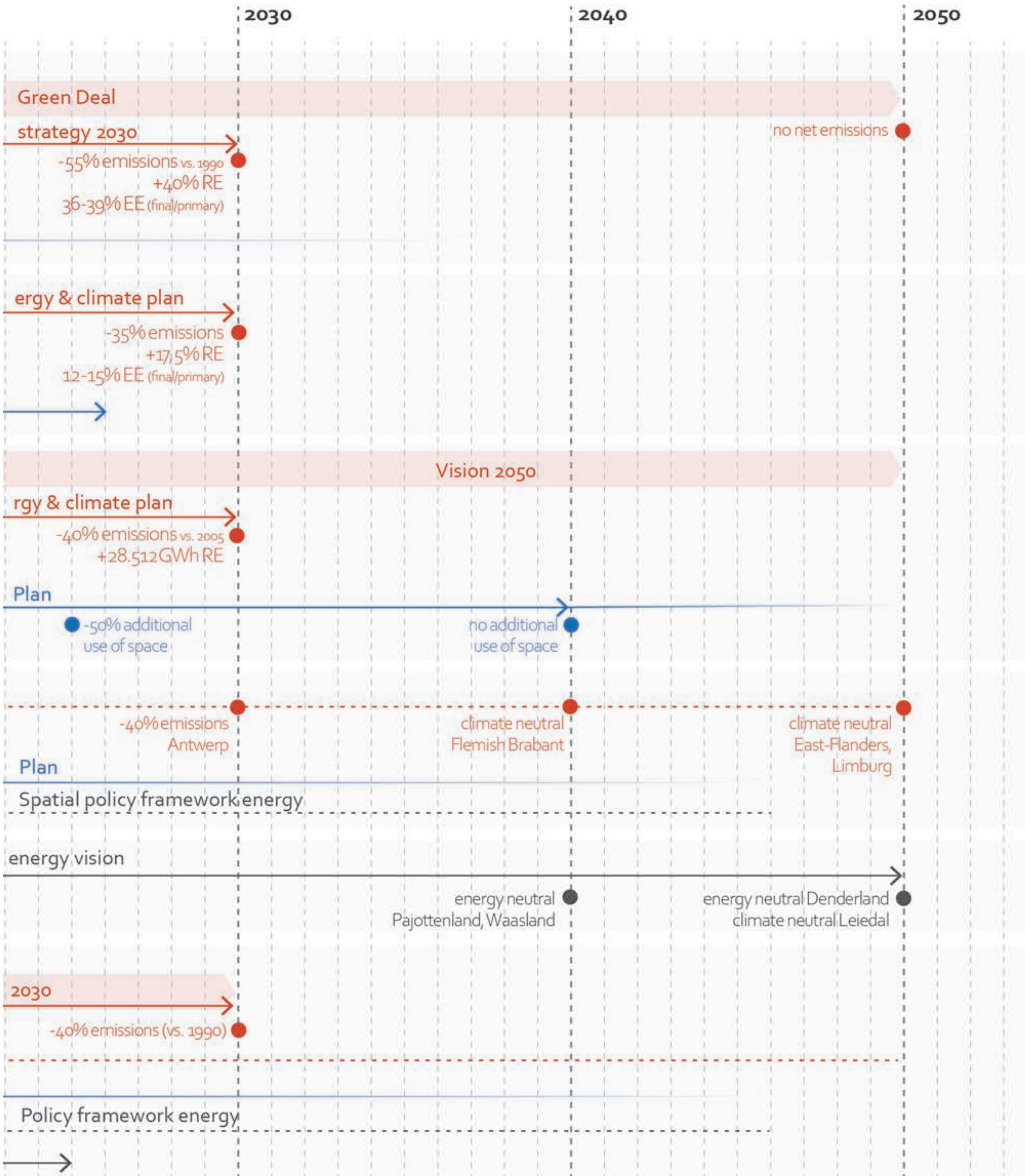


Figure 0.8. Governance - policy timeline. Source: author.


2030
2040
2050
Green Deal
strategy 2030
-55% emissions vs. 1990
+40% RE
36-39% EE (final/primary)
no net emissions
ergy & climate plan
-35% emissions
+17,5% RE
12-15% EE (final/primary)
Vision 2050
rgy & climate plan
-40% emissions vs. 2005
+28.512GWh RE
Plan
-50% additional use of space
no additional use of space
-40% emissions Antwerp
climate neutral Flemish Brabant
climate neutral East-Flanders, Limburg
Plan
Spatial policy framework energy
energy vision
energy neutral Pajottenland, Waasland
energy neutral Denderland
climate neutral Leiedal
2030
-40% emissions (vs. 1990)
Policy framework energy

4. HYPOTHESIS, RESEARCH QUESTIONS AND OBJECTIVES

Flanders' condition of horizontal urbanization, dispersed territorial development supported by isotropic infrastructure networks, can be interpreted as an example of what has been called 'the modern infrastructure ideal': the socially and spatially ubiquitous provision of more or less homogeneous services (Coutard and Rutherford, 2016). Over time, energy production and network management became more centrally organized, and these systems also started to include mechanisms for solidarity and redistribution through a form of 'network citizenship'. They supported territorial integration in multiple ways, by facilitating the provision of homogeneous services in central and more remote areas through spatial cross-subsidization (socio-economic and functional integration), supporting intermunicipal cooperation to organize energy supply (political integration), and developing large-scale, monopolistic and centrally-managed systems based on the appropriation of often distant resources (metabolic integration) (Coutard and Rutherford, 2016).

However, as Coutard and Rutherford show, in many places around the world this modern infrastructure ideal, whether it was fully realized or not, is under increasing pressure in different ways and for different reasons (Coutard and Rutherford, 2016). On the one hand, tales of 'splintering urbanism' show how processes of liberalization, privatization or digitization lead to the unbundling and fragmentation of urban networks and to socio-spatial exclusion and inequality in acces to basic services (Graham and Marvin, 2001; Rutherford, 2008). Urban political ecology also draws attention to the political nature of urban networks and the power struggles and inequalities in access that characterize them (Heynen et al., 2006). Others have nuanced and complemented this perspective by shedding light on more progressive dynamics of urban infrastructure transformation, such as contestation by citizen movements working towards (re-) municipalization, commoning urban infrastructure, or energy democracy (Becker et al., 2017; Beveridge and Naumann, 2016; Burke and Stephens, 2017; Coutard, 2008; Coutard and Guy, 2007).

The energy transition in Flanders also introduces new spatial and social logics into the current energy landscape. Within the existing conditions of a fully serviced urban territory and a context of welfare state institutions that have embedded mechanisms of solidarity and equality, these processes do not result in 'extreme' splintering dynamics. Nevertheless, they have a radically transformative potential as they challenge several core characteristics of Flanders' dispersed territory. The current system is characterized by a dispersed urbanization pattern supported through ubiquitous, fine-mazed and isotropic electricity and gas networks. Energy consumership is individualized, while energy production and governance are mostly centralized. The transition towards more sustainable energy solutions introduces a pluralization of energy systems, whereby density and mixity of urban functions and proximity between energy source and demand start to matter again, particularly in the case of collective heating systems. Energy configurations and governance models will become more spatially selective and diverse, and more collective energy solutions can potentially be developed. Therefore, the transformation of energy systems has a spatially and socio-politically transformative potential, that can contribute to either positive or undesirable socio-spatial dynamics. The introduction of new energy infrastructures and governance arrangements may support more sustainable forms of urbanization based on proximity and density, and could be a lever for more inclusive and democratic forms of energy governance. On the other hand, the pluralization of energy solutions also risks to (re-)produce unsustainable spatial patterns and forms of socio-spatial inequality.

In this research I explore this duality and aim to understand the spatial and socio-political implications of the energy transition in Flanders' dispersed urban landscape.

- I examine how these transformations play out on different scales, from the neighbourhood to the Flemish level, and in different energy domains, from collective heating to wind energy production and energy distribution.
- I analyze and discuss what role(s) different (public) actors play and could play in the energy transition, including municipalities, intermunicipal companies, provinces, and the public energy operator, regulator and Flemish government.
- Ultimately, I ask whether and how spatial planning and design can activate the spatially and socio-politically transformative potential of the energy transition as a lever for more proximity-based spatial development and more inclusive forms of energy governance.

Investigating these central issues, the following sub-questions were essential throughout the research process:

- How have the spatial, social and political dimensions of energy systems been conceptualized in literature, and how does this relate with planning and design theory? How do these perspectives correspond with empirical insights about the spatial and social challenges around energy transitions in Flanders?
- What is the governance and policy context for energy and spatial planning in Flanders, what are the competences and roles of different institutional actors, and what gaps and barriers exist that hinder a fundamentally transformative energy transition?
- What planning and design practices exist in Flanders and elsewhere that couple energy transition with spatial and social transformation, and to what extent do these lead to concrete implementations?

Throughout this work, I aim to reveal the spatial and socio-political potentials and risks of the transition towards more sustainable energy systems. While this research is situated in the context of Flanders' nebulous urban landscape, these insights are also relevant in many other settings. I explore and test how (research-by-)design can contribute to transformative spatial and governance strategies at the neighbourhood and city scale. I observe and analyze whether and how spatial energy planning initiatives imagine and realize spatially and socially transformative transitions at the supra-local level. I unravel the often implicit socio-spatial rationalities underlying regime actors' governance of Flemish energy networks. Combining these perspectives, I aim to identify promising planning and design strategies and approaches that support a more spatially qualitative and fair energy transition, and formulate policy suggestions that can enable their realization.

5. DISSERTATION OUTLINE

In the chapters of this dissertation, I explore these questions from different angles. The first chapter offers a review of different theoretical perspectives on the relation between energy system transformation and space. It is followed by three empirical chapters, that each present an in-depth case study. These empirical cases can be read and understood as separate stories in any particular order. Each chapter focuses on a particular spatial and governance scale, from the city, to the energy region or supra-local level, and the Flemish scale. Accordingly, each chapter addresses the role specific public actors play in the energy transition, in particular the urban administration, the intermunicipal regions and provinces, and the Flemish energy distribution network operator and regulator. While all chapters start from a holistic perspective on energy transitions, they each zoom in on a specific energy domain, namely collective heating systems, wind energy production, and energy distribution networks.

Both spatial and socio-political aspects of the energy transition appear in each of these chapters as complexly interrelated dimensions. However, each of the cases differ in the extent to which the key actors engage with the energy transition as a spatial planning and design question. This ranges from the implicit and more abstract spatial rationalities of energy distribution governance at the Flemish scale, to explicit spatial energy planning at the supra-local level. Adapting to these different types of approaches and responding to specific opportunities within ongoing energy and climate planning processes, I used different methods in each of the cases to explore the socio-spatial questions at stake and the (potential) roles planning and design (could) play in each case. Together, these chapters provide different and complementary perspectives on the spatial and socio-political dimensions of the energy transition in Flanders' dispersed urban landscape. They unravel both implicit spatial logics at play in the energy transition, and explicit strategies that are envisioned to spatialize the transformation of energy systems. Through this spatial lens, they reveal not only the spatial potentials and risks, but also the socio-political questions at stake in the energy transition in Flanders and beyond. In doing so, they offer diverse perspectives on the roles planners and designers can play to recognize and realize the spatial and socio-political potentials of an energy transition in Flanders.

The first theoretical chapter draws connections between the conceptualization of energy systems and space in Transition Studies and STS (energy as socio-technical system), Urban Metabolism Studies (energy as flow) and Urban Design. Based on this literature review, I identify key concepts to describe the relation between energy infrastructure transformation, spatial morphology and energy governance. Bringing together insights from these different research fields, on the one

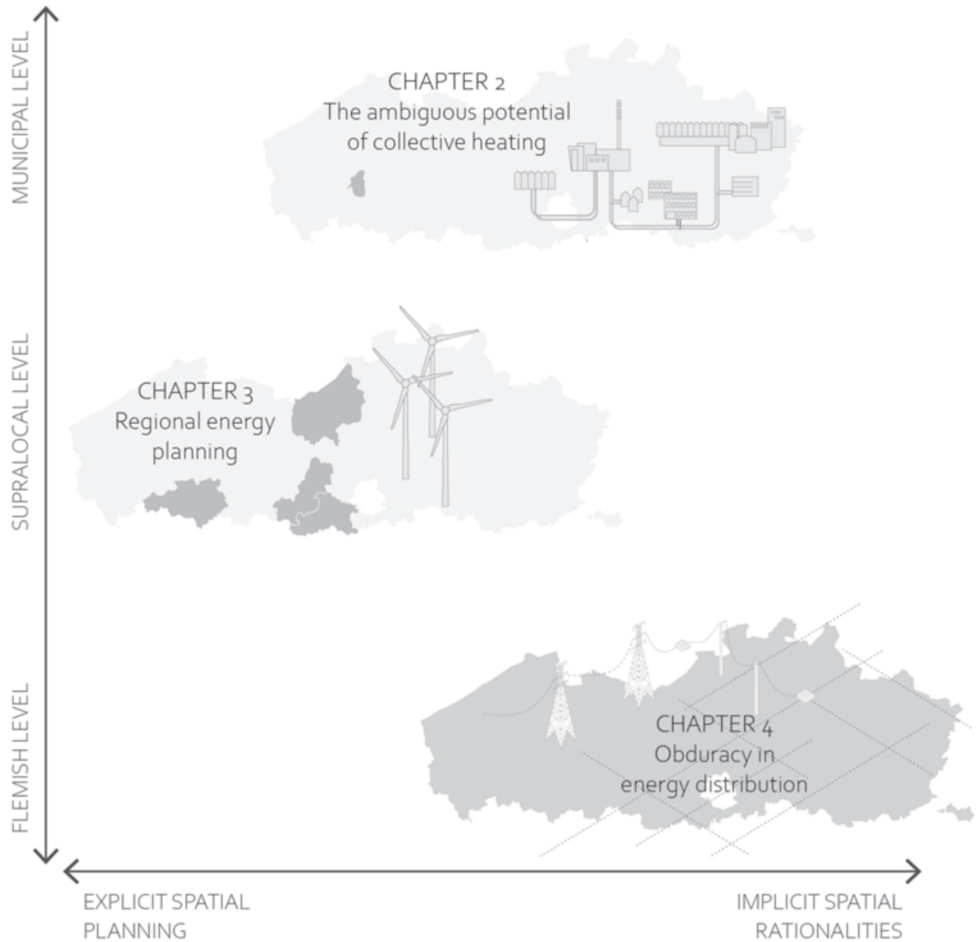


Figure 0.9. Schematic overview empirical chapters.
Source: author.

hand broadens the theoretical understanding of spatial transition dimensions in transition and metabolism studies. Rather than considering space as a context, urban design thinking invites to engage more strongly with the materiality and morphology of energy systems and their relation with urbanization patterns. On the other hand, urban political ecology perspectives invite urban design to engage more seriously with the socio-political dimensions of energy systems. By applying these theoretical perspectives to the dispersedly urbanized landscape of Flanders', I highlight several parameters that allow to describe the spatial and governance characteristics of energy systems in dispersedly urbanized contexts. Some of these parameters re-appear in the empirical chapters as fundamental concepts to understand the socio-spatial questions and dualities at stake in each case, around which the findings are structured.

The second chapter presents a first empirical case which focuses on the transition towards sustainable heating solutions in the city of Roeselare. The introduction of fossil-free heating solutions is particularly interesting, not only because heating represents the largest energy use and is often overlooked in discussions on energy transition. Heating is also relevant from a spatial perspective because fossil-free heating alternatives are a particularly local question and collective heating systems benefit from spatial density and functional mixity. It also has potential from a socio-political perspective because collective heating is an emerging sector, and therefore the policy and regulatory context is more open towards alternative actors and governance models than in the electricity sector.

I explored the spatial and socio-political potentials and risks connected with the introduction and development of (micro-)collective heating strategies in Flanders. Roeselare provided an interesting case as the city was questioning the future of its existing district heating network in the context of developing a climate plan. I combined several qualitative and designerly methods to engage with the urban stakeholders in this process, and explored the transformative potential of the heat transition in the city. These methods included (a) spatial mapping to understand Roeselare's spatial structure and regional energy system, (b) semi-structured interviews with relevant actors such as civil servants, representatives of energy cooperatives, and technical energy experts, and (c) participant observation during the process of developing Roeselare's Climate+plan including workshops with local stakeholders and experts. Based on these methods I set up (d) three scenario and strategy workshops with relevant stakeholders to co-design Roeselare's heat transition. The workshops explored the spatially and socially transformative dimensions of the heat transition by discussing four future scenarios and co-producing heat strategies for three different neighbourhoods. The research revealed opportunities to improve spatial quality by connecting energy with other spatial challenges at the scale of the street, the building block, the neigbourhood and the city. However, it also suggests that, without spatial planning and design, such (micro-)collective benefits would be missed and collective heating infrastructure risks to reproduce undesirable spatial patterns or socio-spatial inequalities.

In the third chapter I analyze how the politics of transitions are addressed in four supra-local energy planning initiatives, and zoom in on contestations around wind energy production. It builds on critical contributions to transition literature that point out how the inherently political character of transitions is often obscured in transition management practices, while planning and design theory highlights the integrative capacity of space and the potential of design as a tool for negotiation. Combining participant observation, in-depth interviews and document analysis, I explore how these regional energy visions spatialize generic energy ambitions in a concrete regional landscape and governance setting. Zooming in on frictions around the location of wind energy turbines as the most contested element in these visions, reveals how tensions emerge not primarily between regional stakeholders, but rather between municipalities, or indeed between the municipal, regional and Flemish governance levels. Regional energy planning explicitly addresses energy transitions as spatial questions, and creates valuable arenas for a holistic approach whereby energy strategies are connected with other challenges of Flanders' dispersed territory. However, regional visions also tend to be developed in a relatively consensual way whereby social and governance dimensions of transitions are minimally addressed. Moreover, regional actors struggle to give these visions regulatory power and translate them into concrete realizations.

The fourth chapter unravels the socio-spatial rationalities underlying energy distribution governance at the Flemish level. It provides a counter-perspective to the chapter on spatial energy planning by exploring how the implicit spatial logics of regime players in energy distribution shape the conditions for energy system transformation in Flanders. I conducted the research in collaboration with Laura Deruytter (fellow PhD candidate at VUB) whose dissertation includes a parallel chapter about the financial logics driving energy infrastructure governance. We used document analysis and semi-structured interviews with key stakeholders in and around network operator Fluvius, to critically analyze the roles of this public distribution company, but also the Flemish government and energy regulator. We explore the tensions between Fluvius' societal role as a public company in the energy transition, and its financial, political and operational approach to energy network management. I unravel the territorial and institutional embeddedness of regional energy systems by untangling three controversies or dimensions of obduracy in Flemish electricity and gas distribution. A first obduracy relates to the potential spatial differentiation of energy distribution tariffs based on spatial density, which is connected to a sensitive debate about redistributing the cost of dispersed infrastructure networks. A second controversy concerns the spatially selective introduction of fossil-free heating solutions, which risk to cannibalize existing natural gas infrastructure. The last question regards the implicit social and spatial redistribution of transition costs through levies on the electricity tariff and reveals the limits of traditional solidarity mechanisms to ensure a just energy transition. Throughout these three debates, a spatial lens helps to unveil inherently political questions of socio-spatial justice and solidarity. With this case, I expose the need to repoliticize the debate about energy distribution in Flanders and demonstrate a serious governance deficit at Flemish level. I also conclude that spatial planning should engage more explicitly with regime players like Fluvius to realize (inter-)municipal spatial energy strategies.

Except for chapter 3, these texts were all published as academic articles in international peer-reviewed journals. In-between these formal chapters, I've included three 'interludes'. These offer reflections about the different research methods I've combined throughout this research, and also function as repositories for some of the empirical material that did not fit into the strict format of the academic articles. The first interlude considers how mapping and drawing supported the action-research process in Roeselare. It also contains a catalogue of some of the key drawings that were produced during this process. In the second interlude I reflect about my positionality as a participant observer in regional energy planning processes and about what knowledges, experiences and perspectives are (not) represented in those settings, and why that matters. It also includes a visual overview of my participation in these regional planning processes. The third interlude unravels the methodological challenges that we encountered during the interviewing process of energy distribution stakeholders. It also presents a selection of relevant quotes that did not make it into the final chapter.

Chapter 1

Energy transition in the nebular city: Connecting transition thinking, metabolism studies, and urban design

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It was part of a special issue entitled: 'Putting Sustainability Transitions into Spatial and Socio-Cultural Context', edited by: Egerman, M, Frantzeskaki, N, Knippschild, R, and Von Wirth, T.

This special issue sheds light on the role of spatial and socio-cultural context in sustainability transitions in cities and city-regions, and explores how and why transitions look fundamentally different in different settings. It brings together conceptual, theoretical, empirical and methodological contributions that illustrate how change dynamics might be initiated, stimulated and accelerated in different cities or regions.

Author contributions: G.J. and M.R. jointly identified the disciplinary fields and concepts reported in this article. G.J. conducted the literature study and gathered the empirical data on the Flemish spatial context and energy transition case. G.J. analyzed the concepts and proposed a first organization of the results, which was further refined in collaboration with M.R. G.J. wrote the paper, re-editing and integrating various suggestions with regards to the structure and presentation of the argument by M.R., who also wrote concluding paragraphs for Section 3.

Abstract

Transforming urban infrastructures is an essential part of creating more sustainable urban regions. But rethinking these complex systems requires a better understanding of their spatial dimensions and their relation with urban morphology and spatial structure. This paper addresses that gap by examining different conceptualizations of technical infrastructure and space in science, technology and society studies (STS), transition thinking, urban metabolism studies, and urban political ecology, and draws connections with the spatial perspective of urban planning and design. It illustrates and tests these concepts through the case of energy transition in the Flemish region of Belgium. Transport and supply networks have played a crucial role in facilitating, structuring, and reproducing the region's characteristic dispersed and energy-intensive urban landscape. Bringing different disciplinary perspectives together, the research broadens the conceptualization of the spatial dimension in transition thinking, and identifies useful concepts and design parameters for urban design to engage with the technical and socio-political complexity of transforming urban infrastructure. It reveals the energy transition as an inherently spatial project, and explores the spatially and socio-politically transformative potential of the transition towards a new energy system.

1. INTRODUCTION

Contemporary life is unimaginable without a continuous supply of energy. But in the context of climate change and finite fossil fuel resources, existing energy systems need to be fundamentally rethought. Such systemic challenges related to technical infrastructures become most visible in urbanized regions, but it is also there that potential alternatives might take shape. This essential role of cities in (energy) infrastructure transformation is also recognized and mobilized in international partnerships and policies such as Habitat III and the Covenant of Mayors (*Habitat III Issue Papers - 18 - Urban infrastructure and basic services, including energy*, 2015; *Habitat III thematic meeting on sustainable energy and cities*, 2016; Kona et al., 2017).

The relation between these networked infrastructures and urban transformation has become a shared concern between different disciplinary fields, such as transition studies (TS), urban metabolism studies (UM), and urban design (UD) (Belanger, 2012; Bulkeley et al., 2014; Castàn Broto et al., 2012; Coutard and Rutherford, 2016; Frantzeskaki and Loorbach, 2010; Heynen et al., 2006; Shannon and Smets, 2010). However, what remains underexplored in TS and UM is how change in socio-technical systems and metabolic flows relates to the physical morphology and materiality of urban space. This relation works in two ways: how do transitions in socio-technical systems shape space, and how does a particular spatial context impact infrastructural transformations and sustainability transitions?

Urban design, on the other hand, has traditionally viewed infrastructure as a means to (re-)shape cities and territories. This approach was epitomized in iconic projects such as Haussmann's Paris, Cerdà's Barcelona, or Frank Lloyd Wright's Broadacre City (Dupuy, 2008). From that perspective, the introduction of new infrastructures in the context of energy transitions can be framed as a fundamentally spatial project.

This paper draws connections between the conceptualization of technical infrastructure and space in TS and UM, and the spatial perspective of UD. It broadens the theoretical understanding of the spatial dimensions in transition and metabolism studies. It also aims to provide context for concepts such as 'transition' and 'urban metabolism' currently adopted in UD discourse and practice, often without fully understanding their theoretical depth and lineage. Connecting these different disciplinary perspectives, this paper develops a conceptual framework to study the transformation of technical systems in relation to urban morphology.

The case of energy transition in the dispersedly urbanized landscape of Flanders, the northern region of Belgium, is used to identify relevant concepts that emerge in the discourse surrounding urban design and energy transition projects. In these practices, the interdependency between energy transitions and processes of urbanization is revealed, but it also becomes clear that a fair amount of discrepancy exists between the operationalization of similar concepts in the 'technical' energy sector, the urban design discipline, and transition (management) approaches. The aim of the framework developed in this paper is to provide a hypothesis of interconnected concepts that can lead to a shared language on spatial energy transition projects between the technical, urban design, and transition disciplines. This framework and its interconnected concepts will be further tested in ulterior in-depth case study research focusing on collective heating systems in a Flemish city.

1.1. Introduction of the case: energy transition in the dispersed landscape of Flanders

To illustrate how a particular form of urbanization matters for the transformation of an energy system, this paper will discuss the case of Flanders' dispersed urban landscape. It combines literature about the origins and mechanisms that have produced this particular spatial structure, with empirical research about the state of the art of energy policy, spatial planning, and energy transition practices in the region.

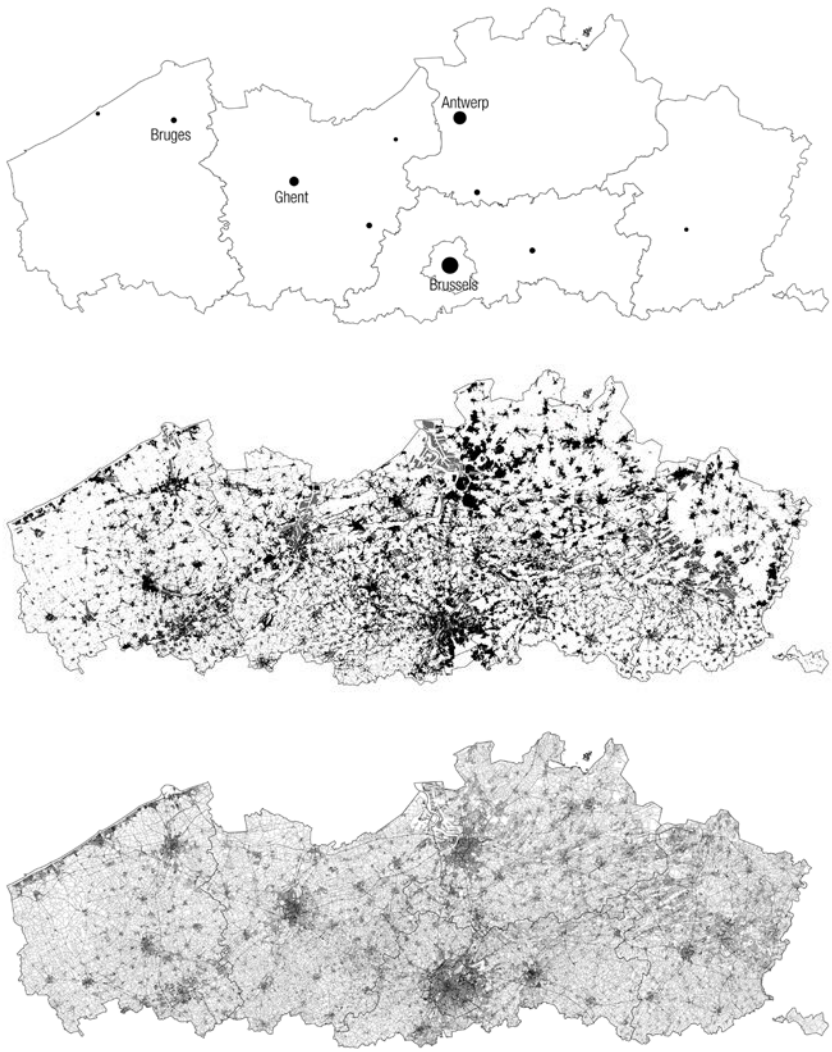

Figure 1.1. Spatial structure of Flanders. (a) location of the main cities, (b) dispersed and sprawling built-up area, (c) isotropic street network. Source: author based on Open Street Map and AGIV.

Transport and supply networks have played a crucial role in facilitating, structuring, and reproducing Flanders' 'nebular' spatial structure (De Block and Polasky, 2011; Ryckewaert, 2002, 2012; Van Acker, 2014). As shown in Figure 1, the region is characterized by a dispersed built-up area, serviced by dense transport infrastructure, supply networks, and services. This form of urbanization is increasingly recognized as fundamentally unsustainable for various reasons (Van Broeck, 2016). Dispersed urbanization creates a high energy demand for transport (Boussauw and Witlox, 2009) and raises the societal cost of supply networks. Heat demand is also relatively high in Flanders, with a relatively old housing stock dominated by relatively large detached and semi-detached housing, often on suburban locations (Bervoets and Heynen, 2013; Vanneste et al., 2008; Winters et al., 2015). Renovation of the existing housing stock is complex due to the dominance of individual home ownership, and goes slowly with a yearly renovation rate of around 1% (*Argusrapport. Energie voor morgen: Krijtlijnen van een duurzaam energiesysteem.*, 2014). In the spatially fragmented landscape, available space for the integration of large new energy infrastructures is limited and contested.

A sustainability transition in the Flemish energy system, therefore, has a double spatial dimension: integrating new infrastructures for the production, conversion, and distribution of electricity, heat, and fuels requires space, and reducing energy demand calls for more energy-efficient buildings and urban structures. Planning research has focused on energy production, analyzing the landscape potential for renewable energy, usually on a regional scale (Revier et al., 2015; Van Esch et al., 2016). On the other hand, energy efficiency policy has focused on the scale of appliances and individual buildings, but rarely approaches energy demand reduction on an urban or collective scale (Juwet, 2017). Recently, the relation between energy and spatial structure, and between improving the energy efficiency of the built environment and the transformation of energy production, has received more attention in policy debate (Cyx, 2017; Raeymaekers, 2017). Energy is no longer framed merely as an 'engineering question', but as an important spatial project, recognizing that a region's energy system and spatial structure are interdependent (Sijmons, 2017; Sijmons et al., 2014). However, strategies to rethink existing spatial structures, or a critical perspective on the socio-political struggles inherent in such fundamental societal and spatial transformations, often remain absent. Based on the literature review and the case study, this paper therefore proposes a conceptual framework including relevant design parameters for spatial planning and design to engage with these systemic and socio-political dimensions of (energy) transitions.

2. MATERIALS AND METHODS

This paper combines an exploratory literature review with empirical research about the case of energy transition in the Flemish region. The literature review explores transition studies (TS), urban metabolism studies (UM), and urban design theory (UD), but also draws on broader material from science, technology and society studies (STS) and urban political ecology (UPE). It focuses on literature that engages with the relation between physical infrastructure, urban space, and social change, and on UD theory particularly related with contexts of dispersed urbanization. The research highlights the transformation of the energy system as a shared concern between these different disciplines, drawing conceptual connections but also identifying tensions and gaps in how these fields conceptualize infrastructures and spatial change.

The case study research involved a review of relevant policy and design studies for energy transition in the Flemish region, and a thorough screening of recent and ongoing practices in the domain of energy transition and urban design. This included diverse projects such as the extension of existing district heating networks, the integration of collective heating systems in new sustainable urban developments, the construction of large-scale renewable energy production infrastructure, the integration of small-scale solar energy on a household level, collective renovation and solar energy production projects by citizen energy cooperatives, etc. These practices were documented through interviews with key actors in the domain of energy and spatial planning, participation in relevant seminars, desktop research, and discourse analysis of concepts used in these practices. This resulted in a taxonomy that visualizes the diversity of energy projects in Flanders in terms of their spatial strategies and governance structures (Juwet, 2017). The analysis of the discourse surrounding energy transition projects and spatial planning in the region was crucial in selecting concepts that were then further developed via a thorough literature review within the relevant fields where these concepts originated. While this paper will not discuss the taxonomy in detail, it allowed the determination of 11 related design parameters for the spatial and governance dimensions of energy transition practices in dispersedly urbanized regions like Flanders.

The paper discusses theoretical concepts that emerged from the literature review and were considered relevant from the perspective of energy transition practice in the Flemish context of dispersed urbanization. It will systematically address the following concepts from (S)TS and UM, connect these with related concepts from UD, and confront them with the reality of energy transition in Flanders: (1) the energy system as a socio-technical system, (2) the obduracy of energy systems, (3) the conceptualization of space as context in the multilevel perspective, (4) (energy) transitions as a fundamental shift, (5) energy as a metabolic flow, and finally, (6) energy as (socio-political) 'power' [Table 1]. These concepts were selected based on the following criteria: (a) they speak about the relation between socio-technical and spatial change, (b) they are adopted by, or have a counterpart in, urban design discourse, and (c) they are essential to understand ongoing energy transition practices in Flanders.

Each of the following sections is organized in a similar way, by (a) focusing and explaining (a set of) (S)TS, UM, or UPE concepts, (b) relating them to UD theories, and (c) confronting them with the realities of physical space and the characteristics of particular energy technologies in the dispersed landscape of Flanders. From this discussion, the paper develops a hypothesis on the interrelationship of 11 parameters for the redesign of energy systems in dispersedly urbanized territories, as shown in Table 1. These parameters will be further operationalized by applying them in action research engaging with ongoing energy transition projects with a clear spatial dimension, notably the case of developing a district heating network in a medium-sized Flemish city.

3. RESULTS

3.1. Energy as Socio-Technical System, space as 'palimpsest' & the isotropy of the electricity network

Transition studies look at processes of fundamental societal transformation, often related with changes in important subsystems such as the energy, food, or mobility system (Block and Paredis, 2012; Fischer-Kowalski and Rotmans, 2009; Rotmans et al., 2001). Some strands study historical transition processes, drawing from historical technology studies or using the perspective of socio-metabolic regimes (Geels, 2002, 2005; Haberl et al., 2011). Others focus on contemporary transitions towards sustainability, studying how to understand and influence system changes based on innovation studies and complex systems theory (Geels, 2004; Geels and Schot, 2007; Rotmans and Loorbach, 2009; Smith et al., 2010). Being part of the broader 'social studies of technology' or STS, transition thinking conceptualizes the energy system as a *socio-technical system.* This concept emphasizes the interdependence between technologies and society (Bulkeley et al., 2014; Monstadt, 2009; Verbong and Geels, 2007), and builds upon the 'systems approach' in technology studies, inspired by Hughes' metaphor of the 'seamless web' (Hughes, 1986). Physical (energy) infrastructures are considered part of a system or network that includes heterogeneous components such as regulatory institutions, people, technical standards, 'ways of doing things', policies, etc.

Transition studies are particularly interested in how these systems change. There is an emphasis on the governance and institutional dimension of (energy) transition processes, while attention for the spatial and material aspects of socio-technical innovation has long been limited (Bulkeley et al., 2014; Faller, 2016). The recent 'geographical turn' in transition studies has started to address this gap by asking how transition processes differ across geographical contexts and introducing spatial concepts such as location, landscape, territoriality, spatial differentiation, scaling, and spatial embeddedness (Bridge et al., 2013; Coenen et al., 2012; Coenen and Truffer, 2012; Faller, 2016; Hodson and Marvin, 2010). However, this research mainly analyzes institutional factors of 'place-specificity' such as local technological specialization or market formation, local institutional variation and actor strategies, or regional visions and policies (Hansen and Coenen, 2015). Only a few studies also understand place-specificity in terms of the physicality and urban morphology of local space, and how it matters to transition processes (Castàn Broto, 2017).

Urban design often uses the metaphor of the *palimpsest* to capture the embeddedness of infrastructure networks within a layered physical urban landscape. Introduced by Corboz, this

Disciplinary field	Theoretical concept(s)	Urban design concept(s)	Design parameters in dispersedly urbanized territories
(S)TS	Energy as socio-technical system *(Hughes 1986)*	Space as palimpsest *(Corboz 1983)*	1. Isotropy * 2. Spatial selectivity * *E.g. Historical evolution of the electricity network*
(S)TS	Obduracy, path dependence, lock-in *(Hommels 2005)*	Retroactive urbanism *(Dehaene and De Meulder 2003; Viganò, Secchi, and Fabian 2016)*	3. Obsolescence as opportunity *° 4. Open and flexible systems *° *E.g. Greening the heating system*
(S)TS	Space as context *(F. Geels 2004; Bulkeley, Castàn Broto, and Maassen 2014)*	Space as stage/agent *(Heynen 2013)*	5. Structuring capacity infrastructure * 6. Proximity * *E.g. (Geothermal) collective heating infrastructure*
TS	Incremental change and fundamental shift *(Frantzeskaki and Loorbach 2010; Fischer-Kowalski and Rotmans 2009)*	Radical incrementalism Urban Trialogues *(Hajer 2011; Loeckx et al. 2004; Vervloesem, De Meulder, and Loeckx 2012)*	7. (De-) centralization *° 8. Individual/collective interventions *° *E.g. (De-)centralization of energy production and network governance*
MS	Energy as metabolic flow, circularity *(Holmes and Pincetl 2012; Kennedy, Pincetl, and Bunje 2011; Odum 1971; Wolman 1965)*	Designing with flows *(Hajer and Dassen 2014; Ibanez and Katsikis 2014; Fernández and Ferrão 2013)*	9. Multi-scalarity *° 10. Cascading * *E.g. (Low temperature) district heating*
UPE	Energy as 'power' *(Coutard and Rutherford 2016; N. Heynen, Kaika, and Swyngedouw 2006; Meadowcroft 2009; Miller, Iles, and Jones 2013)*	Co-production *(Loeckx et al. 2004; Albrechts 2013)*	11. Energy as common ° *E.g. Citizen energy cooperatives*

Table 1.1. Overview of relations between theoretical concepts from (S)TS, UM, UPE, and UD, and (re)design parameters regarding spatial configuration * and governance ° in dispersed territories.

metaphor refers to the accumulation of historical layers of construction that define and transform urbanized territories (Corboz, 1983). Studying the relations between infrastructure networks, urbanization patterns, and their underlying mechanisms has been particularly important in understanding contemporary forms of dispersed urbanization as they appear in Flanders, the Veneto region, the Northeastern Seaboard of the US, and other urbanized regions around the world (Dehaene, 2015; Viganò et al., 2016). By 'unraveling the palimpsest', certain inherent rationalities can be discovered within the seemingly chaotic Flemish territory (Dehaene and De Meulder, 2003). The 'nebulous' urbanization of this landscape was shaped by diverse implicit and explicit urbanisms of domains outside formal spatial planning. Particularly the dense networks of transport infrastructure (railway, light-rail, and highway), developed since the end of the 19th century, were crucial elements in the industrialization and urbanization of the region (De Block, 2014; De Block and Polasky, 2011; Ryckewaert, 2012; Van Acker, 2014). This coevolution of technical networks and urban development was linked with a broader 'system' of long-standing housing practices and policies, economic models, and fiscal structures (Bervoets and Heynen, 2013; De Decker, 2011; Ryckewaert, 2011). These encouraged home ownership (representing 70.5% of the housing market today (Winters et al., 2015)), created a prevalence of single-family dwellings, often in suburban locations, stimulated the settlement of industries across the territory, and supported commuting.

The ubiquitous electricity and gas networks have further facilitated and supported this *isotropic* condition by making cheap and abundant energy available everywhere in Flanders. Bruggeman shows how provincial and local governments historically stimulated the extension of the electricity network into every corner of the Flemish territory, where it was inscribed into the existing social and spatial fabric (Bruggeman and Dehaene, 2017). Becoming part of a project of modernization and industrialization of the Flemish region, the electricity network had to support the spatial and socio-economic integration of the territory, and can be understood as a telling example of what has been called the 'modern infrastructure ideal' or the 'networked city' (Coutard and Rutherford, 2016; Graham and Marvin, 2001; Kaika and Swyngedouw, 2000). This illustrates how energy infrastructures are embedded in complex social, economic, and technical systems, and in a particular spatial structure, that strongly condition how the energy system might be transformed. A sustainability transition in the energy system then can't be limited to replacing fossil or nuclear energy sources with renewable alternatives, but needs to question the spatial configuration of energy networks, housing practices, and locational choices. That includes rethinking the underlying mechanisms that created and continue to reproduce Flanders' spatial structure, such as the fragmented ownership structure in the housing market, the financial mechanisms that support commuting and suburban living, and the lack of *spatial selectivity* in the layout of supply networks and energy- efficiency policies.

While the concept of *socio-technical systems* emphasizes the interdependence of technical systems and society, the *palimpsest* draws attention to the long-lasting coevolution of infrastructures and spatial form. It allows the understanding of the spatiality of this societal embeddedness as a layering of infrastructure in the dispersedly urbanized landscape. From this realization, it becomes clear that spatial energy transition projects have to work on two opposing dimensions in order to steer the energy transition in a spatially sustainable direction. The question needs to be raised as to what extent the current dominance of spatial *isotropy* [Table 1, parameter 1] in dispersedly urbanized territories—as it is reinforced by various layers of energy infrastructure and energy policy—needs to be reorganized by introducing *spatial selectivity* [Table 1, parameter 2] in the energy system. This could also contribute to more compact and bundled—and, as such, more energy-efficient—urbanization patterns.

3.2. Obduracy, retro-active urbanism & the greening of the heating system

STS often characterize infrastructure and spatial structure as obdurate and inert to change. Engaging with this inertia is then an important basis to identify potential pathways of change (Frantzeskaki and Loorbach, 2010). Hommels analyzed how this *obduracy*, or 'resistance to change', is conceptualized in different STS perspectives. She shows that it is associated with diverse dimensions of infrastructures, and recognizes an interactional ('frames'), relational ('embeddedness'), and enduring ('persistent traditions') conception of obduracy (Hommels, 2005). To these mainly immaterial dimensions of obduracy can be added other commonly mentioned factors that complicate change in infrastructures, such as their physicality and spatial embeddedness, material cost (sunk investments), and the time needed for transformation (Bridge et al., 2013; Geels, 2004).

Existing spatial structures and infrastructural arrangements are therefore important factors of *path-dependence*: current and future states of a system depend on the path of previous states (Rotmans and Loorbach, 2009). In contrast with this 'slowness' of spatial change, the speed and unpredictability of technological innovation also forms an important challenge in transition processes. Working within the inherent uncertainty of transitions includes avoiding *lock-in*, whereby a non-optimal solution would become dominant (David, 1985; Meadowcroft, 2009).

Other authors have nuanced this view of infrastructures as inert systems, which tend to become 'normalized' or even 'invisible' over time. Furlong emphasizes their 'malleability', showing how 'mediating technologies' can purposefully engage users in the management of infrastructures and introduce a shift from invisibility to 'active consciousness' (Furlong, 2010: 477). This potential is also attributed to digital energy meters and 'smart' technologies that would allow customers to change their energy consumption behavior based on insights about energy offer and price. On a more structural level, Frantzeskaki and Loorbach explore how infrastructural systems might not be inhibitors, but drivers of transitions (Frantzeskaki and Loorbach, 2010).

Such a perspective resonates with planning and design as inherently transformative practices, where understanding and overcoming the obduracy of existing infrastructure systems is essential. The notion of 'palimpsest' doesn't only emphasize the '*longue durée'* of spatial structures, but simultaneously includes the idea of continuous transformation and human intervention. Corboz reads the land not merely as the result of human and natural processes, but also as a product, and explicitly as a project (Corboz, 1983). Thoroughly unraveling the layers of the dispersed landscape has become part of a project of *retroactive urbanism* (Dehaene and De Meulder, 2003), a reflection developed particularly in the Italian Veneto and in Flanders, that wants to highlight the implicit and explicit 'minimal' rationalities that shape the dispersed territory and serves as a basis for conscious intervention (Ryckewaert, 2002; Viganò et al., 2016).

In the context of the Flemish energy transition, the ubiquitous gas network is a crucial factor of path-dependence for the transformation of the heating system. Today, 67% of households use gas for residential heating, but the network has remaining potential to connect up to 95% of households (Cyx, 2017). Investments in gas-based appliances and infrastructures are still dominant compared to investments in more sustainable alternatives, continuing Flanders' dependence on imported fossil fuels. The prevalence of high-temperature, individual heating systems, the fragmented ownership structure, and the relatively low building density, form important barriers for the introduction of more sustainable (collective) heating systems. Moreover, if individual solutions such as heating pumps would be widely adopted in the region, this would undermine the future feasibility of collective heating networks in areas where they would be the most appropriate solution. This potential lock-in illustrates the tension between an individual's options for a sustainable heating solution and the dependence on collective decisions for transformation on a larger urban scale. Developing a sustainable alternative for heating then requires a long-term perspective for heating systems that are *flexible and open* towards spatial and technological evolutions, and allow appropriate heating solutions for different types of spaces and consumers. Insight in the investment cycles and *obsolescence* of different components of the existing gas system and housing stock are essential to make use of natural moments of replacement and avoid further investment in the 'old' system (Cyx, 2017).

Path dependence in the development of energy infrastructure and urbanization leads to *obduracy* of the energy system. The approach of *retroactive urbanism* implies that future spatial energy projects should be rooted in the understanding of the long time coevolution between spatial structure and energy infrastructure. Retroactive urbanism allows the unraveling of how logics of path dependence have shaped the spatial configuration of the energy system and incumbent urbanization patterns. In that sense, spatial projects for a sustainable energy transition should identify instances of *obsolescence* [Table 1, parameter 3] in energy infrastructure and built environment as key opportunities to reshape the energy system in a sustainable way. Secondly, the design of new sustainable energy systems needs to take into account their long-term impact by designing them as *open and flexible systems* [Table 1, parameter 4], so that they are less prone to the lock-in effects that come with path-dependency.

3.3. Space as context, space as agent & the structuring capacity of collective heating infrastructure

If energy transitions are to include spatial change, it becomes relevant to examine how transition studies have conceptualized 'space' and 'spatial change' in the widely used Multi-Level-Perspective (MLP). The metaphors in this framework describe different 'levels' of socio-technical systems, but don't necessarily coincide with spatial scales. The 'regime' level represents the dominant technologies, practices, rules, actors, policies, and ways of thinking. It is 'dynamically stable' and usually tends to protect vested interests. This makes radical change difficult and rather leads to incremental and path-dependent change processes, or to optimizing rather than transforming practices (Rotmans et al., 2001; Rotmans and Loorbach, 2009; Smith et al., 2010). 'Niches' are the micro level where alternatives or radical innovations emerge. These can influence the regime, particularly when processes at a regime or landscape level create a 'window of opportunity'. The 'landscape' level consists of macroscale political, ecological, and cultural evolutions (Paredis and Block, 2015), but also includes existing infrastructures and spatial structures (Geels, 2004). "*The metaphor 'landscape' is used because of the literal connotation of relative 'hardness' and to include the material aspect of society*" (Geels, 2004: 913) (p. 913). This view conceptualizes the spatial characteristics of the territory, but also the spatiality of physical infrastructures as a context for transition processes, and thereby places them outside the influence of regime and niche players and thus outside actors' scope of action (Bulkeley et al., 2014: 1473; Paredis and Block, 2015).

But for spatial planning and design, having spatial transformation as a central concern, considering the physical 'landscape' merely as a context for processes of change, is a rather limited conceptualization of space. Loeckx and Heynen have brought together different perspectives on the relation between social forces and physical space (H Heynen, 2013). Beyond space as a 'receptacle' or result of social forces, and space as an 'instrument' for social change (exemplified in modernist approaches to urbanism), they recognize a third and more productive position that conceptualizes space as a 'stage' where social processes play out. The metaphor of the stage refers to the possibility to change the stage setting which in turn influences the action taking place. It recognizes that space both accommodates and frames social transformations (H Heynen, 2013). It overcomes technological determinism but at the same time it is not blind to the structuring capacity of built space. The landscape is then not seen as just a 'context', but also as an agent that makes things happen (Loeckx et al., 2004: 158).

Designers have tried to understand this structuring capacity retroactively by studying the role of physical infrastructure and natural characteristics (soil, topography, vegetation, water) in the formation of the Flemish dispersed territory, but it has also become the starting point for design and planning strategies that conceive networks and urbanization together. The OrderinF project, for example, takes a regional public transport network as the basis for a transformation of urbanization and mobility patterns (Blondia, 2014). The principle of focusing urbanization around nodes of high connectivity and services has become part of the new Flemish spatial policy plan (BRV), and starts to be translated in concrete projects such as the implementation of transport regions (Verachtert et al., 2016; Witboek Beleidsplan Ruimte Vlaanderen, 2016). Although energy networks have a much 'lighter' physical impact than transport systems, it is worth investigating synergies between the introduction of new energy infrastructures and strategies of urban development to counter sprawl, densification, or collective renovation. The Atelier Diepe Geothermie was a design-based investigation that first explored this potential for collective heating networks distributing deep geothermal energy in the Campine region in Flanders (*Atelier Diepe Geothermie*, 2015). Collective heating systems, more than electricity networks, require proximity between source and demand. Therefore, the shift to district heating and energy-efficient urbanization based on density and energy exchanges can be mobilized as mutually reinforcing dynamics.

(S)TS conceptualizes space as a mere context in which energy systems take shape, but UD understands space as a stage, highlighting that physical space is not a fixed configuration to which new infrastructures are simply added. To the contrary, it indicates that spatial structure shapes the configuration of new energy infrastructures, but also that new (infra)structures can fundamentally alter urbanized landscapes. For spatial energy transition projects, this means that new energy infrastructures have the capacity to alter or 'structure' [Table 1, parameter 5] urbanization patterns, and this potential should be taken into account in the conception of new energy systems. In cases of dispersed urbanization in particular, 'restructuring' should go in the direction of increasing proximity [Table 1, parameter 6] between urban activities. The fact that particular energy systems also require proximity between source and demand from an efficiency perspective makes such systems interesting candidates for urban design to mobilize the spatially structuring capacities of these infrastructures.

3.4. Fundamental shift, radical incrementalism & the (de)centralization of energy production and governance

TS have reframed 'sustainability' as disruptive to the system, as a fundamental and paradigmatic shift (Paredis and Block, 2015). Energy transitions are considered part of radical societal transformations rather than processes of mere technological optimization. Frantzeskaki and Loorbach recognize two pathways for change in infrastructural systems, with incremental change leading either to 'optimization' (potentially creating lock-in or leading to slow radical system change) or to 'fundamental shift' (Frantzeskaki and Loorbach, 2010). An important question is then how '*incremental change*' can be directed towards a '*fundamental shift*' (Frantzeskaki and Loorbach, 2010), or in terms of urban design, how a local intervention can contribute to systemic change.

Hajer introduced the term *radical incrementalism*: "*radical in terms of result, incremental in terms of the process structure*" (Hajer, 2011) (p. 47). He also emphasizes that, next to a good understanding of past processes and existing spatial structures, creating a fundamental shift also requires thinking outside existing frameworks. Hajer points to the importance of 'imagination' and the potential of shared imaginaries for the future, but at the same time encourages looking for ways in which 'the future is already present' (Hajer, 2017). This view resonates with TS's interest in niche developments and the approach of Transition Management to work with 'frontrunners'. It emphasizes the need to "*utilize the opportunities for transformation that are present in an existing system. It joins in with ongoing dynamics rather than forcing changes*" (Rotmans et al., 2001: 25) (p. 25).

Spatial planning approaches such as Strategic Spatial Planning have developed particular experience in connecting long-term visions with small-scale actions through co-productive processes that involve government, civil society, and private actors (Loeckx et al., 2004). UD methods such as mapping, research-by-design, scenario-building, and design workshops offer powerful tools to visualize the opportunities present in existing territories and to explore alternative futures as a basis for grounded dialogue (Cox, 2014; Marin, 2018; Schreurs and Kuhk, 2011; Viganò, 2016). Several Dutch experiences show how UD can contribute to regional energy visions (Leduc and Van Kann, 2013; Sijmons, 2017; Sijmons et al., 2014; Stremke, Koh, et al., 2012; Stremke, Van Kann, et al., 2012; van Bolhuis et al., 2016). Such research-by-design explorations have also been used in Flanders to explore future scenarios on a regional scale (Revier et al., 2015). But further work is needed to develop them into shared imaginaries that can connect with emerging transition practices and be translated into concrete interventions.

In the dispersed Flemish landscape, the distinction between a *centralized system and decentralization* is not as straightforward as assumed by Frantzeskaki and Loorbach. For the energy system, they associate the 'optimization' pathway' with 'centralization and efficiency improvements', while 'fundamental shift' is linked with 'decentralization and alternative sources' (Frantzeskaki and Loorbach, 2010: 1295). But it is important to distinguish between the governance system and the physical configuration of energy systems, which don't necessarily coincide in terms of 'centrality'. The Flemish electricity network, for example, emerged locally and extended into a very decentralized, isotropic spatial structure, while network governance was progressively centralized into intermunicipal energy companies represented in one organization today. The spatial and governance configuration can also differ for different types of energy flows and parts of the system (production, transmission, distribution, consumption). Renewable electricity production can both be spatially centralized (offshore wind) or extremely decentralized (PV), while green heat production benefits from a stronger local embeddedness and proximity to areas of higher demand. As emphasized by Guy and Karvonen, notably collective heating systems fall between micro- and macro strategies and (re-)introduce the importance of the meso-scale of intervention and governance (Guy and Karvonen, 2016).

As the Flemish territory is "*the chaotic result of thousands upon thousands of individual decisions*" (De Meulder et al., 1999: 90) (p. 90), also its transformation will have to be composed of many individual choices for sustainable change, particularly given the fragmented housing ownership structure. But if more structural transformation is to be realized, this individual level of intervention that has been the focus of energy-efficiency policy in Flanders thus far needs to be transcended. A fundamental transformation of the energy system will most likely combine both decentral and centralized elements in a configuration depending on particular spatial conditions and governance structures. Typically dealing with the collective urban scale, UD can play a key role in connecting *individual and collective*, decentral and larger-scale actions in a systemic approach.

TS conceptualize energy transition as a *fundamental transformation* of a socio-technical system, but at the same time point to the *incrementality* of change processes. UD scholars involved in spatial energy projects have coined the term '*radical incrementalism*' as a mode of transformation that can result in fundamental change over time. The discipline's experience with coproductive planning and design processes offers interesting tools to imagine and visualize such future visions, but also connects these with local opportunities, small-scale actions, and emerging frontrunners. Fundamentally reimagining energy systems also invites assessing the impact of both *centralized and decentralized* energy transition solutions—or a combination of both [Table 1, parameter 7]. Existing energy policy reproduces the incumbent combination of macro strategies for energy production and centralized network governance in semipublic companies, with micro strategies focusing on home owners for renovation and PV production at household level. However, fundamentally rethinking the configuration of the existing energy system and spatial structure requires interventions that go beyond the household level and act on a relevant *collective* scale [Table 1, parameter 8]. This requires interventions that imagine new governance structures and alternative spatial configurations at an in-between level such as the building block, neighborhood, or city-region.

3.5. Circularity, designing with flows & cascading heat flows

Urban metabolism studies conceptualize energy as one of the metabolic flows that sustain urban life. The concept evolved through different disciplines such as human ecology (Chicago School), industrial ecology, urban ecology, and urban political ecology (UPE), each interpreting it in different ways (Castàn Broto et al., 2012; Newell and Cousins, 2014; Wachsmuth, 2012). The industrial ecology approach quantifies the in- and outgoing flows of water, nutrients, energy, and materials in cities. Building upon the work of pioneers like Wolman (Wolman, 1965), Howard and Eugene Odum (Odum, 1971), and the Belgian ecologist Duvigneaud, several conceptual models and methods have been developed for this purpose (Holmes and Pincetl, 2012). These studies usually conceptualize the city as a delineated territory that often gets black-boxed, while the spatiality and interrelation of urban flows and urban morphology remains abstract. Notable exceptions are the work of Duvigneaud about Brussels (Duvigneaud and Denayer-De Smet, 1977), or the Netzstadt project on urbanized landscapes in Switzerland (Oswald and Baccini, 2003), where the study of ecological flows was translated into innovative maps of the urban territory.

An underlying assumption in this field is that the urban metabolism is an unsustainable, linear system, as opposed to the cyclical and more efficient character of natural ecosystems (Barragán-Escandón et al., 2017; Castàn Broto et al., 2012; McDonough and Braungart, 2002). This perspective values notions of 'circularity' and 'closing cycles', linked with 'relocalization' and 'self-sufficiency'. But conceptualizing the city as a bounded territory risks overlooking the complex interdependencies that have always characterized urban regions in relation to hinterlands nearby or further away (Katsikis, 2014). On the other hand, the contribution of more systemic metabolic studies has been to take into account all dimensions of a particular flow. Not only direct energy use, but also indirect or embedded energy in consumption goods or construction materials is then taken into account, for example, in 'consumption-based UM' or life-cycle analysis for buildings or neighborhoods (Allacker et al., 2011, 2014; Athanassiadis et al., 2016). UM studies also allow the understanding of how energy use is distributed across different energy carriers such as electricity, gas, fuel oil, etc. The quantification of flows then has to serve as a basis for policy and design to develop more sustainable metabolisms. But it has proven difficult to accurately reflect urban complexity in such technical calculations, and even relatively exhaustive studies don't necessarily result in operative concepts or effective policy (Kennedy et al., 2011). Moreover, these quantitative approaches have been critiqued as technocratic views that lack a critical perspective and reduce sustainability to a technical optimization of existing systems (Castàn Broto et al., 2012).

Metabolism thinking and ecology have influenced urban design practice and discourse in diverse ways and moments, for example, in the work of scholars like Geddes (late 19th century) (Geddes, 1923), McHarg, or Tjallingii (since the 60s and 70s) (McHarg, 1969; Tjallingii, 1995). Diverse urban designers have conceived urban models that give a spatial expression to a system of flows, either metaphorically, or by taking infrastructures that accommodate various flows as these models' spatial backbone. Strands of ecological and landscape urbanism have revived an interest in ecological processes and flows (Belanger, 2012; Mostafavi and Doherty, 2016; Waldheim, 2006). Recently, the urban metabolism metaphor has become central in the debate again, with several projects mapping urban metabolisms and '*designing with flows*' (Fernández and Ferrão, 2013; Hajer and Dassen, 2014; Ibanez and Katsikis, 2014; Tilly et al., 2014). These approaches visualize and synopsize complex metabolic systems in relation to their spatial context and make complex data intelligible for a broader audience (Marin, 2018). But often they do not engage with the technicality of metabolic systems and underestimate the socio-political complexity of transforming them. It therefore remains difficult to translate these systemic analyses into design proposals or projects.

Introducing 'circularity' in the Flemish energy system and relocalizing energy production poses particular challenges. Truly 'circular' energy systems can't exist, because during any process, entropy increases and exergy (work capacity) is destroyed (Barragán-Escandón et al., 2017; Stremke et al., 2011). In the case of energy, the 'Trias Energetica' (Lysen, 1996) and van den Dobbelsteen's adaptation, the New Stepped Strategy (van den Dobbelsteen, 2008), are used as a more operational approach towards sustainable energy flows. The steps proposed by van den Dobbelsteen emphasize (1) reducing energy consumption, (2) reusing waste energy streams, (3a) producing remaining demand from renewables, and (3b) using waste as food. This strategy also inspired energy-conscious design strategies such as the REAP (Rotterdam Energy Approach and Planning) and LES (*Leidraad Energetische Stedenbouw*) using a multi-scalar approach (van den Dobbelsteen et al., 2009, 2011; Vandevyvere and Stremke, 2012). Reusing waste energy streams is possible mainly in the case of heat flows, where 'circularity' can be replaced by the more accurate concept of '*cascading*': using high temperatures where necessary (e.g., for industrial processes), and reusing residual heat in steps for processes that need lower temperatures (e.g., residential heating) (Stremke et al., 2011). The fragmentation and functional mixity of the Flemish landscape offer opportunities for such energy exchanges between different types of functions. On the other hand, the integration of large energy production facilities such as wind turbines or solar parks is more difficult, because renewable sources have a lower 'energy density' than conventional energy sources. They require more space, which is challenging to find in a densely inhabited region where available space is limited (Revier et al., 2015). Important factors are landscape characteristics and the visual, environmental, and spatial impact of new energy infrastructures, but also public support (Pasqualetti, 2000; Sansen, 2015; Walker, 2008; Wüstenhagen et al., 2007). Moreover, each type of flow (electricity, heat, fuel) or energy source (particularly biomass, household waste) should be studied at its *relevant spatial scale* in terms of energy efficiency, economic viability, carbon impact, and governance. As Flanders currently imports around 90% of its energy (*Argusrapport. Energie voor morgen: Krijtlijnen van een duurzaam energiesysteem.*, 2014), relocalizing energy production might also result in strategic and economic advantages, according to the different forms of ownership and governance used. The question of self-sufficiency in the energy system, and on what scale it should be approached, is therefore very relevant in contexts of dispersed urbanization and in the Flemish context in particular.

UM studies conceptualize energy as a *metabolic flow* and link sustainability to the objective of circularity and 'closing cycles'. UD has rediscovered a tradition of '*designing with flows*', developing a systemic approach to urban metabolism by spatializing and visualizing flows of energy, materials, water, or waste. But the theoretical ideal of self-sufficiency or circularity within a bounded area ignores the fact that cities have always depended on other regions for (energy) resources. The large spatial footprint of renewable energy production compared to fossil or nuclear energy further complicates this question, particularly in densely urbanized territories like Flanders. Therefore, 'circularity' immediately raises the issue of '*scale*' [Table 1, parameter 9] and the need for planners and designers of energy transition projects to consider the relevant spatial scale of a particular (energy) flow. They need to address the connection of governance systems and physical infrastructures across multiple spatial scales in order to (re)think the mechanisms at work in a specific spatial context. Moreover, perfect circularity is impossible in the case of energy, because its quality ('exergy') diminishes during any process where work is performed. However, the alternative concept of *cascading* [Table 1, parameter 10], is an interesting way to operationalize the exergy principle by revalorizing energy flows that would otherwise be wasted. It also has important spatial implications as it requires coupling urban activities based on their energy profile, making it a promising concept to organize spatial activities more efficiently, particularly in a context of dispersed urbanization.

3.6. Energy as 'power', co-production & energy as common

Where quantitative metabolism approaches have been criticized to 'depoliticize' metabolic flows and disregard the social, political, and historical dimensions of urban metabolism, STS and UPE have developed more critical approaches to urban infrastructures.

TS recognize that the transformation of the energy system is not just a technological project but involves the emergence of new actors and *shifts in power relations*, inevitably leading to conflict and contestation. Several authors have drawn attention to these socio-political aspects of transforming urban infrastructures (Bulkeley et al., 2014; Byrne and Toly, 2006; Coutard and Rutherford, 2010; Meadowcroft, 2009), and have studied and conceptualized the forms of power at work in such transformative processes (Avelino and Rotmans, 2009; Hoffman and Loeber, 2016).

Social studies of networked infrastructure have also shown that they are not 'neutral engineers' stuff'. They show how the creation of the networked city, from the mid-nineteenth century, was part of a project of spatial, socio-economic, and metabolic integration, or the 'modern infrastructural ideal' (Coutard and Rutherford, 2016; Graham and Marvin, 2001; Kaika and Swyngedouw, 2000). In contrast, studies of contemporary phenomena emphasize the exclusionary impact of infrastructure reconfigurations. Graham & Marvin's 'splintering urbanism' thesis illustrates how processes of liberalization, unbundling, and bypassing can lead to exclusion and embed social inequalities in the design, materiality, and functioning of technical networks (Graham and Marvin, 2001).

UPE has reframed urban metabolism as a fundamentally political concept, using it as a critical lens to understand the relation between capital, power, and nature (Castàn Broto et al., 2012; Heynen et al., 2006; N Heynen, 2013). It interprets urban metabolism as a number of interconnected physical and social processes, studying not only the material aspects of metabolic flows, but also their social, cultural, and political meaning (Castàn Broto et al., 2012). The metabolic perspective is then used to unveil uneven power relations and inequalities in the 'socio-political production of nature', and its translation into urban infrastructures.

These critical analyses are important but have rarely suggested institutional or governance improvements or proposed positive alternatives (Monstadt, 2009). Coutard and others nuanced this 'alarming' view, emphasizing the need for a 'politics of hope' and a better understanding of alternative, context-sensitive stories of contestation (Coutard, 2008; Coutard and Guy, 2007).

But (energy) transitions are also opportunities to question the socio-political shaping of urban infrastructure more fundamentally, and rethink the interdependence of people and systems of collective consumption. Key choices in energy transitions are "*not so much about different fuels or technologies, but between different social, economic and political arrangements built in combination with new energy technologies*" (Miller et al., 2013) (p. 139). The satisfaction of social needs was traditionally seen as a question for the state. But the erosion of the welfare state and the rise of an increasingly 'energetic' society of empowered citizens and entrepreneurs (Hajer, 2011) call to rethink this conventional role.

The '*commons*' framework offers an inspiring alternative. Commons-thinking foregrounds collective governance practices and forms of ownership that go beyond the market-state dichotomy (Harvey, 2011; Mattei, 2012). Energy is then not seen as a commodity but as a common good, and individuals not as mere consumers but as citizens that claim the right to participation or ownership. An increasing number of practices show how citizens can take control over systems of energy production and distribution (Becker et al., 2017; Seyfang and Haxeltine, 2012; Shove and Walker, 2007; Vansintjan, 2016).

This also calls for a more critical engagement of urban planning with the political forces at work in (energy) transition processes, and a better understanding of the socio-economic impact of different potential outcomes. The discipline has so far mainly focused on visualizing the spatial impact of new energy systems while the governance and political dimension has remained underexplored. UD can build upon its experience with design and planning as a process of co-production between public and private actors and civil society, to connect the technical and spatial complexity of urban infrastructures with its socio-political dimensions (Albrechts, 2013; Loeckx et al., 2004; Vervloesem et al., 2012). As suggested by Sijmons, urban design methods such as research-by-design and scenario building should go beyond technical discussions and make socio-political questions and diverging ideological positions explicit (Sijmons, 2017).

In the Flemish energy field, new actors are emerging and the role of traditional actors has been called into question. The governance of electricity and gas distribution networks in the region has historically been centralized into the hands of intermunicipal companies (having the Flemish municipalities as their main shareholders). But certain voices from civil society question their potential role in the energy transition because of their lack of transparency and democratic accountability, and inherent conflicts of interest (Walraven, 2017; Willems, 2016). As a regime player these intermunicipal companies could play a key role in the transformation of the energy system, but they also have strong vested interests and sunk investments in the existing networks. Citizen energy cooperatives have developed projects for renewable energy production, claiming wind and sun as common resources, but also for reducing energy demand through collective renovations, and for the implementation of district heating systems. They argue for democratic and financial participation of citizens in energy infrastructure, emphasize the potential benefits of this participation for local economies, and are often successful in raising public support for new energy infrastructures (Vansintjan, 2016; Willems, 2014). Such 'commoning' approaches in the field of energy mirror similar developments in other domains such as food and housing, where a diversity of 'collective' housing models such as cohousing and Community Land Trusts are emerging (Aernouts and Ryckewaert, 2015).

Both STS and UPE have critically assessed the role of (political) *power relationships* in the transformation of energy systems and infrastructures. This calls for UD to broaden its conception of urban development as a process of *co-production*, to include not only spatial but also socio-political dimensions of spatial energy projects explicitly in a participatory approach. This raises the societal acceptance of new energy infrastructure projects and supports the democratic legitimacy of the spatial (energy) solutions proposed. Commons theory adds to the issue of a democratic decision-making process, the dimension of a long-term sustained collective management of energy as a common resource rather than a commodity. As such, the *commons* [Table 1, parameter 11] provide a good lens to assess the socio-political aspects of spatial energy projects by combining the dimensions of a shared physical resource (the energy system and its infrastructures), a democratic decision-making process, and a long-term collective management of the resource. Moreover, commons-based institutions could jointly govern not only the energy system, but also other (physical) resources such as housing.

4. DISCUSSION. SPATIAL AND GOVERNANCE (RE)DESIGN PARAMETERS FOR ENERGY SYSTEMS IN DISPERSED TERRITORIES

The case of energy transition in the Flemish nebular city shows how place-specificity, in the sense of spatial morphology and urban structure, matters in sustainability transitions. Table 1 lists a number of spatial (re)design parameters for energy systems in dispersedly urbanized territories, and for the Flemish context in particular. The research reveals that a transformation of the energy system is inextricably linked with the need to rethink incumbent, unsustainable spatial patterns. In the case of dispersed territories like Flanders, the question is how this energy-intensive form of urbanization can be reimagined in terms of '*proximity*'. That doesn't mean taking the 'compact city' as an ideal, but finding a more sustainable balance between spreading and concentration. If spatial planning wants to be effective in guiding spatial structure, it needs to understand and mobilize the inherent spatial logics of domains that influence urbanization, such as housing and transport policies, but also, as this paper argues, energy policies. Notably, a 'rebundling' of urban development in relation to sustainable mobility and energy systems is the way forward.

The Flemish case also illustrates how different energy flows or infrastructures (electricity, gas, heat, fuel) have a different relation with spatial structure, depending on the importance of proximity between source and demand, and on the spatial selectivity of the network. Once a network is distributed isotropically over the territory, it loses its spatially (re)structuring potential. Moreover, each flow has to be analyzed at the right spatial scale, going beyond abstract notions of 'circularity' or 'decentralization', and recognizing the limits of becoming self-sufficient within a certain urban territory.

The switch towards a sustainable heating system, with the introduction of collective heating networks and the potential dismantling of the ubiquitous gas system, then emerges as a particularly relevant opportunity to mobilize the energy transition as a lever to revalorize 'proximity' in urban development. More than electricity and gas networks, collective heating systems benefit from proximity between source and demand and are more feasible in denser urban areas where complementary urban functions are mixed. The spatial logics of these networks can therefore be mutually reinforcing with the principles of energy-conscious urban design and sustainable mobility. This requires a spatially selective development of collective heating systems in areas where sustainable urban development is possible and desired. Another challenge for urban design is to understand and work with the spatial consequences of technical concepts such as 'cascading', for example, by identifying opportunities to exchange heat between different urban functions and rethinking locational choices based on the energy profile of specific activities.

Integrating the transformation of the energy system into spatial planning and policy does not only require a consideration of the spatial configuration and prerequisites but also of the governance dimensions of various sustainable energy solutions. Therefore, Table 1 also lists a number of concepts related to the governance of the energy system. Interventions that mobilize the restructuring capacity of energy infrastructure can only be developed at a collective scale and therefore need to go beyond the individualism in the Flemish housing and energy system. Similar to emerging collective housing practices, the introduction of new energy infrastructures opens opportunities for '*commons*'-inspired forms of governance. Developing more democratic and inclusive forms of governance is particularly relevant in the case of collective systems such as district heating. These are embedded in local spatial structures, living cultures, and economies, and strongly depend on public support and social change for their implementation.

5. CONCLUSIONS

This paper has brought together complementary theoretical perspectives on the transformation of technical infrastructures from transition studies, metabolism studies, and urban design theory. On the one hand, the metaphor of UM recently became central in UD debate and produced new approaches to visualizing and spatializing metabolic flows. But for these approaches to become useful in concrete projects, they need to engage more deeply with the materiality and politics of urban change. This paper highlights the value of concepts from TS and the broader STS-field, where the notions of urban infrastructures as 'socio-technical systems', 'obduracy', and of 'fundamental shift' offer a more useful framework to understand the complexity of energy transitions. They capture both the technical material and the socio-political dimension of transforming the energy system, and point to the need for urban planning and design to address this multidimensional embeddedness in approaching the energy transition as a spatial project. On the other hand, the urban design perspective broadens the conceptualization of space merely as 'context', and emphasizes the spatially structuring potential of technical infrastructures. It invites the thinking of energy transition as part of a multifaceted process of spatial change.

The conceptual framework outlined in this paper allows theorizing such an integrated view of energy transition as a process of spatial and socio-political transformation. However, while it has become clear in theory that the energy transition is about more than replacing fossil fuels with renewable alternatives, realizing its full transformative potential requires a context-specific reading of spatial challenges and opportunities and a societal debate that recognizes more explicitly the socio-political questions that are at stake. This paper therefore proposes 11 design parameters describing the spatial and governance dimensions of energy transition strategies that are particularly relevant in contexts of dispersed urbanization. These parameters can be operationalized to analyze, design, or evaluate spatial energy transition practices and spatial development projects. They will be tested and validated in the next phase of this research project in an action–research approach designing different scenarios for the future development of heating systems in Flanders. The aim is to explore how urban planning and design processes can move beyond technical discussions of energy transition to include spatial transformation of unsustainable settlement patterns and a shift towards democratic and inclusive forms of governance.

Chapter 2

Exploring the ambiguous socio-spatial potential of collective heating in Flanders. Planning and design as lever for a sustainable energy transition

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Abstract

Energy networks have supported and reproduced Flanders' dispersed urbanization, but today this energy-intensive landscape is running into its ecological and societal limits. As a part of the energy transition, a pluralization of heating solutions is emerging in the region. Collective heating systems introduce logics of proximity, spatial selectivity and collectivity in this landscape characterized by dispersion, ubiquity of services and individualism. This paper explores what spatial and socio-political questions are at stake in the transition to a fossil-free heating system: can it support proximity-based spatial development and energy democracy or will it contribute to socio-spatial fragmentation and exclusion? These potentials and risks are revealed through an in-depth case study of the city-region of Roeselare, based on scenario and design workshops with stakeholders. The research indicates that spatial planning and design have a key role in visualizing the spatial and socio-political potentials of the heat transition, by visualizing opportunities for collective solutions at multiple scales, connecting energy strategies with other spatial questions and imagining more inclusive governance models.

1. INTRODUCTION

Networked infrastructures 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 et al., 2014). Debates on urban energy systems usually focus on a transition towards renewable and ecologically sustainable energy technologies. Meanwhile, fundamental shifts in energy governance are taking place, with processes of liberalization and privatization on the one hand and struggles for energy democracy through cooperative and municipal ownership on the other hand. Moreover, spatial design disciplines have understood the energy transition as an inherently spatial question (Sijmons et al., 2014). In dispersedly urbanized regions, the introduction of alternative energy systems could either reproduce energy-intensive urbanization patterns or contribute to more sustainable use of space. Urban energy infrastructure is thus becoming '*a key battleground for the direction of social, political and territorial change*' (Coutard and Rutherford, 2016: 263). Particularly the emergence of collective heating systems presents opportunities and risks for spatial development and energy governance because it introduces logics of proximity, spatial selectivity and collectivity in a landscape characterized by dispersion, ubiquity of services and individualism. This paper evaluates the spatially and socially transformative potentials and risks associated with the heat transition, either contributing to more sustainable spatial development and inclusive energy governance or (re-)producing dispersed development, fragmentation or exclusion. To understand these ambiguities, the analysis mobilizes conceptualizations of the relation between energy infrastructure, spatial morphology and energy governance as developed in transition studies, science, technology and society studies (STS), urban metabolism and urban political ecology literature and spatial design theory (Juwet and Ryckewaert, 2018).

Because heating and cooling represent around 50% of the energy demand in EU28 countries, developing fossil-free heating systems is a key part of the transition towards a sustainable energy system (Connolly et al., 2014). Sustainable alternatives include both individual (solar boilers, heat pumps capturing ambient heat from air, soil or water, etc.) and collective ('district heating') heating systems. District heating is a promising solution for heat demand in urban areas, and allows to recover large amounts of excess heat that are not used today. In Belgium, thermal energy to heat buildings, produce hot water and to power industrial processes represents 52% of the total energy demand (Paardekooper et al., 2018). In the northern Flemish region, heating forms 85% of energy use in the residential sector (Winters et al., 2015). In 2017, only 5.2% of heat used in the region was produced from renewable sources, compared to 13.4% for electricity and 6.5% for transport (Jespers et al., 2018). Theoretically there is a high potential for collective heating systems, with a VITO study estimating that up to 62% of Flanders' heat demand could be cost-effectively provided by district heating systems based on residual heat (Renders et al., 2015).

Through an in-depth case study exploring possible energy futures for the city of Roeselare, this paper identifies the risks of socio-spatial fragmentation and exclusion, and ways for spatial planning to mobilize the heat transition as a lever for more sustainable spatial development and more democratic forms of energy governance.

2. COLLECTIVE HEATING IN DISPERSED TERRITORIES: BEYOND THE 'MODERN INFRASTRUCTURE IDEAL'

2.1. Energy distribution networks as manifestations of the modern infrastructure ideal

The Flemish energy system is embedded in a dispersedly urbanized landscape that was shaped by a co-evolution between infrastructure networks and an individualistic housing model (De Block and Polasky, 2011; De Meulder et al., 1999; Ryckewaert, 2002). Energy supply systems for electricity and gas historically supported and reproduced this process of dispersed urbanization (Bruggeman and Dehaene, 2017). As a part of a societal project to modernize and integrate the region, they can be interpreted as a manifestation of the 'modern infrastructure ideal' (Coutard and Rutherford, 2016; Graham and Marvin, 2001). These energy networks made cheap and centrally produced energy available in every corner of the landscape, facilitating the functional and metabolic integration of the territory. Managed by increasingly centralized 'intermunicipal energy companies', whose 'public service obligations' include social redistribution mechanisms, these systems also served the territory's social and political integration (Coutard and Rutherford, 2016). This socio-spatial organization of the energy system was linked to a notion of 'network citizenship' where emancipation was supposed to reside in network connection at an individual level, rather than enacted in the urban sphere at the collective level (Kaika, 2004).

2.2. The limits of dispersed urbanization

Today the ecological and societal limits of this territorial organization are becoming clear, and the need to rethink dispersed urbanization patterns is a central concern in the planning community and increasingly in public debate. Flanders' nebulous spatial organization is considered unsustainable for many reasons, ranging from its impact on natural water systems, the fragmentation of ecosystems, the relatively high societal cost of collective services like energy distribution and its consequences for mobility and energy systems (Van Broeck and van Ypersele, 2019; Vermeiren et al., 2019). The dominance of relatively old and large single-family housing leads to a high heating demand, and retrofitting this existing building stock is a complex and slow process due to the individual ownership structure and architectural diversity (Cyx, 2017; Winters et al., 2015). Fragmentation and scarcity of space also complicates the spatial integration of large-scale renewable energy production, but the region's mix of activities might offer opportunities for energy exchange between different activities. Therefore, developing a sustainable energy system in Flanders needs to include rethinking spatial morphology, but the current energy policy has mainly focused on stimulating energy efficiency and renewable energy production at the individual building level. Not only does this approach have a Matthew effect[1] and mainly benefit middle-income households, it also disregards potential efficiency and socio-spatial gains that collective-scale solutions can offer.

2.3. Beyond the modern infrastructure ideal: fragmentation and exclusion or integration and emancipation?

Meanwhile, socio-technical studies of contemporary urban infrastructure transformations reveal how the modern infrastructure ideal is waning (Coutard and Rutherford, 2016). On the one hand, critical urban political ecology accounts of ongoing infrastructure transformations emphasize the political nature of urban networks and reveal inequalities in access to and power over urban flows (Heynen et al., 2006). The 'splintering urbanism' thesis points to the way the dynamics of liberalization, unbundling and bypassing lead to fragmentation and exclusion (Graham and Marvin, 2001). But extreme 'splintering' tendencies are relatively limited in the North-West European context as they go against a socio-political tradition based on redistribution and equality (Rutherford, 2008). Also in Flanders, the liberalized energy market is regulated and welfare and solidarity principles have been inscribed in legislation.

On the other hand, both spatial design studies and struggles by civil society over urban energy systems provide 'counter-stories', emphasizing the positive potential of infrastructure transformations. Spatial design approaches have shown how energy system transformation can contribute to spatial quality on different scales, from innovating road sections to catalysing neighbourhood renewal, (re-)structuring urban development, improving landscape value or reframing regional economy and identity (*Atelier Diepe Geothermie*, 2015; Cavalieri, 2014; Custers, 2018; Sijmons, 2017; Stoeglehner et al., 2016; van Bolhuis et al., 2016; Wächter et al., 2012)

Citizen energy movements defend a socio-political agenda for the energy transition by struggling to (re-)appropriate, re-municipalize or collectively manage local energy infrastructures. For them, key choices in energy transitions are '*not so much about different fuels or technologies, but between different social, economic and political arrangements built in combination with new energy technologies*' (Miller et al., 2013: 139). While such normative and ethical dimensions are often absent in current energy debates, concerns about energy security, energy democracy, anti-war and anti-corporate politics were already present in alternative energy visions and debates from the 1960s and '70s (Illich, 1974; Lovins, 1977; Nader, 1980). Recently, concepts such as 'energy democracy' (Burke and Stephens, 2017; Morris and Jungjohann, 2016; Szulecki, 2018), 'energy justice' (Miller et al., 2013), the 'right to infrastructure' and 'energy as commons' (Becker et al., 2017; Byrne et al., 2009) are used to rethink the role of citizens in the ownership, decision-making and access to (sustainable) energy sources and infrastructures. Energy infrastructure then becomes a site to re-imagine the role of the (local) state and individuals in collective consumption, and to develop new forms of urban citizenship (Webb, 2016).

1 Certain advantages of social government policy, often inadvertently, go more to higher than to lower socio-economic groups.

2.4. The emergence of collective heating in Flanders

Particularly with the emergence of collective heating systems in Flanders' dispersed territory, relations between energy infrastructure configuration, spatial morphology and energy governance are put into question. Several studies have explored these relations, through cases in the UK (Bush et al., 2016; Guy and Karvonen, 2016; Hawkey et al., 2013; Karvonen and Guy, 2018), France (Hampikian, 2017; Rocher, 2013), Germany (Späth and Rohracher, 2015), Denmark (Chittum and Østergaard, 2014) and Sweden (Rutherford, 2008). Despite the specificity of each context and research perspective, they indicate a number of key characteristics and concerns. The cases recognize the relation between collective heating, spatial morphology and energy efficiency, as district heating is only economically feasible with sufficient 'linear heat demand density'1. Rocher recognizes a structuring potential for heating infrastructure in urban space, while Späth reveals the tensions between energy-efficient housing and collective heating systems. Most authors emphasize the role of local governments in visioning and governance because district heating introduces a meso-scale in-between national energy infrastructure and individual consumership. Countries like the UK, France and Belgium are experimenting with heat planning, inspired by Denmark's successful experience with municipal energy planning (Chittum and Østergaard, 2014). Governance models vary in terms of (partnerships between) public, private and citizen ownership and spark concerns about the de facto monopoly of heat supply, affordability and accessibility, social redistribution and consumer participation in decision-making (Hawkey et al., 2013; Rocher, 2013; Rutherford, 2008).

In Flanders, both individual and collective alternatives to fossil fuel-based heating are slowly adopted, raising questions for policy, legislation and planning. In the emerging 'heating and cooling sector', market roles are not strictly regulated. Commercial firms as well as public organizations and citizen cooperatives are developing district heating projects, with varying feasibility criteria, tariff structures and spatial strategies. Legislation around customer protection, social tariffs and redistribution is slowly emerging and organized ad hoc in some projects (Energiedecreet, 2017). Because three quarters of the energy budget for a Flemish household goes to heating, the energy efficiency of housing and the heating cost are key aspects in tackling energy poverty (Goedemé et al., 2017). Nevertheless, energy poverty and equal access to sustainable energy solutions, have received little attention in the energy transition debate in Flanders.

District heating can provide a crucial element in efficient urban energy systems, because it allows to make optimal use of the exergy or 'quality' of different energy carriers (Vandevyvere and Stremke, 2012). Collective heating systems can recover residual heat from high-exergy processes (e.g. industrial processes or horticulture), to be used in low-exergy activities (e.g. heating buildings) in a 'heat cascade'. However, this depends on locally available production and storage opportunities, and requires sufficient proximity between source and demand. Regarding heat demand density, a commonly used 'rule of thumb' specifies a minimum annual linear heat

1 Heat demand per length of network, often expressed in kWh/m. Large urban or industrial activities or higher building density usually contribute to a higher linear heat demand in a certain street or area.

density of 3 MWh/m (detailed feasibility study from 1,8 MWh/m) (Nussbaumer and Thalmann, 2014). But spatial context is crucial, with lower system costs for a small number of big users and higher costs for many individual residential connections, or when canal or railway crossings are necessary. More than electricity systems, therefore, sustainable heating solutions will be spatially diverse and context specific.

2.5. The case of Roeselare

Roeselare, a town of around 62 000 inhabitants in West-Flanders offers a valuable case to analyze the heat transition's spatial and governance dimensions. The city's low-density urbanization and the modest experience of the urban administration with spatial energy planning are representative of many places in Flanders. At the same time, Roeselare's public waste management company is a pioneer in district heating in Flanders.

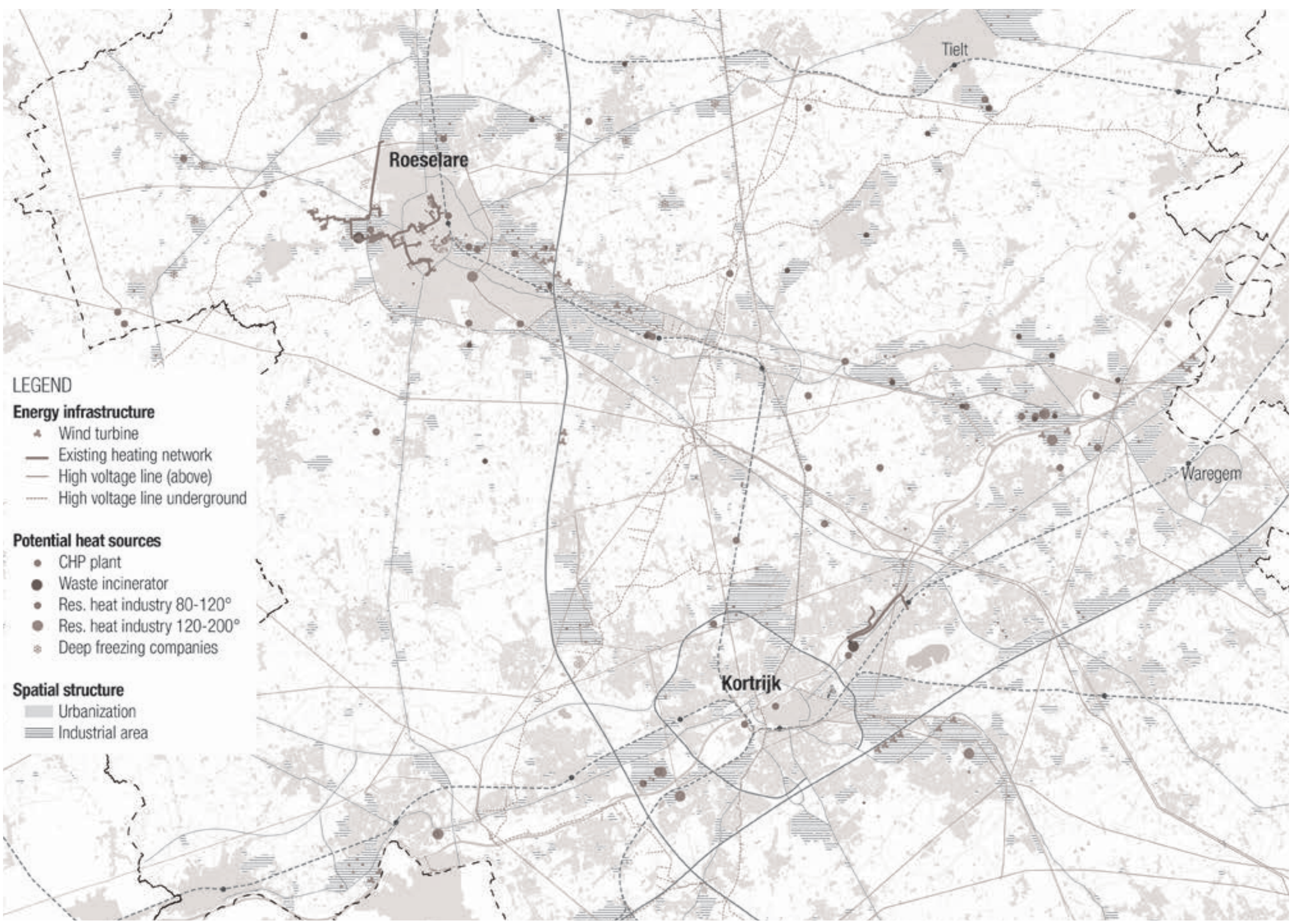
Roeselare is a part of a dispersedly urbanized region with interwoven residential and industrial areas along the layered infrastructure networks of the Mandel and Leie valleys (Cattoor and De Meulder, 2011) [Figure 1]. The neighbouring region of Leiedal around Kortrijk is exploring whether this landscape provides opportunities for a regional heat infrastructure (Cox et al., 2019). As a hub for the region's horticulture, frozen food and cattle farming companies, Roeselare has the potential to develop a more circular economy (Revier et al., 2015).

The city's compact centre is surrounded by a fringe of low-density residential allotments, gradually filling up the space between the inner and outer ring road. This continuing urbanization puts pressure on the creeks flowing together into the Mandel river valley, regularly leading to floods or droughts affecting local agriculture and living conditions.

In 2017, the municipality set up a co-creative process to formulate a 'Climate⁺plan' as part of Roeselare's Covenant of Mayors 2030 engagement. It followed two tracks: a technical study analysing current carbon emissions, energy use and renewable energy potential in the city, and a participation process with local stakeholders, including an international design workshop (*City-zen roadshow*, 2018). The technical study showed that heat for industrial processes (18%), heating and hot water (37%), together represents more than half of the city's energy use. The CityZen workshop visualized that Roeselare would need more than five times its municipal surface in forest to offset its current carbon footprint and that natural gas for residential use is responsible for 18% of those emissions. Roeselare's low density, strong car dependence and need to revalorize green-blue networks were identified as crucial challenges, while the city's position in the heart of the regional food industry and the expansion potential of the district heating network were considered important opportunities. The Climate⁺plan formulated ambitious goals and inspired concrete initiatives, such as the founding of a local energy cooperative (Vandevyvere et al., 2018). However, it did not manage to spatialize those ambitions and draw clear connections with planning policy. Socio-political questions, such as the need to question the role of regime players, relieve energy poverty and include vulnerable inhabitants in energy policy, were not explicitly addressed.

Roeselare's existing district heating network was set up in 1986 by intermunicipal waste company Mirom and is fuelled by the waste incineration plant at the edge of the city. The network expanded opportunistically over time and today provides heat to diverse meso-scale urban activities: schools, the public swimming pool, hospital campuses, companies, social housing apartments and several recent residential projects [Figure 2]. Today, the further expansion of the heating system not only is considered a key in realizing Roeselare's climate ambitions but also raises long-term planning questions. Can existing housing be connected to the network? How can its sources be diversified beyond waste incineration? Can a more interconnected network structure be developed and what are possible stepping stones? Which alternatives are possible for neighbourhoods that will not be connected to district heating? What will Mirom's role be in the future, and how can citizens participate in the expansion of the network? These questions and the output of the Climate+ process formed the starting point for the workshops discussed in the next paragraphs.

Figure 2.1. Spatial structure of Roeselare and Kortrijk regions, indicating existing electricity infrastructure, collective heating networks and potential heat sources. Source: elaborated by author based on data from Provincie West-Vlaanderen, Mirom, POM West-Vlaanderen, and GRB, Agiv.



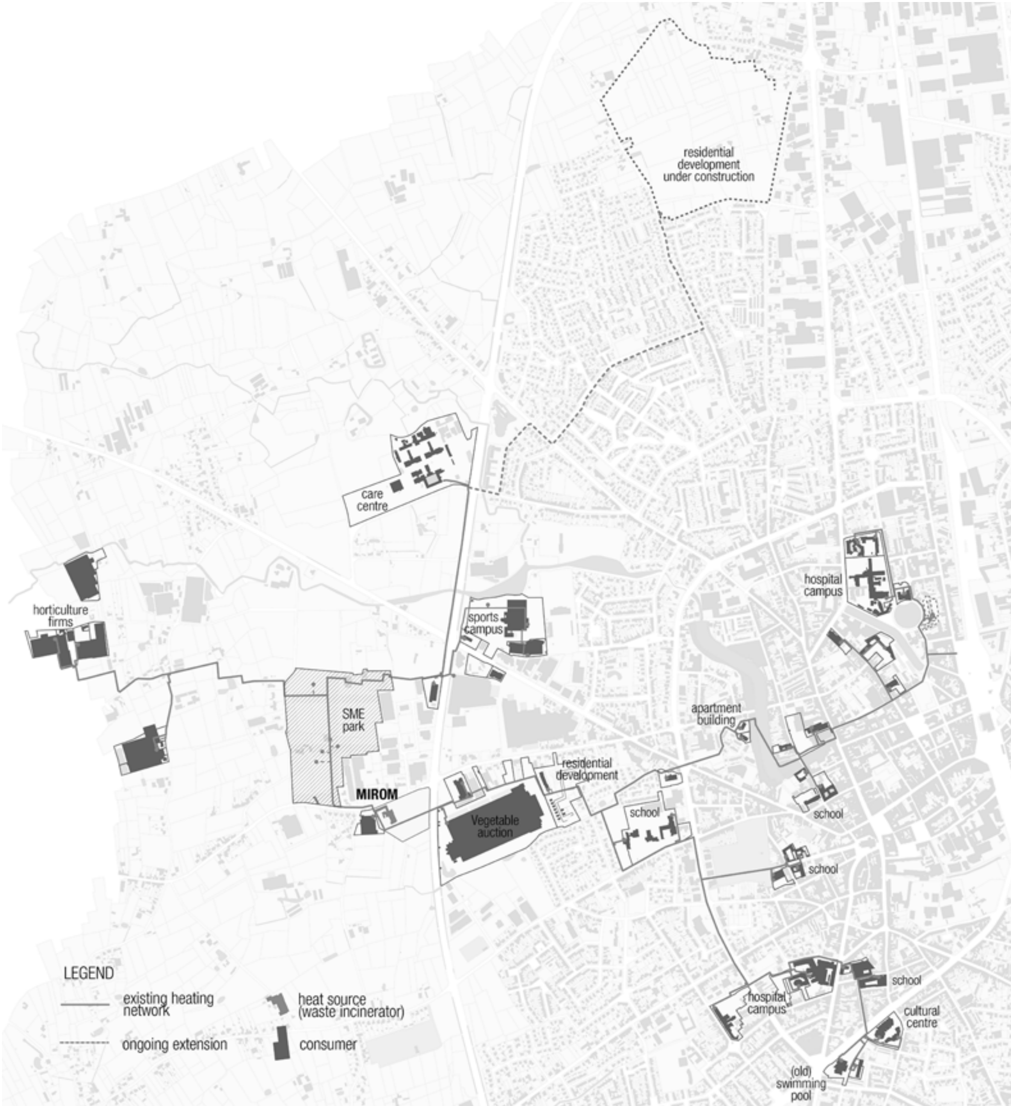


Figure 2.2. The existing district heating network in Roeselare, including the waste incinerator and diverse customers. Source: elaborated by author based on data from Mirom, Stad Roeselare, and GRB, Agiv.

3. MATERIALS AND METHODS: SCENARIO AND STRATEGY WORKSHOPS FOR ROESELARE'S HEAT TRANSITION

The case study is based on action-research combining qualitative and design research methods. Action research aims to deal with real-world problems and explores new ways of doing together with stakeholders, through the active involvement of the researcher in a cyclical process of action and reflection (Denscombe, 2001). Therefore, it is considered particularly suitable to address sustainability challenges and their local manifestations (Wittmayer et al., 2014). The main basis for this article is formed by three scenario and strategy workshops with experts and local stakeholders, co-organized by the author and Roeselare's administration. Preparation for the workshops was based on (1) a spatial mapping of the city's spatial structure, energy infrastructure, planned projects and energy opportunities; (2) 12 semi-structured interviews with heating sector experts and local stakeholders and (3) participant observation during the co-creation process for Roeselare's Climate⁺plan.

Scenarios are often used in energy planning to explore different technological options for the future. Today, they usually do not address the normative societal questions that were present in early scenario studies, with Limits to Growth as a key pioneer (Meadows et al., 1972). Lovins' work on 'hard' or 'soft' energy paths and Naders' 'Energy choices in a democratic society' explored not only the economic and socio-political consequences but also the ethical dimensions of different energy scenarios (Lovins, 1977; Nader, 1980).

In spatial design, scenarios are used to understand the spatial consequences of (hypothetical) trends in contexts of uncertainty and complexity and have become an important tool to explore environmental questions or contemporary forms of dispersed urbanization (Schreurs and Kuhk, 2011; Viganò, 2016). All these dimensions appear in the case of Roeselare, where no consensus exists about how to shape the energy transition and spatial development.

Stremke et al. have used (external) scenarios as a basis for integrated regional energy visions (Stremke et al., 2012). The 'Ignis Mutat Res' project explored spatial strategies through radically different normative scenarios for diffuse urbanity in three alternative worlds: 'cradle to cradle', 'different growth' and 'deep ecology' (Cavalieri, 2014).

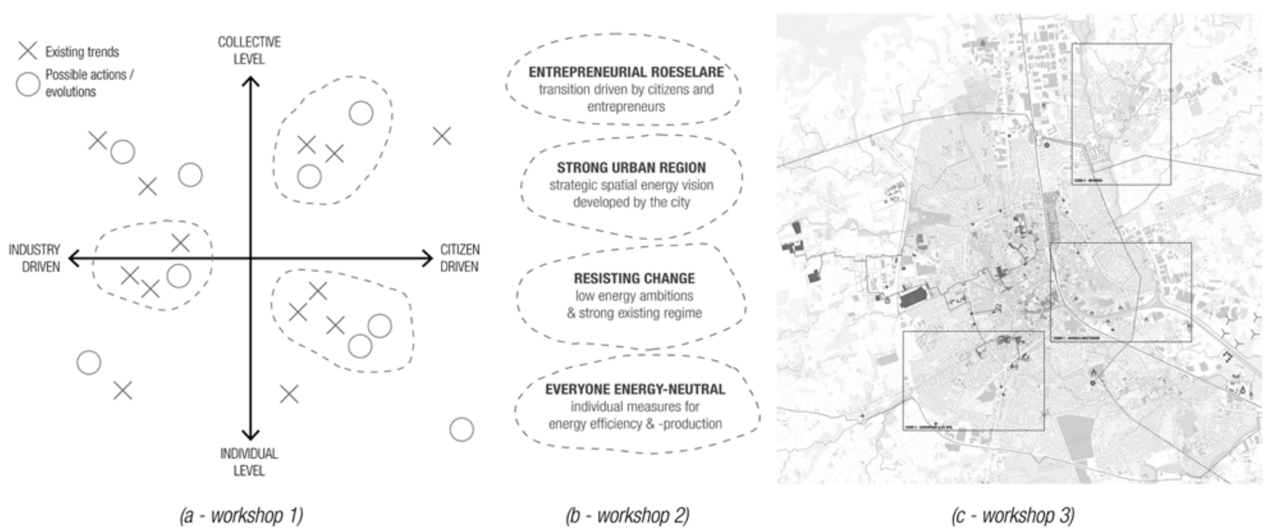


Figure 2.3. Workshop methodology: from (a) clustering trends, to (b) developing and evaluating future scenarios and (c) designing neighbourhood strategies.
Source: elaborated by author.

This research mostly followed Stremke et al.'s framework, including the mapping of present spatial and energy structures and near-future developments and combining concepts from the scenario exercise in an integrated spatial vision. Instead of using external national or regional scenarios, or using theoretical 'alternative worlds', in this case the scenarios were co-designed with workshop participants and related to the local context. They helped to broaden the discussion beyond technical questions, and to set the scene before formulating concrete strategies for Roeselare. The aim was to tease out conflicting insights about spatial energy choices in relation to urbanization patterns and to make explicit diverging socio-political positions about the potential role of the local government, citizens, the public waste company, and other actors in governing Roeselare's energy system.

In the first workshop [Figure 3], a small group including Roeselare's climate and environment officers was asked to explore current and possible trends in energy and spatial development. These were placed in quadrants according to their spatial and governance dimensions, clustering mutually reinforcing evolutions. This informed four future images for Roeselare, which differed in terms of the spatial and energy choices they represented, the role of key actors and the governance structure they proposed [Table 1].

These future images formed the input for a second workshop with around 30 stakeholders, including members of Roeselare's spatial planning, mobility, environment and neighbourhood participation departments, energy experts, external civil servants working on energy and spatial planning, civil society organizations, entrepreneurs and Mirom. The scenarios were developed in mixed groups, by building a timeline, drawing out spatial principles and evaluating socio-economic implications.

Table 2.1. Overview of scenario concepts.

	Entrepreneurial Roeselare	Strong urban region	Everyone energy-neutral	Resisting change
What if? Spatial and energy choices	What if the transition would be driven by bottom-up projects of local citizen organizations and companies?	What if the municipality would develop a spatial energy plan as basis for transition?	What if Flanders optimizes non-spatially selective support for individual investment in energy efficiency and -production?	What if gas and nuclear sectors keep resisting strong planning and energy policy?
Initiating actor(s)	Citizens and entrepreneurs	Municipality of Roeselare	Flemish government	Regime players in energy sector
Governance structure	Coalition of citizens and companies	Public energy company	Subsidized private initiative	Market dynamics

Complementary spatial and governance concepts emerging from the scenario discussions became the starting point for the third workshop, which zoomed in to three different areas in Roeselare: the canal harbour, the residential urban fringe and a peripheral village centre [Figure 3]. This time the group included 30 participants: spatial planners and designers, energy experts, members of the city's planning and environment department, and stakeholders related to the three areas (social housing company, inhabitants and local industry). Base maps with energy data, spatial morphology and information about planned projects were provided. Participants co-designed energy strategies and imagined governance mechanisms addressing the specific opportunities and challenges of each area.

The workshops were recorded and the graphical material was collected and elaborated. The analysis of this rich output was guided by theoretical concepts identified in a literature review linking transition studies and the broader STS perspective, urban metabolism studies and urban design (Juwet and Ryckewaert, 2018). This paper proposed a list of socio-spatial concepts characterizing the relation between energy infrastructure, spatial morphology and energy governance. Using these concepts to understand the case study findings, tests their usability and indicates how the conceptual framework should be enriched and elaborated. An adapted version of the framework is represented in table 2.

<table>
<tr><th>Theoretical concept(s)</th><th>Urban design concept</th><th>Design parameter</th><th>Ambiguities in findings</th></tr>
<tr><td>Energy as socio-technical system (TS, STS)</td><td>Space as palimpsest</td><td>Isotropy & spatial selectivity</td><td>Diversification vs. fragmentation</td></tr>
<tr><td>Space as context (TS, STS)</td><td>Space as agent</td><td rowspan="2">Structuring capacity of infrastructure</td><td rowspan="2">Introducing proximity vs. reproducing dispersion</td></tr>
<tr><td rowspan="2">Fundamental transformation, incremental change (TS)</td><td rowspan="2">Radical incrementalism, vision and strategic projects</td></tr>
<tr><td rowspan="2">Radical incremental transformation</td><td rowspan="2">Obduracy vs. obsolescence as opportunity</td></tr>
<tr><td>Obduracy, path dependence, lock-in (TS, STS)</td><td>Retro-active urbanism</td></tr>
<tr><td>Energy as 'power' (UPE)</td><td>Co-production</td><td>Energy as common</td><td>Collectivity & unburdening</td></tr>
<tr><td>Energy as metabolic flow, circularity (MS)</td><td>Designing with flows</td><td>Multi-scalarity</td><td>Governance pluralization vs. capacity</td></tr>
</table>

Table 2.2. Conceptual framework describing the relation between energy infrastructure, urban morphology and energy governance, adapted from (Juwet & Ryckewaert, 2018).

4. RESULTS: DISCOVERING THE AMBIGUOUS SPATIAL AND SOCIO-POLITICAL POTENTIAL OF ROESELARE'S HEAT TRANSITION

4.1. Spatial selectivity – diversification or fragmentation

Heat transition strategies will be necessarily spatially selective because different types of neighbourhoods require different sustainable heating solutions. As one participant noted: '*one size fits all is not the solution*'. This implies a break with Flanders' tradition of supporting '*everything everywhere*'. Energy efficiency and renewable energy subsidies are not spatially selective and difficult to access for low-income households. To support the heat transition, policy mechanisms therefore need to be more spatially and socially tailored. By targeting specific types of neighbourhoods, renovation and energy subsidies can avoid supporting all-electric solutions where district heating would be more appropriate or stimulating renovation in locations with low connectivity and services. Prioritizing subsidies towards inhabitants with lower socio-economic profiles would be more effective to support those households that need it most.

Spatially selective integration of heating networks requires a more focused societal investment in collective infrastructure, and as put by a workshop participant: '*avoid the mistakes we made with gas*'. While policy historically aimed to maximize the connectivity degree for natural gas, even in rural areas, this is simply not feasible with more capital intensive district heating infrastructure. Rethinking the modern ideal of ubiquitous and cheap network connection is a part of a broader debate about the societal cost of dispersed urbanization and the transformation of policy mechanisms that support it.

On the other hand, selective heat network developments risk to cherry-pick economically more interesting new-build projects rather than investing in the transformation of existing tissue. Moreover, certain neighbourhoods have more self-organizational capacity to set up collective systems than others. Today already, district heating projects in Roeselare emerge as part of new residential projects, both in the urban core and in the periphery, while connecting existing housing remains unfeasible. As one participant remarked: '*even if we don't choose anything, a lot will happen*'. Mirom considerably expanded its network during recent years and plans to continue expansion based on emerging opportunities. Intermunicipal company Fluvius extended the network into Roeselare's periphery to connect a new neighbourhood. Two companies exchange process heat, other businesses in the harbour are exploring the feasibility of a steam network. Workshop participants agreed about the need for a clear framework to guide this pluralization of heating configurations. It should propose the most interesting heating strategy for each neighbourhood, and regulate tariff coherence and technical compatibility between fragmented 'heat islands'. '*Without structure, it will be a wild prairie*'.

Importantly, this framework should not only specify where the existing network should be expanded but also define the areas where district heating will not be developed and propose an alternative approach. Focusing attention on district heating alone, risks to create high individual renovation and installation costs for those inhabitants that have no access to collective heating.

4.2. Structuring capacity of infrastructure – introducing proximity or reproducing dispersion

Because a collective heating system benefits from density and proximity between source and demand, it can be combined with urban densification as mutually reinforcing strategies. Strategically designing the main structure of Roeselare's heat network into a more flexible, interconnected system can be linked to urban renewal projects and densification of the urban centre, while reducing urbanization pressure on the city's creek valleys [Figure 4].

During the workshops, a ring structure as 'heat backbone' was proposed, linking strategic reconversion projects as potential consumers, with industrial areas as 'energy hubs' where energy can be produced, exchanged and stored. Urban renewal projects can start as 'heat network islands' and then provide heat to stimulate sustainable transformation in their direct surroundings, and connect with the urban network in a later phase. Developing Roeselare's industrial areas and harbour as 'energy hubs' would unlock other heat sources, connect new heat production and storage facilities and allow connection with a future steam network in the harbour. This would decrease Roeselare's dependence on waste incineration and allow to 'green' the system over time, an important concern for several participants. Reframing the relation between the city and the food industry in its harbour by developing these synergies, can help to anchor important economic activities in the region.

One risk is that the so-called 'heat zoning plans', increasingly developed in Flanders, remain merely technical documents based on data about current heat demand and possible heat sources. Planning district heating as strategic element in spatial development, requires a broader vision indicating where development or densification are advisable or need to be phased out on the long term. Another concern was that the opportunistic construction of district heating routes can attract unanticipated urban development in areas where that is undesirable. This might happen with the peripheral branch of the network recently constructed in Roeselare. One participant remarked that: '*district heating offers an opportunity but can also be a threat*'. Moreover, valorizing heat from unsustainable or badly located industries could further embed undesirable spatial patterns and economic activities.

However, while all participants agree in theory with the need for a long-term spatial strategy for district heating, some found the workshop exercise too 'abstract', and stressed the need for short-term pilot projects. '*It's nice to play with drawings, but the reality of district heating is much more than drawing a line on a map'*. The messy struggle to '*get a pipe in the ground'* means projects in practice start from seizing attainable opportunities rather than from long-term strategies.

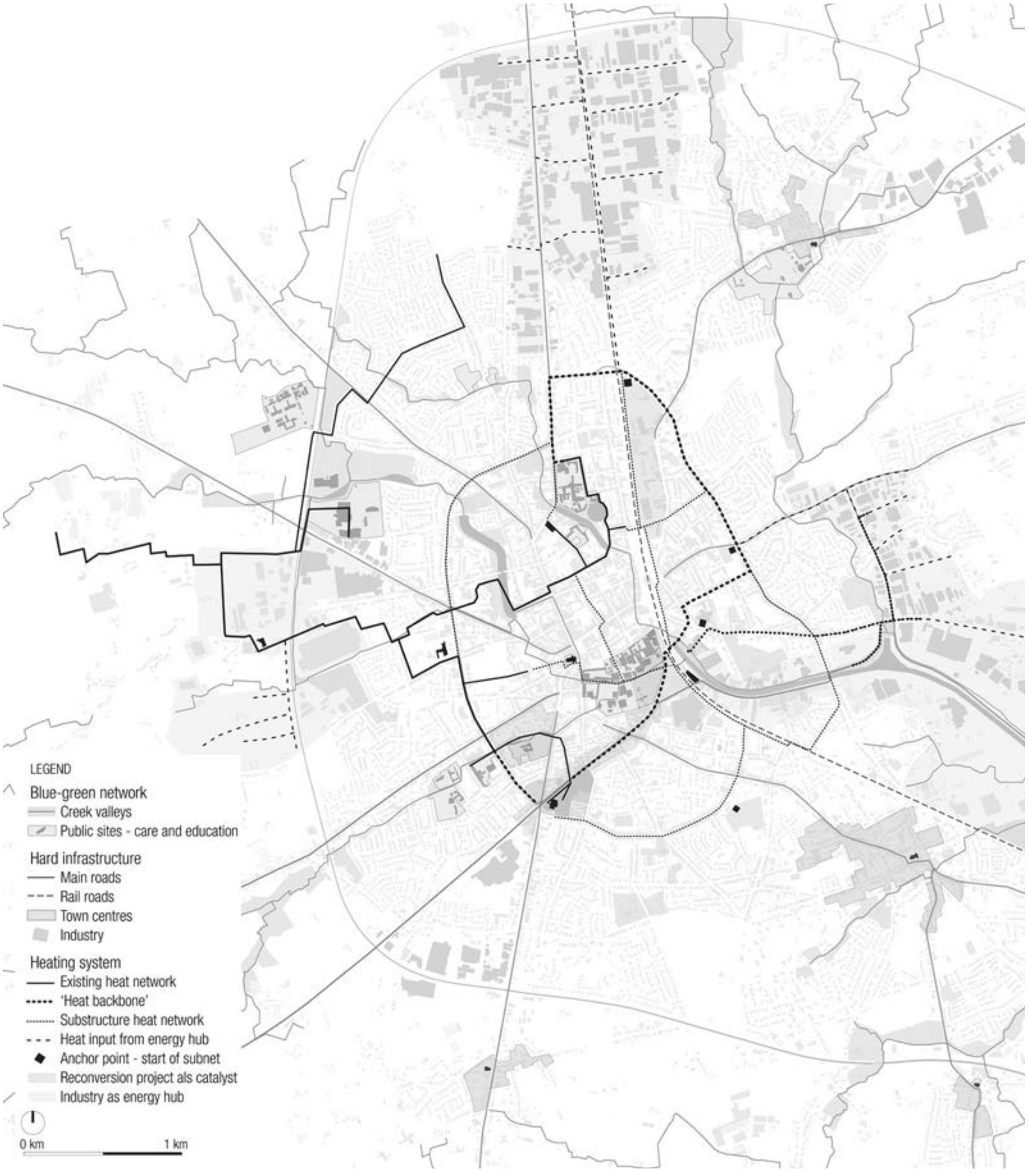


Figure 2.4. Roeselare's layered spatial structure of radial infrastructures carrying industries and town centres, interwoven with creeks as carriers of soft mobility and public sites for care and education. The 'heat backbone' is indicated as a new spatial figure carrying sustainable urban development and densification projects. Source: author based on workshop drawings and discussions.

4.3. Radical incremental transformation – obduracy vs. obsolescence as opportunity

Next to strategic projects the transformation of Roeselare's heating system requires many incremental, context-specific interventions at the scale of buildings, streets and building blocks. But the existing building stock and its dependence on the ubiquitous gas network contribute to the obduracy of existing heating configurations. Renovation is necessary to make buildings 'heat-net-ready' or adapted for individual or micro-collective heat installations. This is particularly challenging in Roeselare, where a large part of the housing stock dates back to the post-WWII years and scores low on energy efficiency. The possibilities to improve these conditions strongly depend on inhabitants' profile: owner or renter, investment capacity, life phase, personal aspirations, etc. One participant admitted that '*the more I work on this, the more I think we underestimate the challenge*'. To accelerate the retrofit of older neighbourhoods and reach more vulnerable households, participants suggested pre-financing renovations in a cooperative ESCO-formula or setting up a rolling fund based on Community Land Trust principles (inspired by a pilot project in the city of Ghent (*Dampoort KnapT OP, Wijkrenovatie met noodkopers*, 2016)).

Participants emphasized to maximally '*make use of natural moments of replacement and transformation*' on different scales. For large energy infrastructures, this means finding synergies with planned urban projects in Roeselare such as industrial reconversion projects, the redevelopment of the former public swimming pool and the redesign of the southern ring road. At street level, it means coordinating works to sewage, telecommunication, energy, water, parking and cycling infrastructure. Such interventions offer opportunities to create more permeable, green, safe streets that contribute to sustainable mobility, water infiltration and reducing urban heat island effects. At the household level, it means influencing decision moments about moving, renovating or replacing boilers, stoves and cars. For companies, it includes steering decisions about (re)location or expansion, or investment in new energy installations or production lines. Because all these 'replacement cycles' have different rhythms and logics, 'energy matchmaking' is crucial, and sometimes 'in-between' solutions are necessary in working towards a long-term strategy.

Meanwhile, despite these strategic debates, space- and energy-intensive urbanization in Roeselare continues. Many renewal and densification projects are located in the urban centre, while the last greenfield 'housing zones' in the urban fringe are filled up with low-density residential subdivisions. This leaves a large stock of outdated, oversized and energy-intensive houses in existing peripheral allotments where the incentives to re-invest are low.

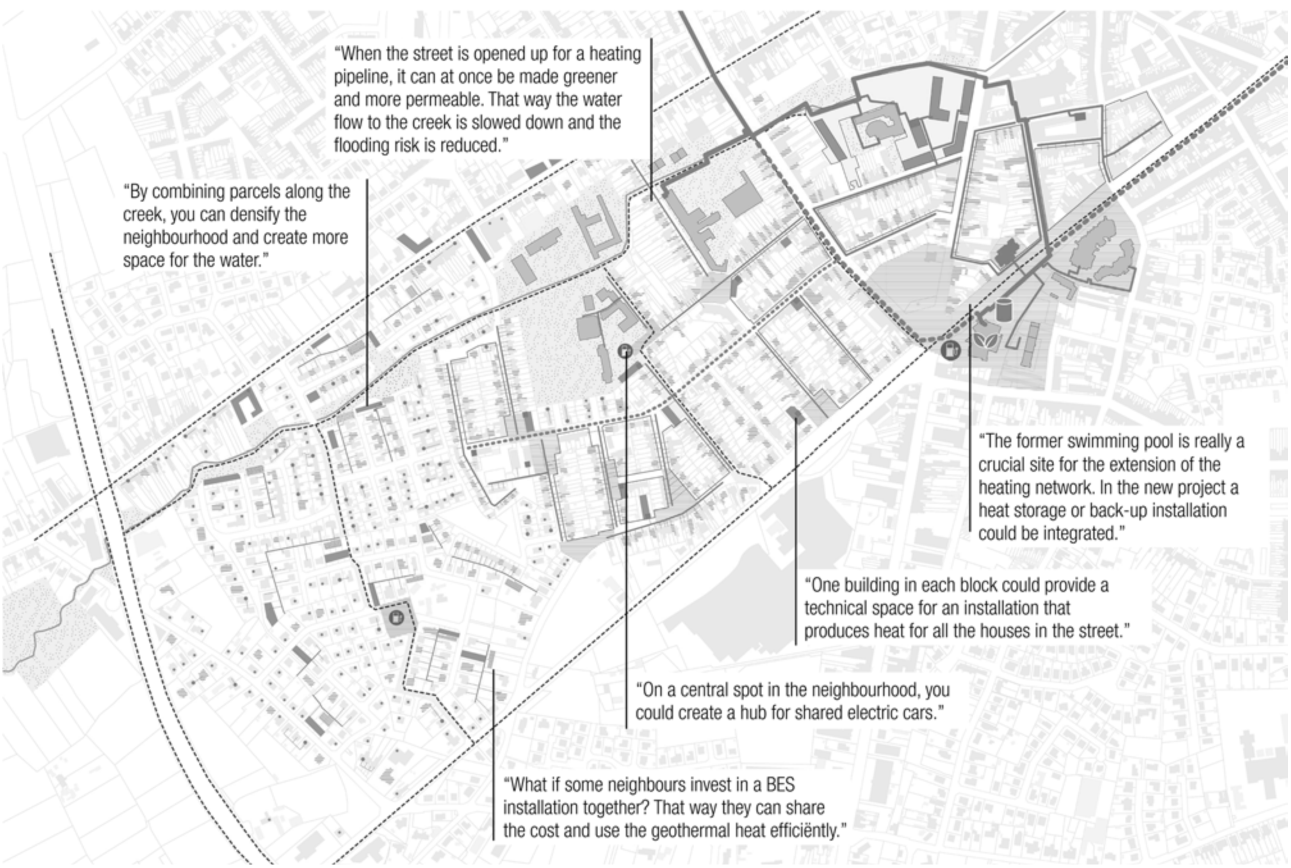
As elsewhere in Flanders, Roeselare's dependence on the natural gas system strengthens the inertia of existing heating solutions. Gas is not only tied up with essential aspects of daily life (heating, fireplaces or cooking on gas), but also with the institutional setup of the network operator, intermunicipal energy company Fluvius. This public company could play a key role in phasing out natural gas, and also has to deal with municipalities' historical investment in what would then become stranded assets. Many participants were critical: '*Fluvius needs to understand that this is more than a problem of depreciation terms, this is a societal challenge to move away from fossil fuels*'. Tackling that challenge requires a transparent public debate about energy distribution that recognizes the spatial logics, political character and social sensitivity of energy distribution governance. Fluvius' technocratic and opaque mode of operating critically inhibits this potential.

4.4. Energy as common – collectivity and unburdening

District heating and individual electric installations often appear as the two fossil-free options, but as one participant remarked: '*there are a lot of solutions in-between… a collective system starts with two or three*'. The transition offers opportunities for shared energy infrastructures and spaces at multiple scales and for citizens to take up new roles beyond energy consumership.

For low-density residential allotments, individual all-electric solutions (e.g. solar energy, heat pumps) are often proposed, in line with current energy policy which mainly supports building-level interventions. One inhabitant testified that '*there's no need for collective solutions in such a neighbourhood, because everyone has what they need on their own parcel*'. The heat transition could create opportunities to introduce micro-collective installations and spaces into this individualized environment. When every home owner is confronted with costly investments in renovation and heating installations, this can spark collaboration: sharing an underground seasonal heat storage installation between neighbours with adjacent gardens, combining plots or splitting parcels to add extra housing units or adding a roof apartment while renovating. This way, the transition can trigger more structural transformations of the built tissue and realize efficiency gains through micro-collective heat production.

Figure 2.5. Heat strategies for different parts of the urban fringe in the 'Groenpark' neighbourhood: extension of the existing network in the city centre, collective building-block solutions in terraced housing neighbourhood, and individual and micro-collective installations in low-density residential area.
Source: author based on workshop drawings and discussions.



In neighbourhoods with a terraced housing morphology, space for heat pumps, solar boilers or underground heat storage is often scarce. Heat production could then be collectivized at the block or street scale, incrementally developing a neighbourhood heat network over time [Figure 5]. Through integrated design, such strategies can combine shared energy infrastructure with other facilities and sharing practices such as shared composting or gardening, water buffering, car sharing, collective bike storage, workshops or electric mobility hubs.

Many participants believed energy cooperatives and citizen organizations should play a crucial role in the energy transition. If citizens could co-finance and decide about the district heating network in their street, public support for often far-reaching transformations would increase. Others were more sceptical about the potential role of citizens. They remarked that cooperatives only have limited financial impact and preferred a strong role for public organizations. '*Be aware of what you give to citizens, because sooner or later the government will have to solve it anyway… basic services are given to the government for a reason*'. Moreover, so far civil society in Roeselare has not strongly organized around the energy transition topic. An energy cooperative was founded as a result of the Climate+plan process, but still has to develop organizational and financial capacity.

Several participants emphasized that the transition cannot merely be based on the self-organizing capacity of local citizens, and raised doubts about who would initiate (micro-)collective solutions. They advocated for the 'unburdening' of inhabitants, particularly by supporting renovation processes. Since '*the areas with most opportunities for the district heating network, are also the areas where the most disadvantaged population lives*', public investment in heating infrastructure and adapted support for renovations could make a crucial difference in the housing quality and energy cost in these neighbourhoods. From that perspective, the lack of concern in local and Flemish energy debates about social issues like energy poverty, and the slow development of a legal framework for (social) tariffs for district heating, are problematic. The workshops not only tried to address such topics by inviting relevant experts and stakeholders, but also revealed a lack of experience with feasible inclusive, scalable renovation solutions.

4.5. Multi-scalarity – governance pluralization vs. capacity

The workshops produced ideas for new governance structures to support transition at multiple scales. Spatial strategies, co-creation processes and coalitions will be required at neighbourhood, city and city-regional level, while Flemish energy policy needs to create the right conditions for a local transition.

Participants expected the city administration to become the 'director' of the energy transition by taking up multiple roles: co-producing a shared spatial energy vision, initiating and investing in key (infrastructure) projects, building connections with and between stakeholders, coordinating co-creation and implementation processes for collective projects, and guiding private investments towards a common long-term direction for each neighbourhood. An advantage for the administration is that it can build on Mirom's expertise and years of fruitful collaboration between city and district heating operator. But as the network expands, also waste management company Mirom has to re-balance its priorities and professionalize its energy supply activities. Moreover, as one participant emphasized: '*heat doesn't stop at the border*', so regional collaboration and visioning will be required. Regional energy planning initiatives for the neighbouring region of Leiedal, and in the province of East-Flanders provide inspiring examples (Custers, 2018). However, none of the existing supra-local organizations (intermunicipal spatial development company, province) have taken up the task of developing a spatial energy vision for the region of Roeselare. The energy transition could spark stronger regional collaboration between Roeselare and the surrounding municipalities, but this seems to depend on the city's own initiative for such a partnership.

A returning demand for the Flemish government is to create ambitious policy conditions to stimulate local transitions. They should help local policy-makers to make choices that are politically sensitive, because they restrict individual liberties such as the choice of energy technology or supplier, spatial development rights, etc. Key decisions include setting a deadline for phasing out fossil fuel-based heating systems (as in the Netherlands), discouraging discharge of residual heat and facilitating or even imposing spatial energy planning (as in Denmark), taxing fossil heating options and (financially) supporting collective and individual alternatives.

A crucial limit for Roeselare's administration to take a central role in the heat transition is its limited staff capacity, expertise and investment towards the energy transition. The city's energy and climate initiatives today are often project based and under political pressure to deliver short-term results and visibility, and need to find stronger integration in other spatial planning and policy domains.

6. DISCUSSION AND CONCLUSION

The case study provides insight into the ambiguous spatial and governance implications of sustainable heating infrastructures. The findings also enrich the literature-based conceptual framework developed in an earlier paper (Juwet and Ryckewaert, 2018), and they suggest ways for spatial planning and design to support the energy transition.

First, the case study reveals the ambiguities of the socio-spatial implications of pluralizing (sustainable) heating configurations. If strategically planned as a part of an integrated spatial vision, collective heating systems could support urban densification and renewal, introduce collectivity in individualized housing environments, reframe the relation between city and industry, contribute to improved living quality in vulnerable urban areas and trigger more democratic forms of collaboration between citizens, private sector and local government. Without a shared spatial framework, an opportunistic and spatially selective integration of collective heating systems risks to (re-)produce socio-spatial inequalities or further embed unsustainable spatial development patterns. The workshops show that spatial planning and design can identify and visualize such potentials and risks, while a purely technical approach to the heat transition would miss opportunities to improve spatial quality and inclusive energy governance.

Second, several concepts identified in the transitions, metabolism and design theory literature, proved useful to make sense of Roeselare's energy transition and bring out some of its tensions (Juwet and Ryckewaert, 2018). The case illustrates the 'spatial selectivity' of sustainable heating solutions as a break with isotropic energy networks, confirms the 'obduracy' of the existing energy system and built environment and shows that the transformation of energy infrastructure, urbanization patterns and energy governance is a 'multi-scalar' challenge [table 2.]. It clarifies that the energy transition as fundamental spatial transformation includes both the structuring capacity of strategic infrastructure projects and incremental small-scale transformations. The case study allows to complement the conceptual framework in the following ways. The workshops showed more concretely how design can mobilize the 'spatially structuring capacity' of sustainable heating infrastructures at different scales by linking the energy transition to other spatial questions, e.g. by planning heating systems together with densification or urban renewal projects, by rethinking street profiles or neighbourhood morphologies in synergy with collective heating solutions or by discouraging dispersed urbanization through spatially selective energy policy and infrastructure investment. Regarding the role(s) of citizens in the energy transition, not only opportunities for emancipation through financial and democratic participation but also the need to 'unburden' specific users through adapted support and financing mechanisms are important. The research suggests not only that new governance configurations are needed to deal with the 'multi-scalarity' of transition processes, but also shows the need to develop the spatial energy planning capacity of municipalities, supra-municipal organizations, spatial design practices and civil society.

Third, the case suggests how planning can support the energy transition as a lever for more sustainable spatial development at different scales. However, a single case study based on future explorations rather than implemented policy has its limits in terms of drawing generalized conclusions, and further research on other scales and contexts remains necessary. The participants in Roeselare formulated a clear call for integrated spatial energy planning. This would couple strategic urban interventions with a comprehensive framework to guide small-scale incremental change in different types of neighbourhoods. While traditional land-use planning is often seen as maintaining the existing order rather than transforming it, strategic planning is understood as a framework for transformative action towards a long-term vision of change (Albrechts, 2013). The workshops suggest that effective energy planning needs to combine elements of both in innovative ways, linking heat zoning plans with long-term visions and strategic pilot projects to reach fundamental change.

Strategic planning has contributed to spatial quality in cities across Flanders, but has not always been able to address inequality in those cities or to prevent further dispersed urbanization in the region (Voets et al., 2010). However, its key three tracks (long-term spatial vision, strategic urban projects, and participation) are still relevant – recent approaches to 'transition management' show substantial resemblance and propose a combination of long-term visioning, transition experiments and co-creation through an arena of frontrunners. For a small town like Roeselare, a strategic energy plan helps prioritize projects that can catalyze broader change. But the energy system is socio-technically and spatially so embedded in fiscal and legal structures, housing practices, existing infrastructures and built environment, that a transition also requires incremental change and involves a variety of actors in different domains. A 'zoning' approach to the energy transition could be inspired by the municipal zoning plans for sewage developed in Flanders since 2008. These specify which zones are or will be connected to the public sewage system, and where individual water purification installations are obliged. A heat zoning plan specifies desired technological choices (collective heating, all electric, etc.) for different neighbourhoods and should link these with spatial development ambitions (densification, renewal, 'phasing out'). It would provide investment security for diverse stakeholders (inhabitants, building sector, network operators) and guide their initiatives towards the urban energy vision.

Local energy transition only becomes possible when the right conditions are set at Flemish level. Unfortunately, the shift from structure planning to policy planning (Witboek Beleidsplan Ruimte Vlaanderen, 2016) signals a move towards less directive and more project-based planning that leaves the initiative with municipalities, citizens and developers, and for which no strong policy instruments have been developed yet (Voets and Schraepen, 2019). The city-regional level of intermunicipal development companies or provinces also has a crucial role in energy planning. The planning of wind energy, waste incineration and other larger-scale energy production, district heating or energy transmission networks need to be addressed at the supra-municipal scale. Regional energy plans can provide clarity and facilitate public support for long-term developments, couple energy projects with landscape improvement, create opportunities for citizen participation, and support local energy planning processes, but they need a stronger juridical basis and implementation strategy.

A fundamental energy transition implies questioning the roles of traditional actors in the energy sector. Making vested interests and conflicts explicit during the planning process, for example by involving not only technical and spatial expertise but also socio-political actors and local stakeholders, helps to re-imagine governance structures in more democratic ways. For municipalities, this can involve responsibilizing (intermunicipal) energy companies to mobilize their expertise towards more sustainable solutions, or setting up partnerships with citizen initiatives. However, the workshops also revealed that experience with inclusive energy production and renovation solutions in Flanders is limited and needs attention.

Spatial planning and design can broaden the energy debate from a technical to a societal discussion, showing the opportunities that become possible by linking the energy transition with other social and spatial challenges. Further research is needed to explore how spatial planning tools and stakeholder coalitions can be developed to co-produce and realize these ambitions.

Interlude A

Mapping – visualizing and re-imagining territorial energy dimensions

"*A drawing says more than a thousand words*", and therefore the power of visualization should not be underestimated. After all, the drawings in Sijmons' book '*Landschap en Energie. Ontwerpen voor Transitie*', inspired me to start this doctoral research in the first place.

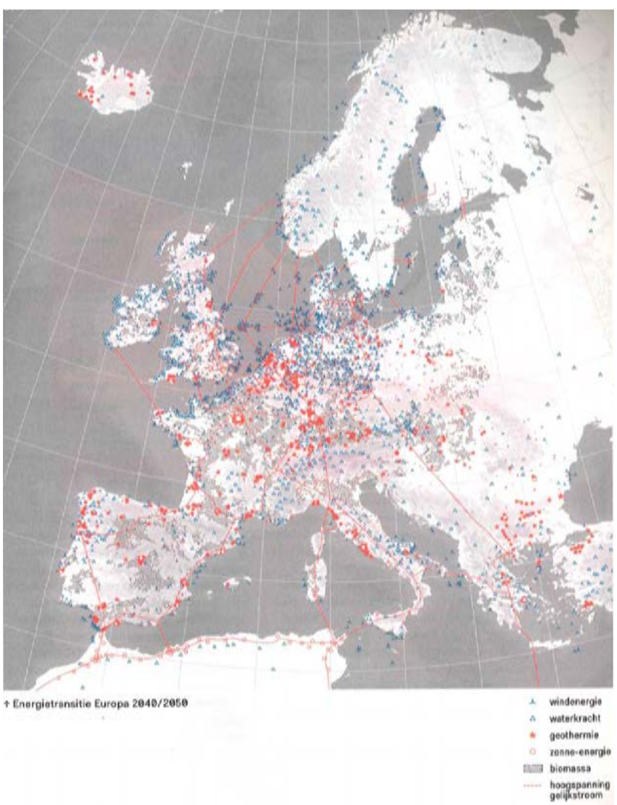


Figure A.1. Energietransitie Europa 2050.
Source: Sijmons et al. (2014), Landschap en Energie.

Mapping and drawing are essential tools for any spatial designer. These methods are used not only to describe and visualize the territory, but also to unravel and re-imagine it. In his seminal essay on 'The Agency of Mapping', James Corner argues that the cartographic process of selecting, schematizing, synthesizing and representing is never neutral or passive, and therefore mapping is "*perhaps the most creative act of any design process [...] as a project in the making*" (Corner, 1999). The territory can be interpreted as a palimpsest (Corboz, 1983), and in contexts of dispersed urbanization, mapping is then often used to unravel and visualize the different layered rationalities that (re-)produce horizontal urbanization (Cattoor and De Meulder, 2011; Viganò et al., 2016). From such a perspective, high expectations come with the act of mapping, and therefore with the mapping process, and with the graphical skills and imagination of the designer. But the way these maps and drawings come about often remains black-boxed as a 'creative process' that is rarely examined in detail. In her research-by-design about circular economy, Julie Marin masterfully illustrates how designerly tools can be put to work to spatialize, contextualize and re-imagine the territorial dimensions of urban metabolic flows. She shows how traditional designerly instruments, such as maps, sections and schemes, can be reinvented as 'resource cartographies', 'metabolic transects' and 'flow agent diagrams' that visualize spatial logics and actors around flows of water, food, energy or materials. By integrating diverse types of data and articulating their territorial dimensions, these designerly drawings provide a basis for the co-production of alternative spatial configurations (Marin, 2018). In this interlude I reflect about the roles maps and drawings played in the action research I set up during Roeselare's climate planning process. How did mapping help to make sense of Roeselare's urban morphology and energy infrastructure? What difficulties did I encounter in collecting and visualizing technical data and local knowledge about the urban energy system? How could maps, schemes and narratives help to introduce a more systemic spatial and social perspective in Roeselare's reflection about an urban energy transition, and could they stimulate a co-productive dialogue? And how did this research-by-design influence climate and urban policy in Roeselare?

Key moments in the process of developing Roeselare's Climate+ plan were the so-called 'SWAT-studio' and the 'City-zen Roadshow' that took place in 2018, both of which I participated in. During the SWAT-studio, a group of TU Delft students in building technology came to Roeselare for a one-week design workshop. This work formed the preparation for the City-zen Roadshow, an intensive week of co-creation and design with a team of international energy experts and urban designers. The programme was composed of a cycling tour, interviews with key urban actors, a serious game and carbon accounting workshop, and design workshops on energy and future neighbourhoods. The results, including energy roadmaps towards a carbon-neutral Roeselare, a sustainable urban and neighbourhood vision and a number of inspiring collages depicting alternative futures [Figure 3], were presented to the Roeselare administration and interested stakeholders. These images featured new applications of urban agriculture and aquaponics, innovative energy technologies and building techniques, and green-blue spaces for production and encounter.

The initiators of the Roadshow explain the power of the Roadshow as follows: "[We] *take the power of design and imagination that the team has with respect to urban sustainability and place it directly in neighbourhoods that most need it. [...] We go off to a city, engage with city government, citizens and academics and in a short space of time deliver a future vision for them that takes new technologies and lifestyles and binds them together in a strategy plan for carbon descent. To do all that in 5 days is a challenge but [...] the way the city engages with us in such a short timescale is so different that it is liberating and allows them to be more imaginative and free thinking.*" (*City-zen roadshow*, 2018)

"*The Roadshow is a unique event; its solutions are vital, hard earned, candid and realizable. It aims to bring together people with many differing interests and specialisms, but also many varied aspirations of what the city offers now, and what it should perhaps offer in the future. To ensure that outcomes of this collaboration are from the city, and by the city, the Roadshow and SWAT Studio actively seek the participation of the motivated, the informed and the open-minded.*" (*City-zen roadshow*, 2018).

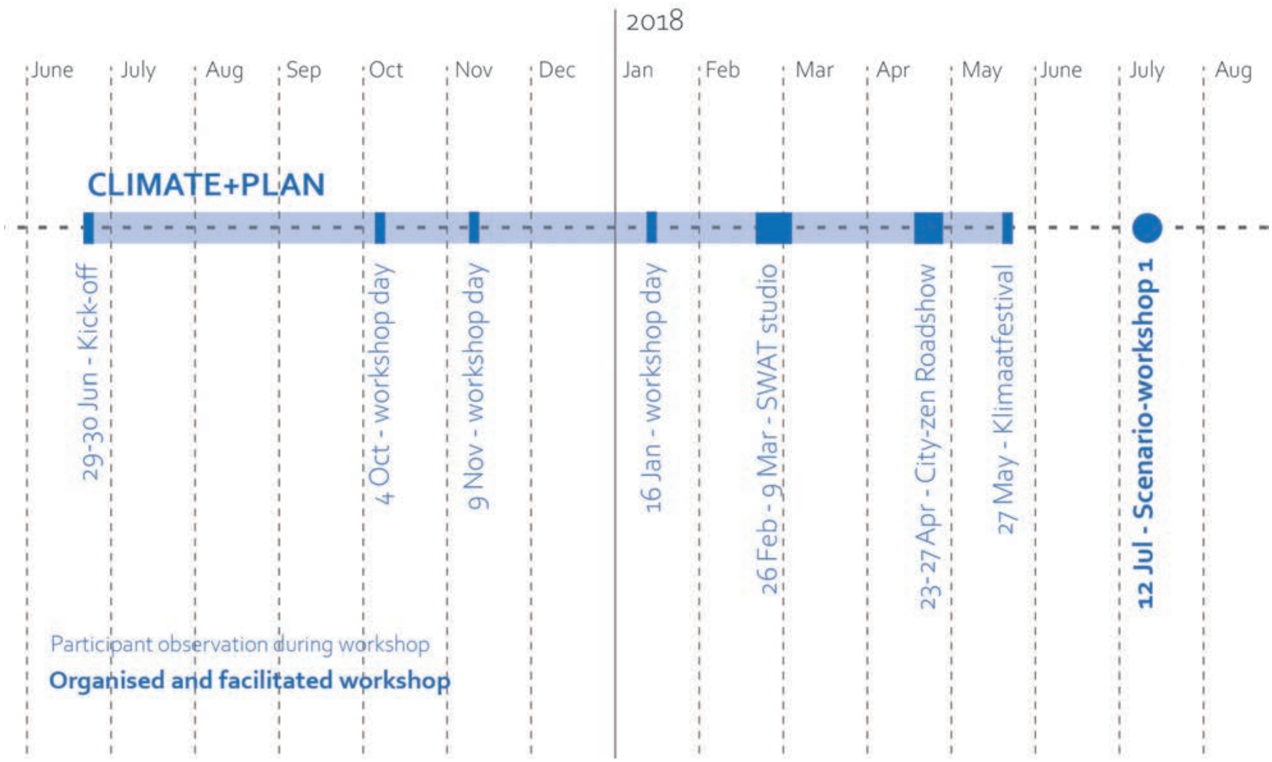
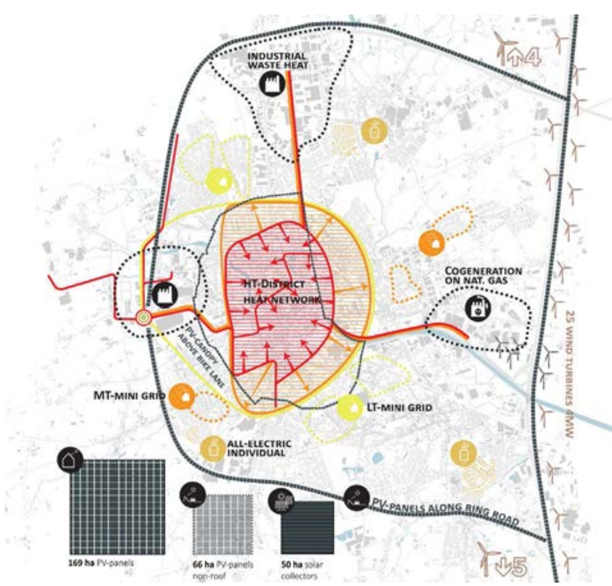


Figure A.2. Roeselare process timeline.
Source: author.



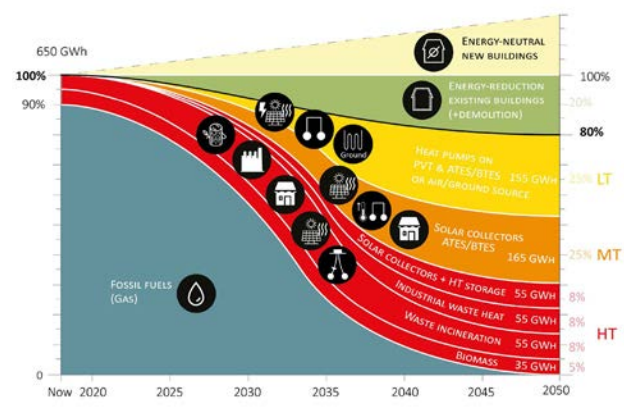
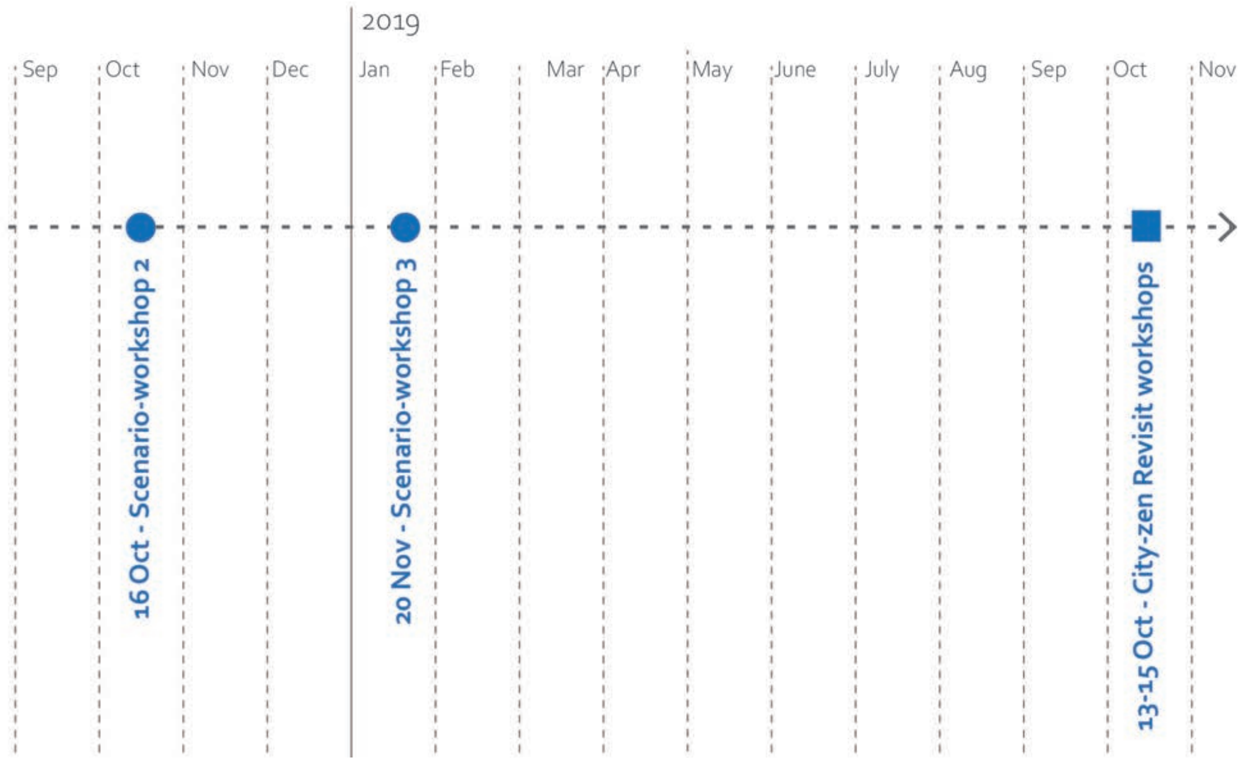


Figure A.3. City-zen Roadshow visual results: Roeselare urban energy strategy 2050 (left), Roeselare energy balance (top), collage Techno Terp (all-electric self-sufficient renovation) (top right), Food Agora (bottom right).
Source: City-zen Roadshow, Greg Keeffe and Siebe Broersma.



Given the short-term engagement of the City-zen design team with Roeselare, and its relatively superficial understanding of the socio-spatial context of Roeselare as a basis for the proposed future vision, these accounts seem to overestimate the impact of the City-zen design strategies for the city. Nevertheless, the momentum created by the event, and the resulting collages and design strategies were successful in convincing Roeselare's mayor to support the ambitions of the Climate+plan. As the plan was finalized, how could I contribute meaningfully to the continuation of his process?

During that period I became a regular guest at the town hall of Roeselare. As part of my action research approach, I decided to work there on most Fridays to become familiar with the realities of climate planning in the city and started to collaborate closely with the team of climate expert Timo. With this approach I gained a privileged insight into the barriers these civil servants encountered to implement climate projects and integrate climate measures throughout different policy domains. I also started collecting and synthesizing data about Roeselare's energy system. I received relevant information from the city administration, for example about spatial morphology and building age, although these data were not always complete. Obtaining data from network operator Fluvius, however, turned out to be more difficult. Especially information about the natural gas use at street level, which could serve as a proxy for linear heat demand, appeared relevant to visualize because it could help to identify potential locations for collective heating systems. But several emails to the network operator went unanswered. Over time though, Fluvius' attitude shifted and many datasets became available online as open data. Still, interpreting and representing these data in a useful format proved a challenging test of my GIS skills because the data could not easily be linked to a spatial GIS layer. The data about natural gas did not include information about other heating fuels and could therefore misrepresent heating demand on street level. Inspired by a neighbourhood typology proposed by Kelvin Solutions (Cyx, 2017), I also developed a typology of neighbourhood types for heat transition, based on spatial morphology, building age and energy demand data.

At this stage, mapping involved an intensive process of collecting, selecting, interpreting and representing often complex technical data. It became a tool to synthesize and present information about spatial morphology, energy infrastructure, local (residual) energy sources and energy demand. Mapping also became a way to harvest and visualize knowledge that was otherwise scattered and hidden. I discovered that the environmental officer Bert in particular, because of his long work experience evaluating environmental permits, was an infinite source of information about ongoing and planned projects in the city, and about the energy installations at industrial sites. I organized an interview to 'harvest' this knowledge, and together we noted what he knew, on a simple base map. Together with public data I reworked this information in maps about 'energy potential' and 'planned projects'. Although this was all very interesting, what use was this information when it remained in my hands? How could these maps support Roeselare's administration to imagine a sustainable future energy system?

Together with Timo and Bert I decided to organize a series of scenario workshops to enhance the discussion about Roeselare's future energy vision with the administration and other key urban stakeholders. On the one hand, these scenarios would pick up some of the key themes that emerged during the Climate+ plan process: the crisis of the urban water system which strongly affected Roeselare's inhabitants and its agricultural hinterland, the dominance of car mobility in the city's streets and public spaces, and the need for a more strategic approach towards the further expansion of Roeselare's district heating system which could contribute substantially to reducing Roeselare's carbon emissions. On the other hand, I aimed to introduce a more systemic spatial perspective into the discussion about Roeselare's energy future, and to address more 'social' energy themes such as energy poverty and citizen-based governance models.

In a first small workshop, we explored energy trends and actors, in relation to the specific socio-spatial context of Roeselare. Based on a rich understanding of Roeselare's energy and stakeholder landscape, we conceptualized four scenarios about a possible future energy system, and I drafted four detailed future narratives. These narratives proved very helpful to introduce dimensions of ownership, governance, stakeholders and power in a second scenario workshop with a diverse group of key stakeholders. I provided basic maps representing the city's spatial morphology, green-blue systems, and energy system. We asked participants to draw the spatial consequences of each scenario on a map of Roeselare. While some groups hesitated to put pen to paper, in another group an invited planner and a spatial designer took the lead and drew up a scheme synthesizing the city's spatial structure as an alternation between blue-green creek systems and built space organized along hard infrastructures. They proposed a closed district heating ring infrastructure as a backbone for the urban energy system.

Figure A.4 Mapping at Roeselare workshop 2: urban energy vision with radial valley structure and closed district heating network.

At this occasion, drawing became a useful tool to support strategic thinking and co-design spatial strategies for an alternative energy future. Exploring the spatial consequences of the different scenarios also helped to build support for a spatial energy framework for the city, as participants realized that "*without guidance it would become a wild prairie*" or "*projects would remain isolated islands*". At the same time, this workshop showed how the social and governance dimensions of Roeselare's energy futures could not easily be represented in maps alone, although working on a spatial background inspired insights such as "*the neighbourhoods with most district heating potential are also the most underprivileged neighbourhoods*" and "*there are many collective opportunities in-between the city-level and the individual level*". As it turned out, the scenario narratives proved very valuable to tease out discussions about energy justice and energy democracy, and participants remarked that "*we risk to create a Matthew effect as subsidies don't end up with the households that need them the most*", and "*there is not one step you can take without involving people*".

In a third workshop, we zoomed in on three different neighbourhoods in Roeselare. Base maps visualized the neighbourhoods' spatial morphology, energy system, and planned projects. This time, we aimed to design neighbourhood energy strategies, and therefore we invited more participants with a planning or design background to ensure that design capacity would be present in each group. Together, the participants imagined spatial energy concepts and governance approaches that responded to the particular challenges in each neigbourhood: a strategy based on electric heating and mobility for the suburb of Beveren, a district heating network for Roeselare's industrial harbour, and a combination of micro-collective heating arrangements and incremental densification in the Groenpark neighbourhood. I decided to translate these workshop results in maps at the city scale that visualize the strategic concepts of a radial heating system and industrial areas as energy hubs, drawings at the neighbourhood scale to show the context-specific spatial strategies, and schemes that explain the governance ideas at the scale of a neighbourhood, an industrial area and the city. I also produced a report with an overview of the workshop process and output. Not only was this an accessible and tangible result for the city administration, it offered more space for all the visual material than the traditional format of an academic article.

But, as a workshop participant remarked later, "*building a district heating network is much more than drawing lines on a map*", and indeed, in the following months it became clear that moving forward with the opportunities we identified, would require more facilitation to unburden vulnerable inhabitants, to build strong stakeholder coalitions, develop feasible business cases and identify financing strategies. Then, what impact did the drawings we produced during these co-creation moments really have in Roeselare? Although this is hard to trace, looking back, I can see how the ideas we co-produced, influenced the city's next steps in terms of climate and energy planning in various ways. One year later, in October 2019, I collaborated again with the Roeselare administration and researchers of the '*Open Universiteit*' to organize the 'City-zen Revisit', a three-day event to catalyze breakthrough projects. We decided to focus on some of the key ideas from the energy scenario workshops: collective renovation in the vulnerable neighbourhood of Krottegem, connecting existing housing to the district heating network, the development of a shared heating system for Roeselare's industrial harbour, and the installation of a hydrogen station near the city's waste incineration plant. At this occasion, the focus was less on spatial strategies and more on estimating feasibility and building trust between potential partners. Since then, some of these ideas, such as the hydrogen station, were abandoned, but the city also decided to move forward with the development of a heat zoning and heat transition plan, attempts to set up collective renovation for vulnerable households in Krottegem and explores opportunities to connect existing neighbourhoods to the existing network.

Throughout this action research process, the role of maps and drawings evolved, from collecting and visualizing technical data and local knowledge, contextualizing energy within the territorial structure of Roeselare, to supporting a dialogue between local stakeholders and other experts, facilitating a more systemic perspective on the urban energy system, and representing co-created energy and governance strategies. However, rather than the maps and drawings in themselves, the co-creation moments they facilitated were key to stimulate a dynamic of transformation around Roeselare's energy system and introduced new perspectives on energy transition in the city. The maps, narratives and visual results of this process are included on the following pages of this interlude.

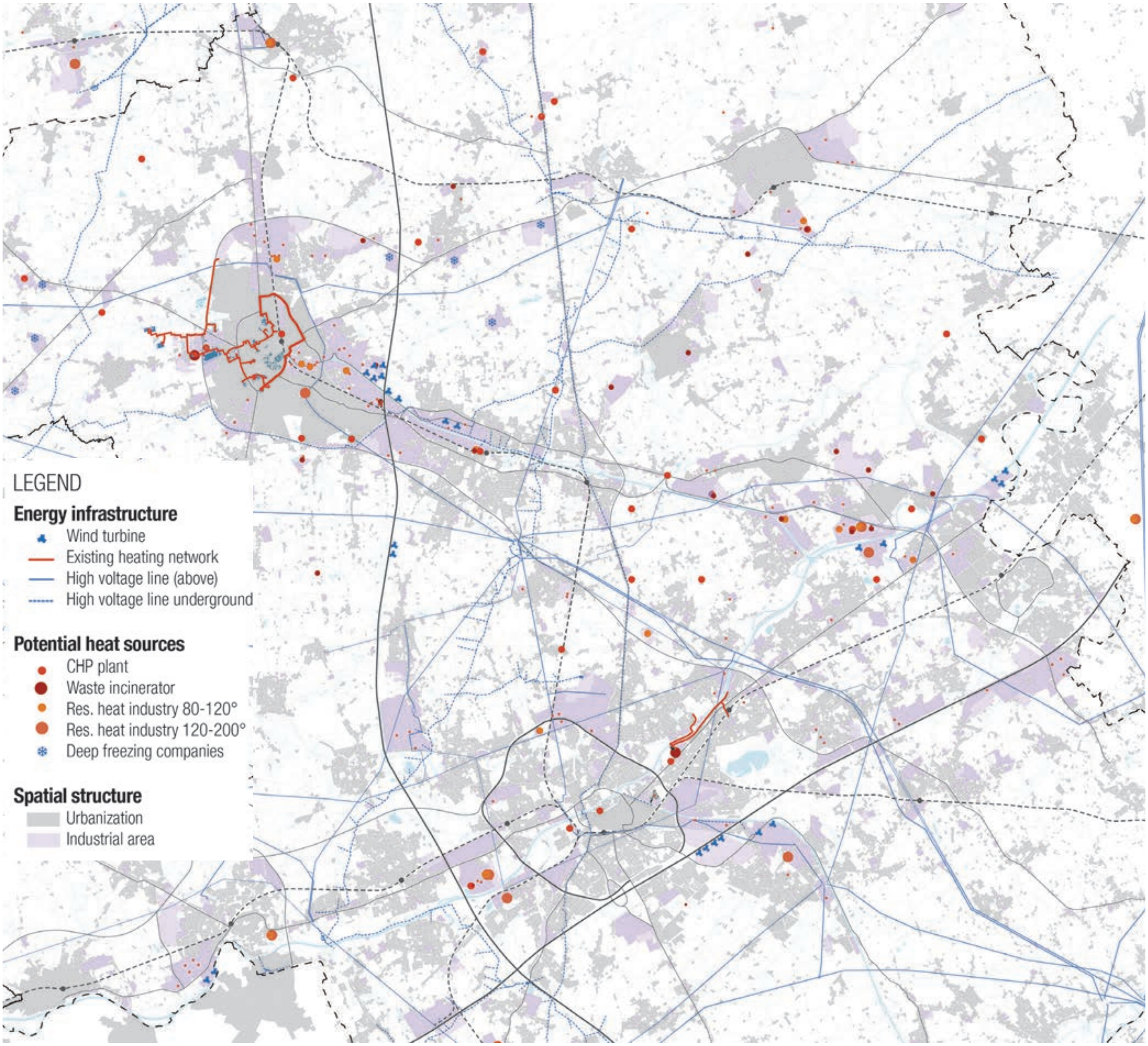


Figure A.5. Regional context: energy infrastructure and urbanization.
Source: author based on GRB, Geopunt.

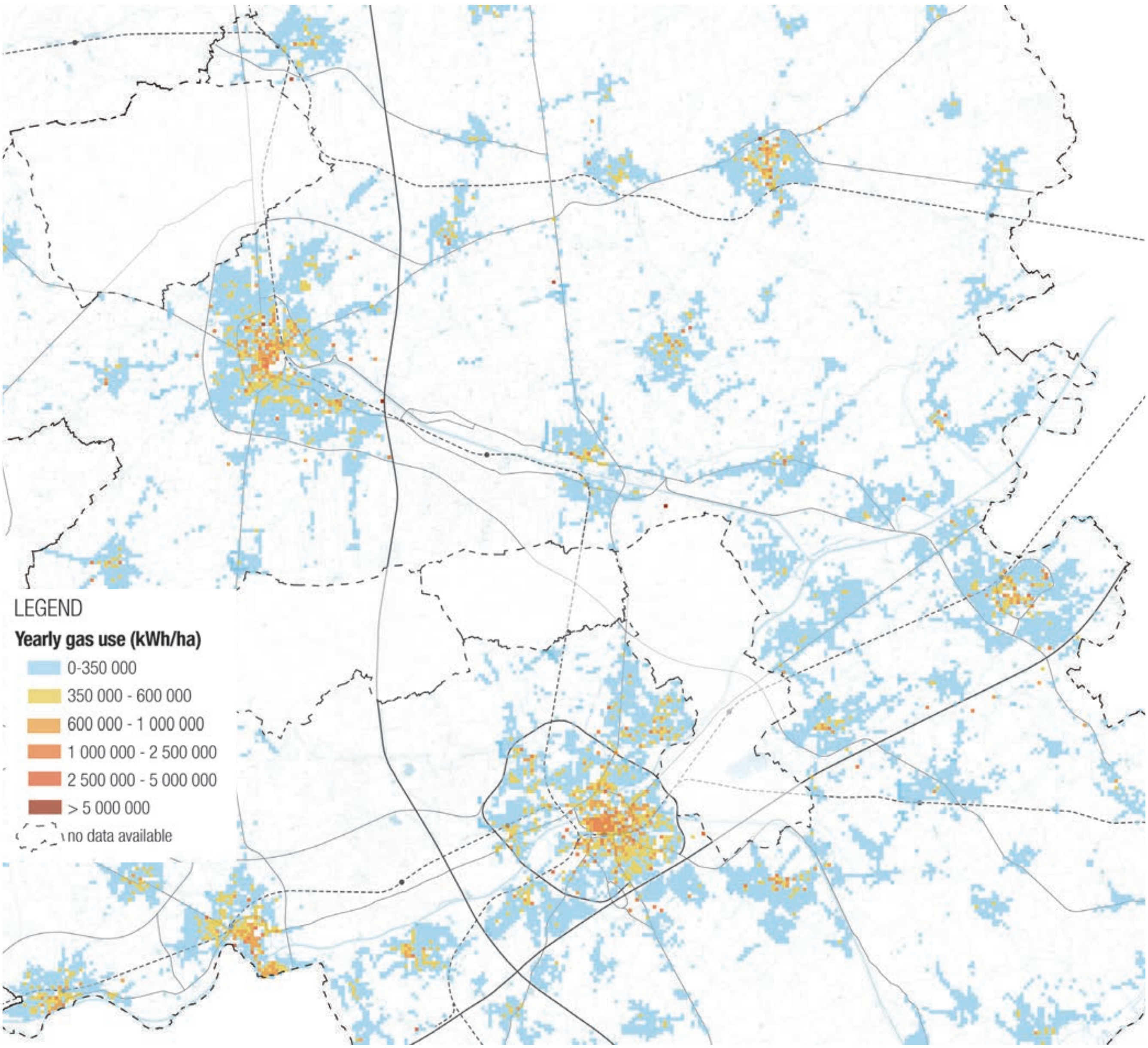


Figure A.6. Regional context: linear heat demand.
Source: author based on Fluvius data.

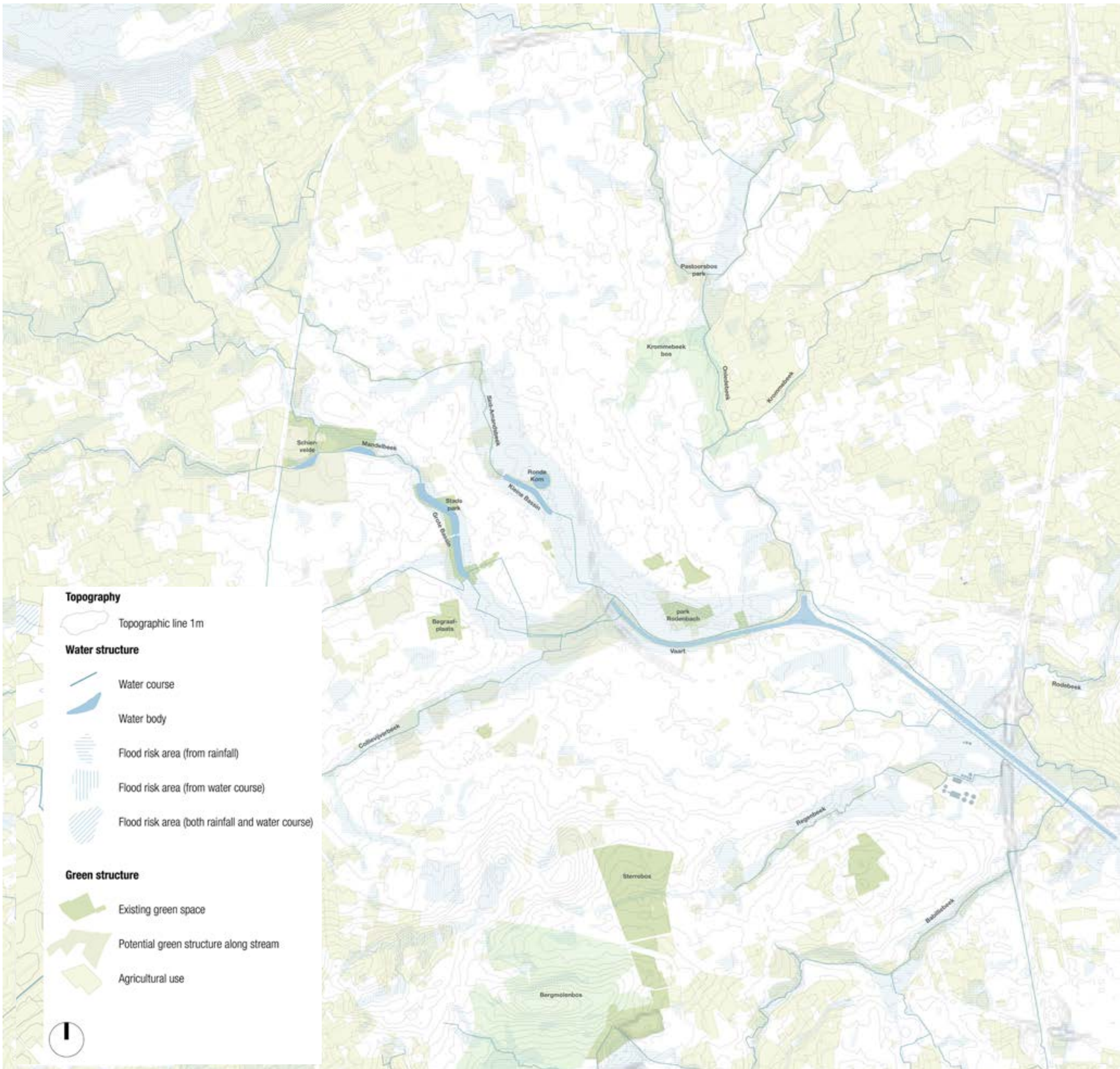


Figure A.7. Existing spatial structure - green-blue networks.
Source: author based on GRB, Geopunt.

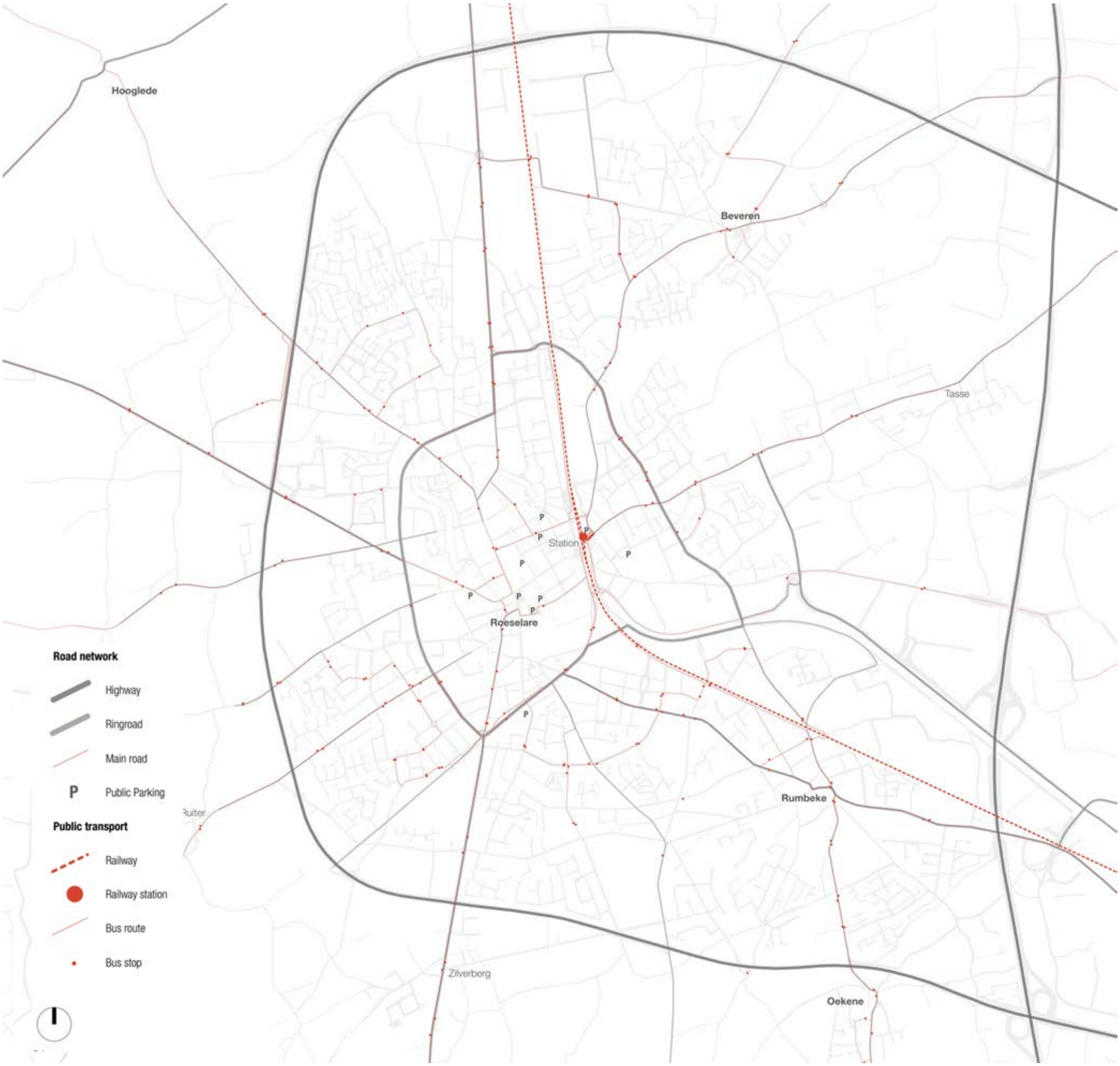


Figure A.8. Existing spatial structure - mobility.
Source: author based on GRB, Geopunt.

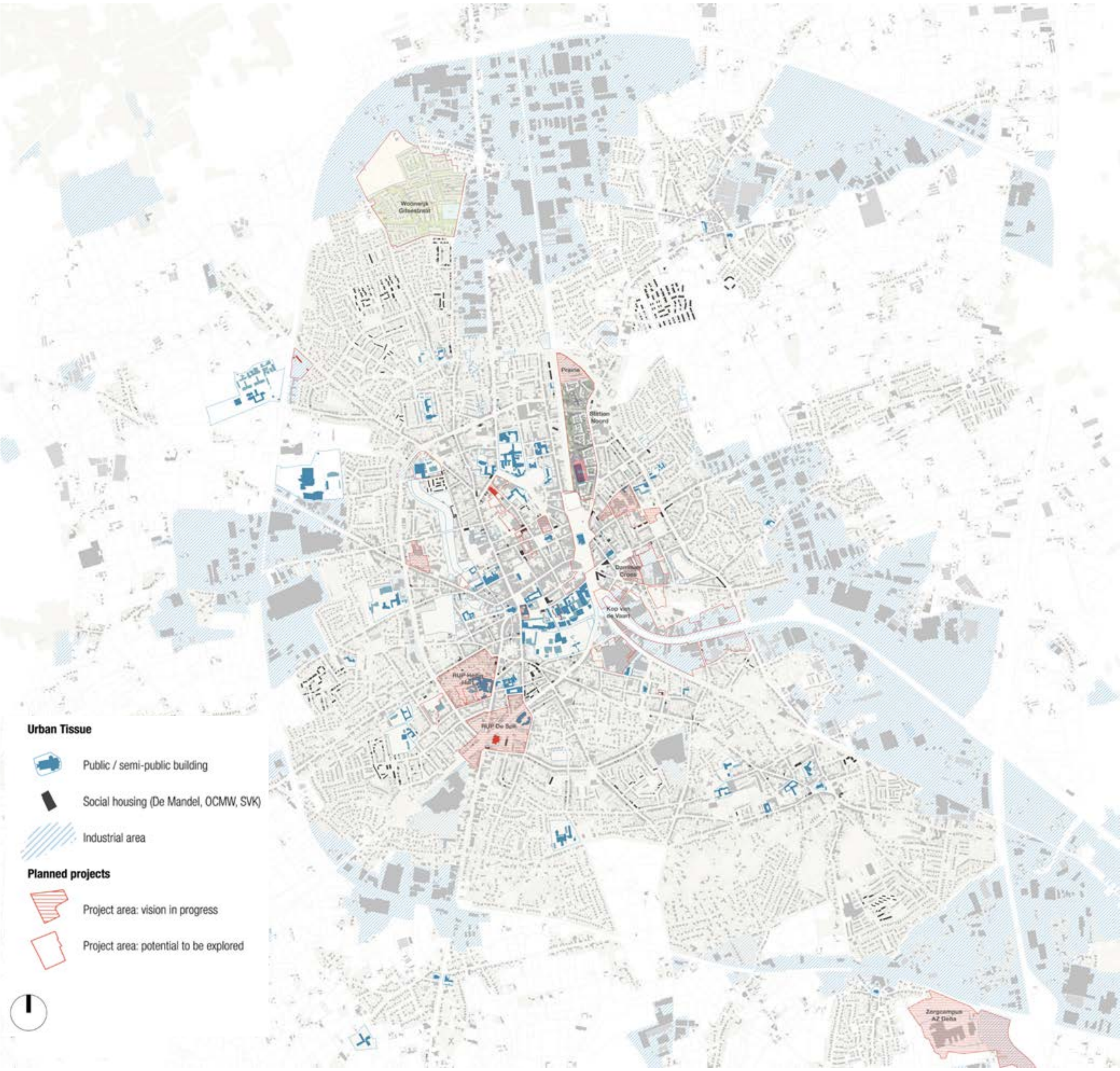


Figure A.9. Existing spatial structure - built tissue.
Source: author based on GRB and interviews.

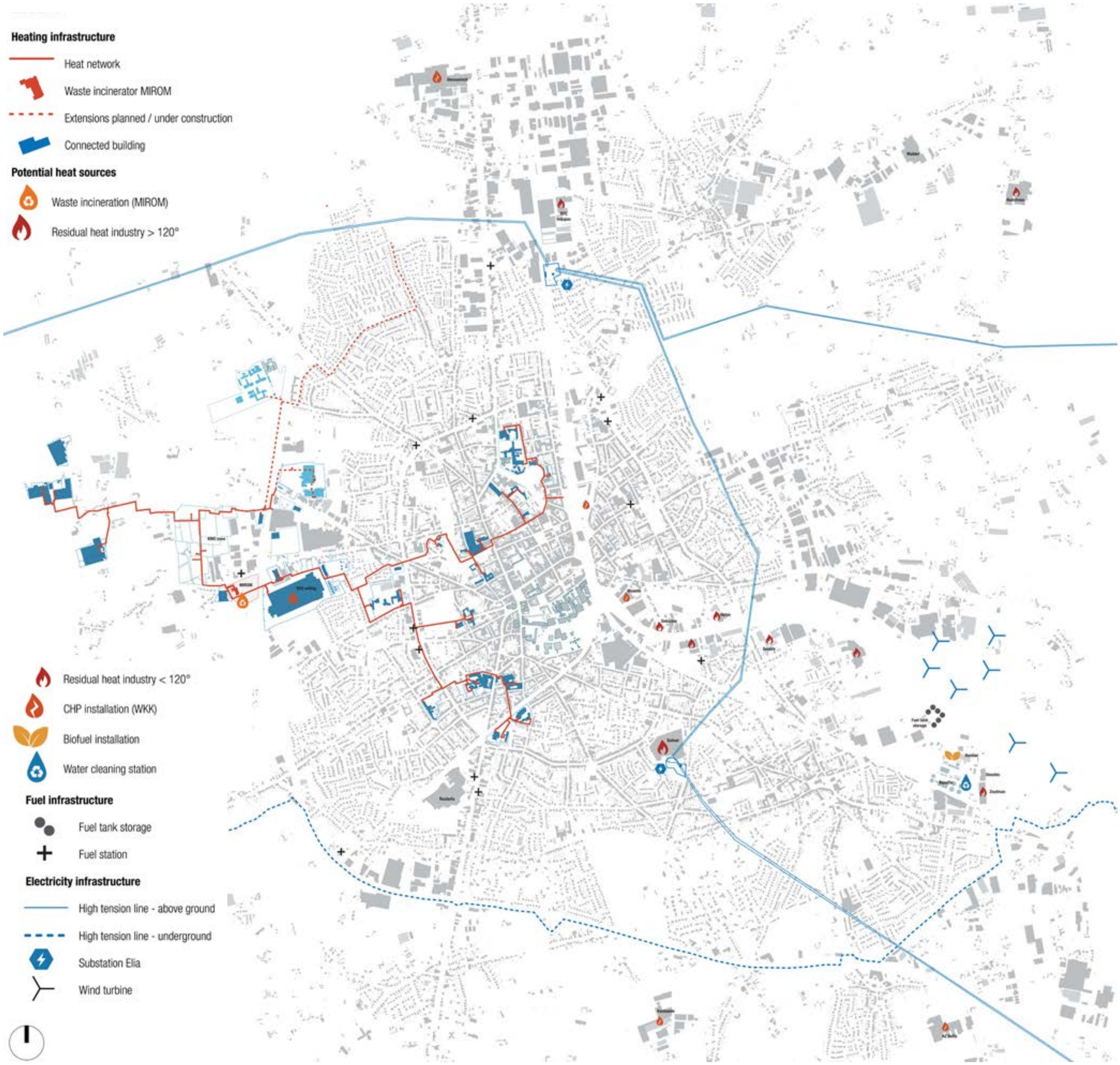


Figure A.10. Existing spatial structure - energy infrastructure.
Source: author based on Geopunt data and interviews.

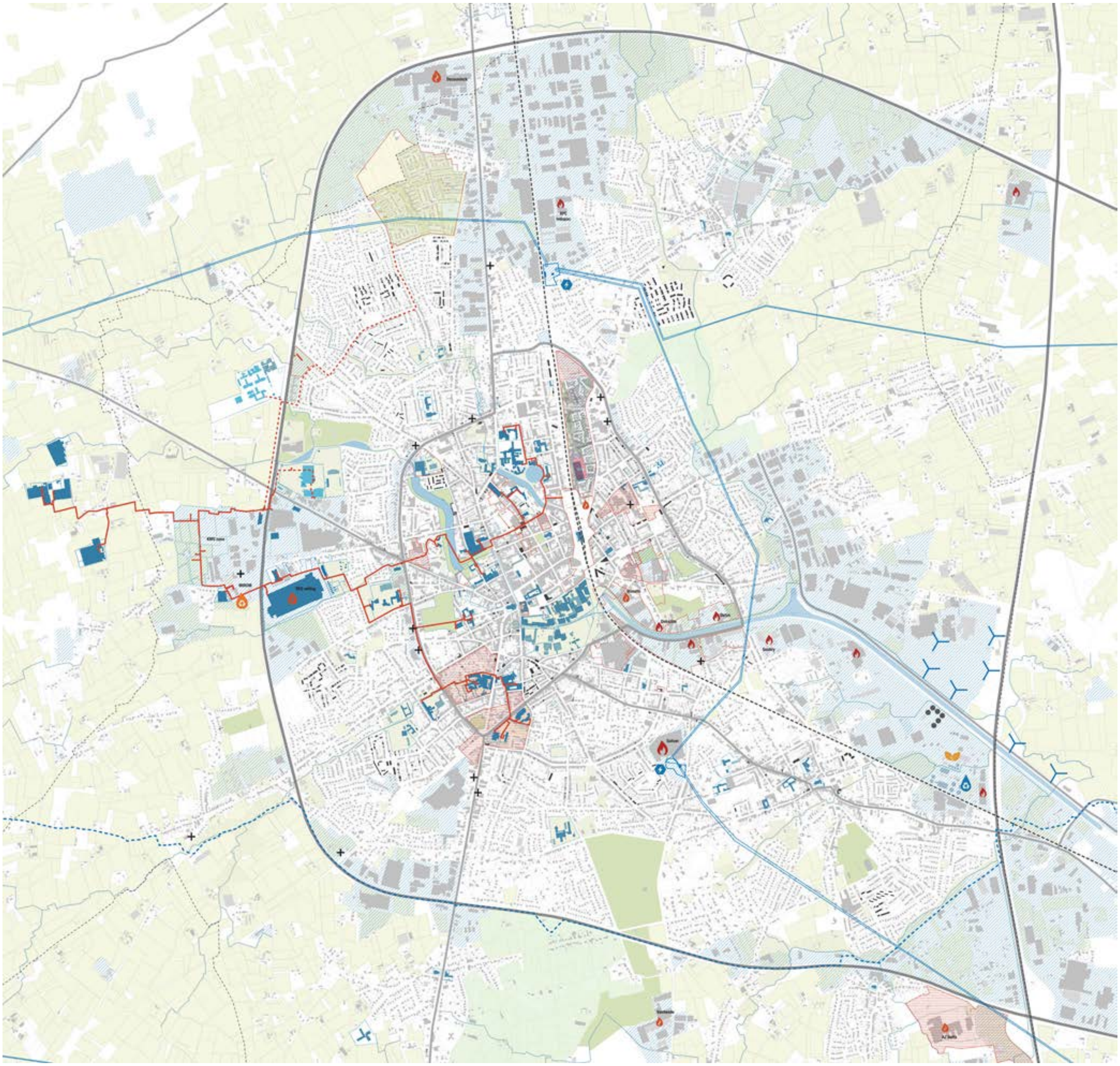


Figure A.11. Synthesis existing situation.
Source: author.

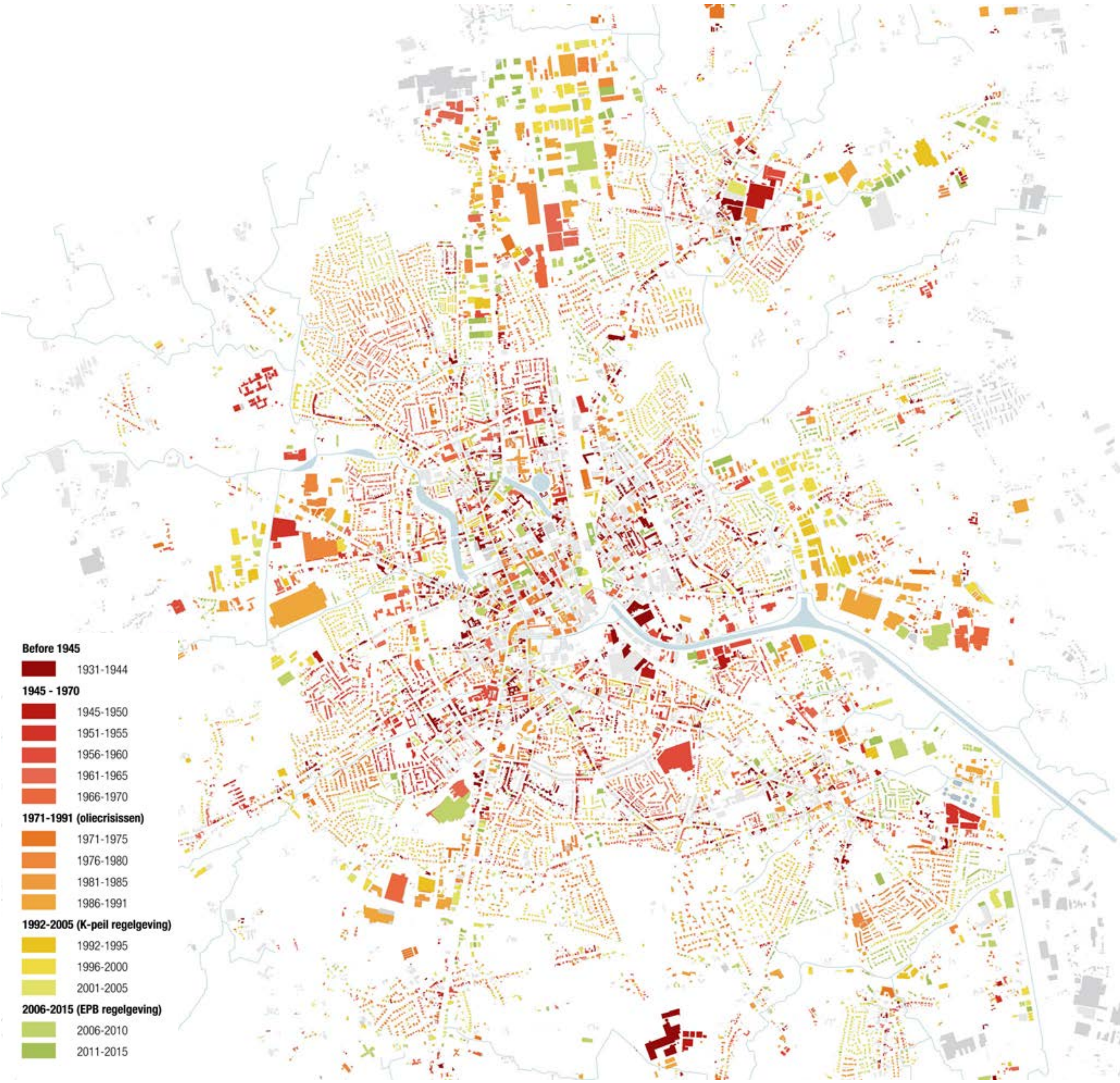


Figure A.12. Existing spatial structure - building age.
Source: author based on municipal data.

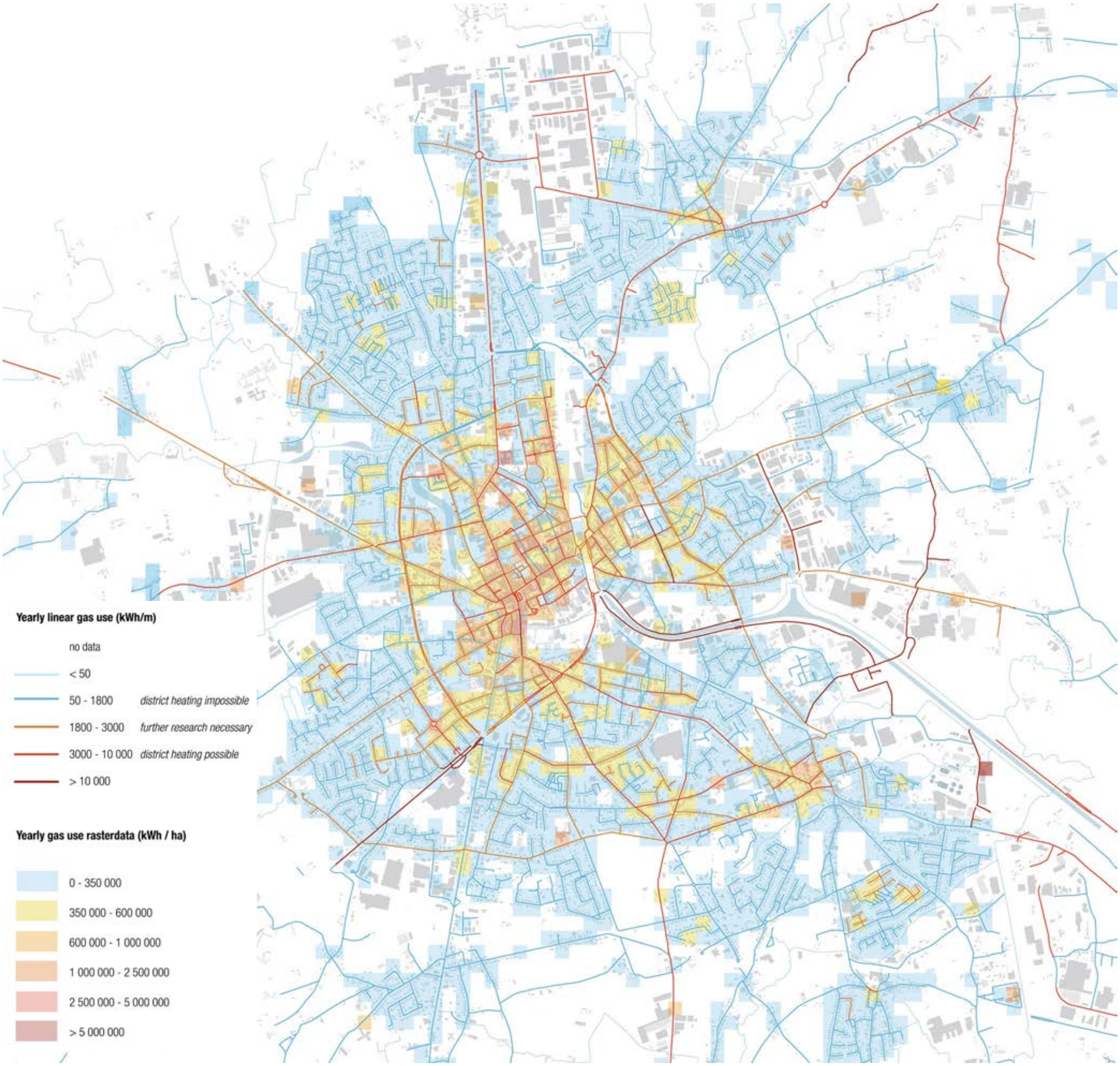


Figure A.13. Existing spatial structure - linear heat demand: current natural gas demand / m.
Source: author based on Fluvius data.

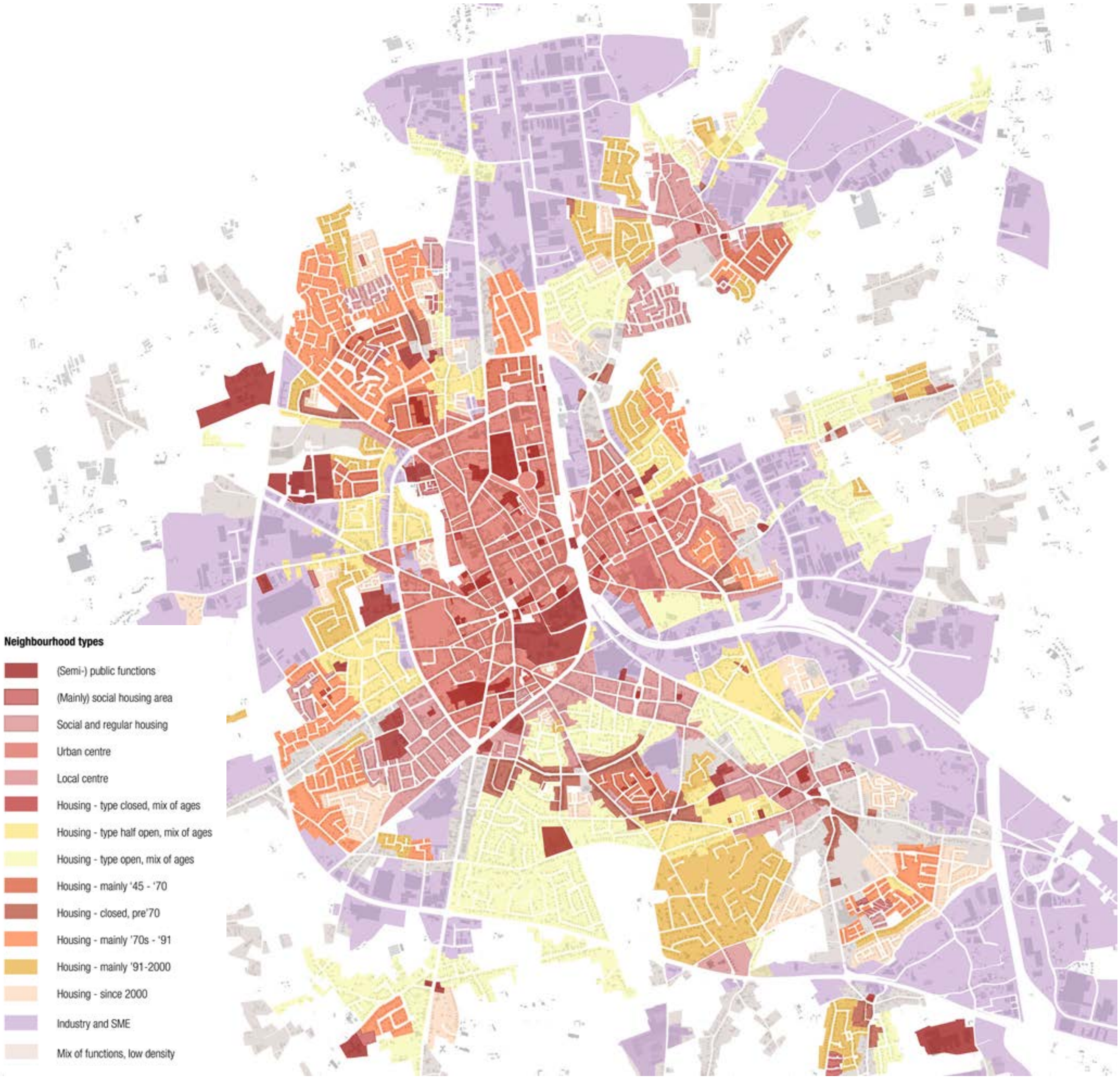


Figure A.14. Existing spatial structure - neighbourhood types.
Source: author based on morphology, function and building age, municipal data.

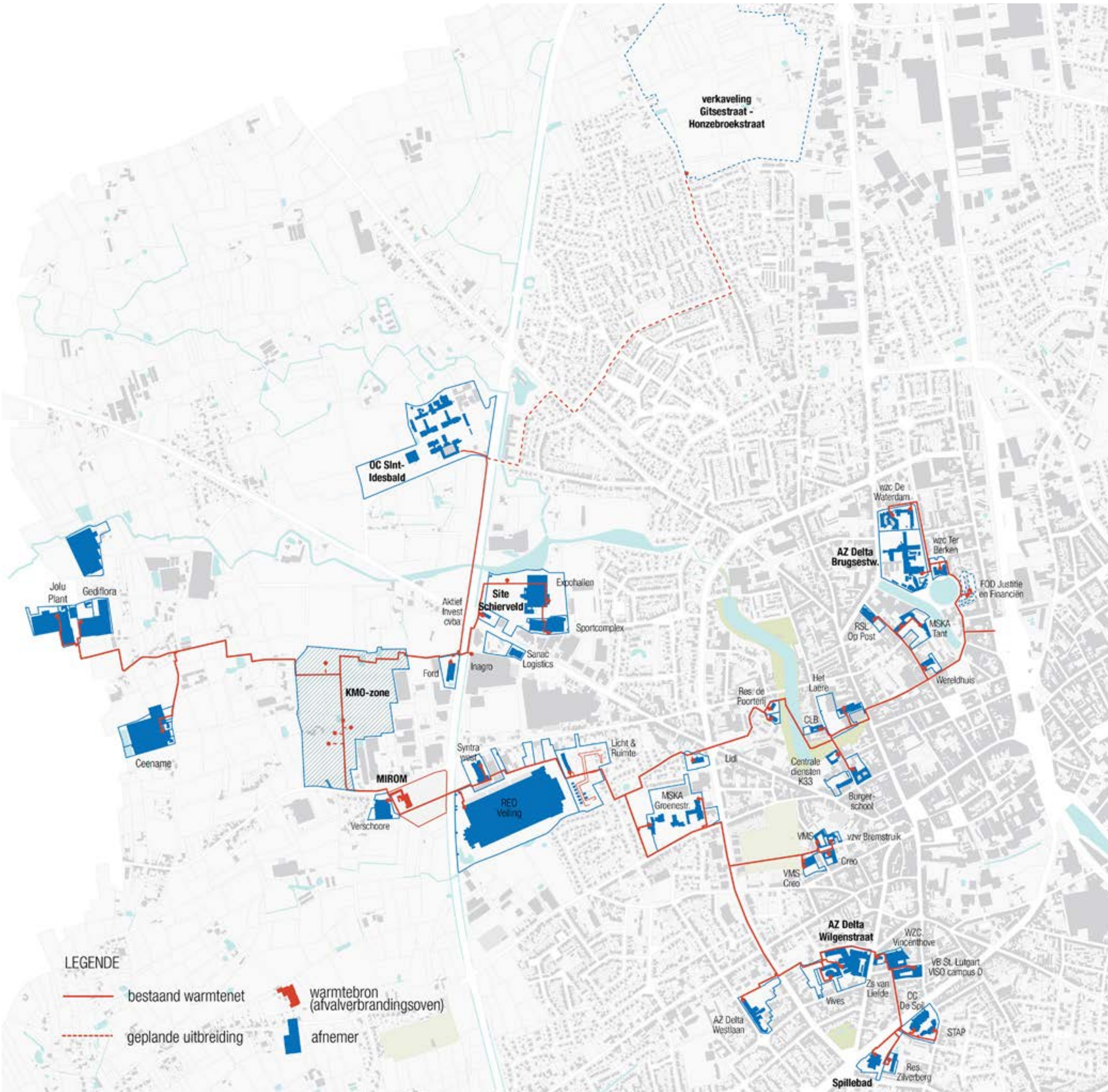


Figure A.15. Existing situation district heating network Roeselare.
Source: author based on MIROM data.

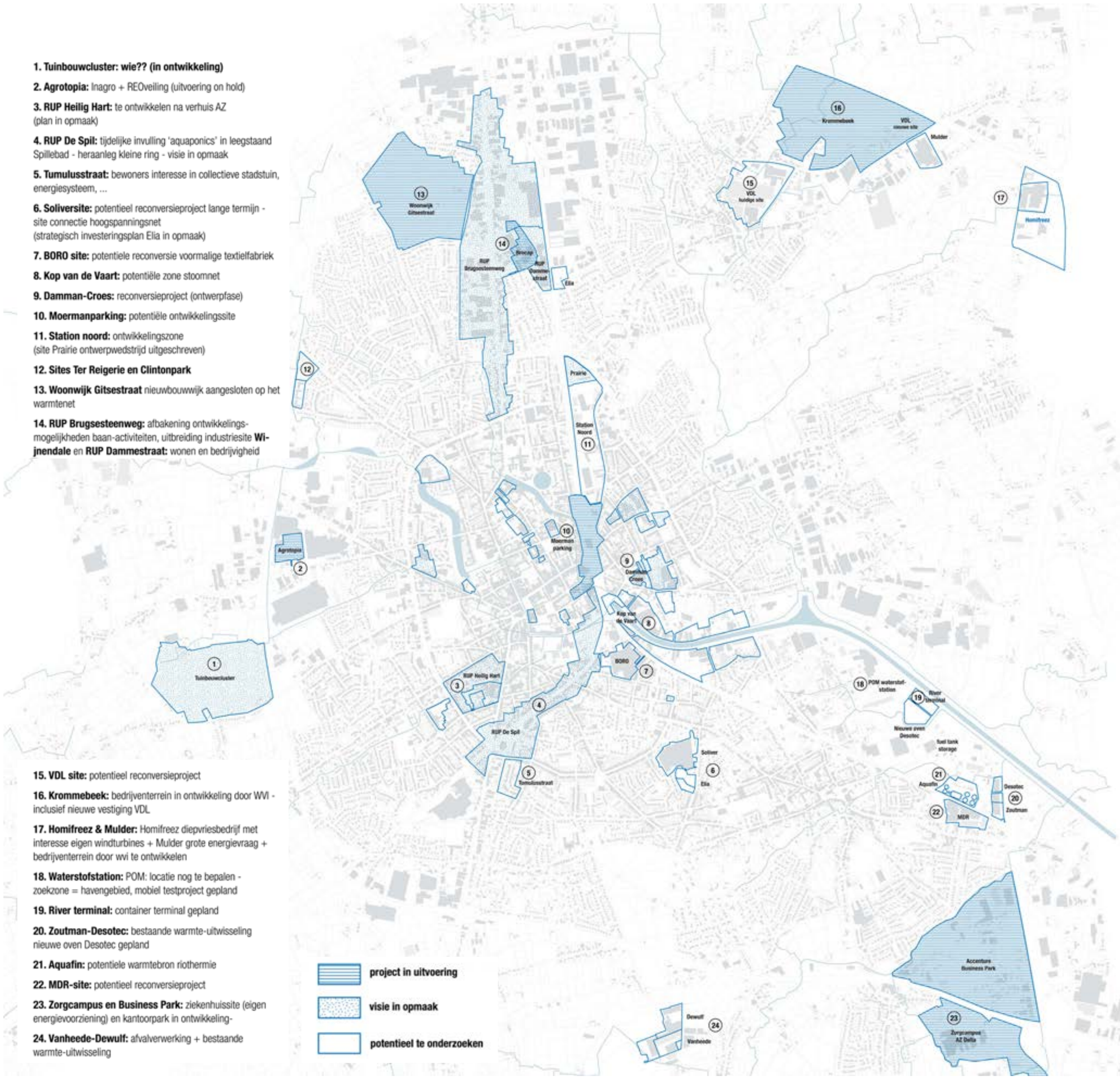


Figure A.16. Planned and potential projects.
Source: author based on interviews.

ENTREPRENEURIAL ROESELARE – HEAT IN LOCAL HANDS

It's 2050... Through sustainable business practices, Roeselare's companies are well-known as frontrunners in their sector. Moreover, all over the city, citizen initiatives have emerged around energy, urban agriculture and water questions, and the urban heat infrastructure is almost entirely in local hands.

Some motivated local industry leaders started a sustainability platform together with Roeselare's citizen cooperative, and initiated the city's transformation. Over the past decades, many innovative initiatives were set up and various strategic sites have undergone radical changes: Agrotopia inspired all sorts of projects on urban agriculture and aquaponics, the Prairie and Damman-Croes grew into pilot projects for sustainable heat applications, the AZ Delta site became a testing ground for collective housing typologies, the city's first Virtual Power Plant emerged at Schiervelde, and the Kop van de Vaart became a cluster for circular food industry. Innovative energy services and technologies such as blockchain are used to automatically optimize the energy use of entrepreneurs and residents. A shared energy system and ecological urban garden developed by the inhabitants of Tumulus Street inspired other groups of residents to get started themselves.

The citizen cooperative invested heavily in the heat network and developed it in a pragmatic way. They also built collective energy production and storage systems, and supervise structural building block renovations.

Urban development is project-based and mainly concentrated around the poles of transformation. But some locations prove less interesting for investment and have hardly changed at all. Some of the changes are hard to follow for some inhabitants, and not everyone is on board with the collective approach. Moreover, the urban administration does facilitate new initiatives, for example, by providing a citizens' budget every year, but on the other hand, it has also phased out many of its public services. As a result, the bottom-up developments do not have a clear framework and some groups fall by the wayside.

Figure A.17. Scenario narratives [translated from original Dutch version].
Source: Author based on scenario workshop and conversation with RSL administration.

STRONG URBAN REGION – DISTRICT HEATING AS STRATEGIC CATALYST

It's 2050... and you would hardly recognize Roeselare! Because of its strong urban policies, the city has become a leader in the field of energy and sustainability.

Roeselare developed an energy strategy at the city level that formed the framework for new urban development projects, citizen initiatives and entrepreneurship. The city also set up a strong collaboration with the other municipalities in the region.

The city started its own public sustainability company that, among other things, invested in local energy production and storage. It also drew up a tailored energy strategy for each neighbourhood. The local heat network was strategically expanded as a carrier for sustainable densification projects, and supplemented by individual heating solutions in the urban fringe. A few years ago, the district heating network was finally connected to the regional backbone that connects Roeselare to the region of Kortrijk. For the production of wind energy, the most appropriate locations were selected together with the surrounding municipalities. Business parks were transformed into central links in the energy system: business clusters are now developed on the basis of their energy profile and supply energy to the heat network and the surrounding neighbourhood.

More space was created for the many creeks that cross the city, their valleys now form the basis for a resilient blue-green structure. The increase in built-up space was halted and the population growth was absorbed by smart densification in the urban fringe. People move around mainly by bicycle or use the high-quality public transport system.

However, the city's strict framework did not offer much room for bottom-up initiatives. There was quite some resistance to the most radical measures and not all residents and entrepreneurs were easy to convince. Moreover, the heavy investments weighed on the city budget and the municipal tax had to be increased. Nevertheless, Roeselare's sustainable image also appeals to new residents, and the city's air quality and local water system are clearly improving.

HITTING THE BRAKES – CONTINUING WITH NUCLEAR ENERGY AND NATURAL GAS

It's 2050... and at first glance Roeselare is not that different from 2018. Resistance to sustainable change turned out to be very high among citizens, industry and politicians, and people put their trust in technological solutions for the climate problem.

The government's sustainability ambitions were repeatedly downgraded. The implementation of the Climate + Plan ran into difficulties because the city did not invest in the expansion of the climate team.

The nuclear phase-out was postponed, slowing down the large-scale application of wind and solar. But ongoing technical problems with the nuclear power plants required heavy investments that were reflected in the price of electricity. For this reason, energy was also imported from neighbouring countries and Scandinavia. Research focused on technologies that can reduce the environmental impact of fossil fuels. The existing gas grid was further optimized and sales of gas boilers continue to increase until today. Here and there, green and synthetic gas is mixed into the network. The MIROM district heating network is also running at full capacity now, as waste flows continued to increase.

The sustainable ambitions of the key urban projects of the 2020s eventually became missed opportunities because bold choices were not made for fear of lack of public support. Public transport continued to be dismantled and the individual car remains the dominant mode of transport.

But repeated power cuts, increasing traffic jams, poor air quality, and recurring floods and droughts strongly impact daily life in Roeselare. The agricultural sector struggles immensely, while the competitiveness of local industry declined due to the financial burden of energy imports and a lack of innovation. The brain drain persisted, the city's population growth came to a halt a while ago, and meanwhile more and more buildings are remaining vacant.

EVERYONE ENERGY NEUTRAL – EVERYTHING EVERYWHERE

It's 2050... and many buildings in Roeselare have been transformed into smart energy plants.

Thanks to a thorough subsidy- and tax policy from Flanders, every home owner, company, school or organization was encouraged to invest in energy efficiency and production. The city's smart energy office became a central hub to provide knowledge and coordinate local measures.

Almost every building now has a low heat demand, is equipped with the most efficient appliances and lighting, and is heated with a heat pump, solar water heater, or through a connection to a heat grid. Smart meters and home batteries have become standard. More and more public buildings, companies and new housing estates connected to the heat network, and thanks to subsidies, here and there some existing housing units as well. Nevertheless, both heating and mobility were strongly electrified. This electricity is produced locally by the solar cells on every roof, or imported from offshore wind farms.

Because urbanization continues to increase plot by plot, there is indeed no space available anymore in the regional landscape for wind turbines. Subsidies have also been used to renovate rural homes and suburban villas, sometimes dividing them into multiple housing units. Energy-neutral neighbourhoods and sites for circular industry further filled up the space within Roeselare's ring road. Although self-driving electric cars have become the norm, traffic jams abound. Charging stations and smart monitoring have have become an integral part of the streetscape.

The costs of energy supply and dispersed urbanization continue to weigh on the Flemish and local budgets. Nevertheless, progress was made in terms of energy savings and efficiency. Because of the policy focus on specific target groups, families in energy poverty, tenants, apartment dwellers and entrepreneurs have also made great strides towards sustainability. But by tackling everything on an individual level, opportunities were missed to realize more structural urban change.

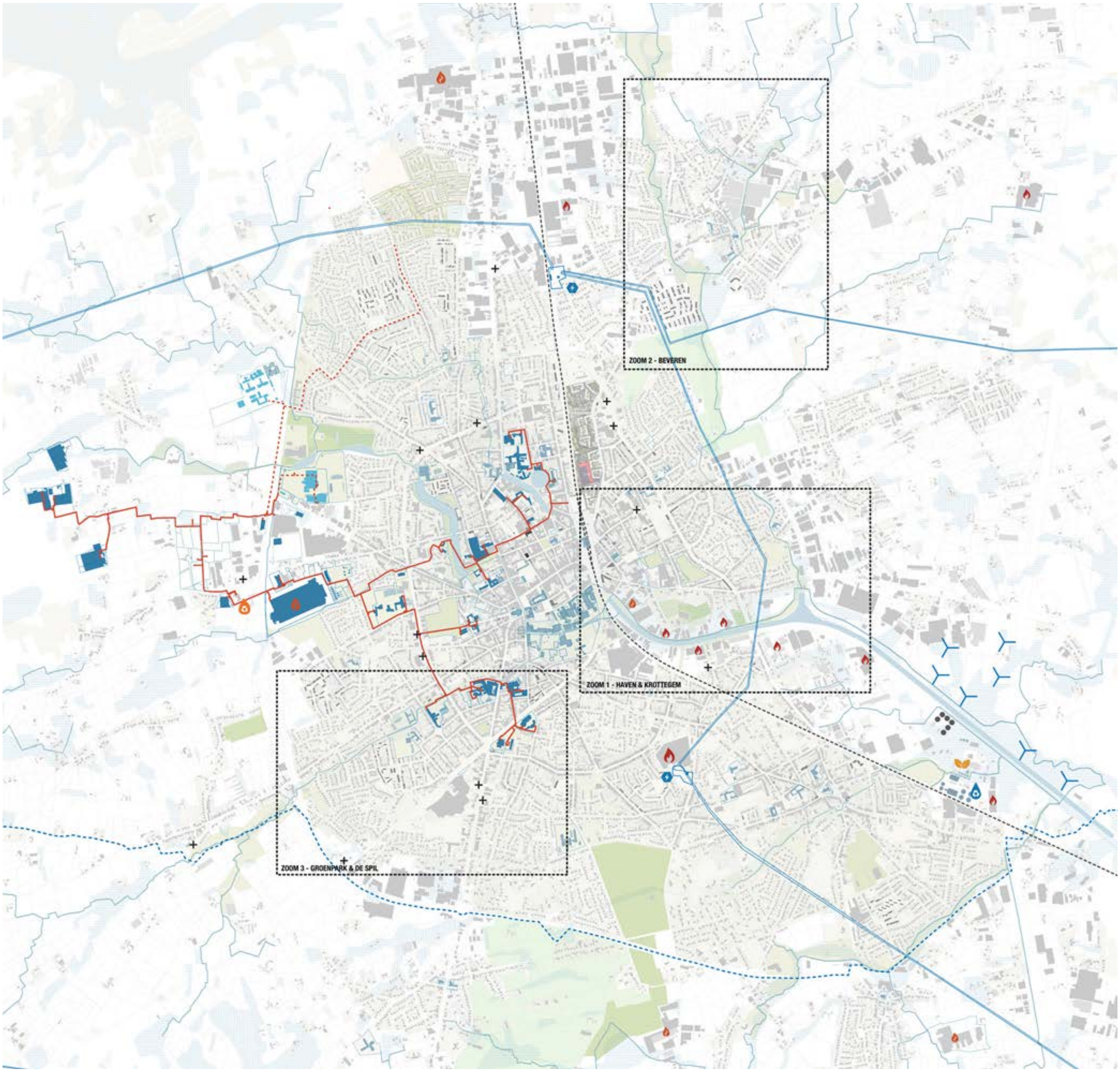


Figure A.18. Location of the three 'design zooms': 'Haven-Krottegem', 'Groenpark-De Spil', 'Beveren'. Source: author.

Figure A.19. Base maps for design zooms.
Source: author based on Google maps, Geopunt, municipal data.

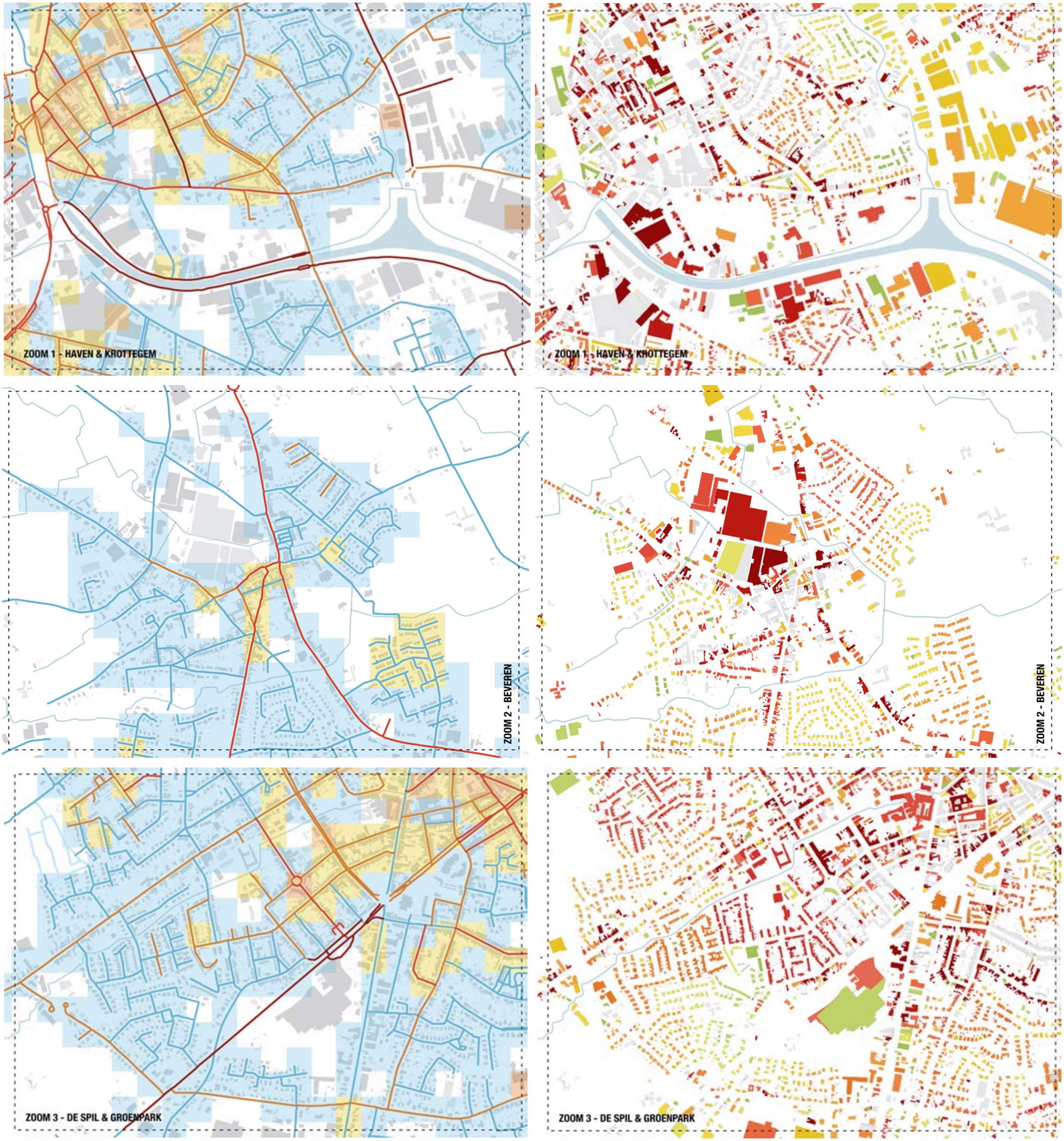

ZOOM 1 - HAVEN & KROTTEGEM
ZOOM 1 - HAVEN & KROTTEGEM
ZOOM 2 - BEVEREN
ZOOM 2 - BEVEREN
ZOOM 3 - DE SPIL & GROENPARK
ZOOM 3 - DE SPIL & GROENPARK

Figure A.20. Possible structure for a 'district heating backbone'.
Source: author based on workshops.

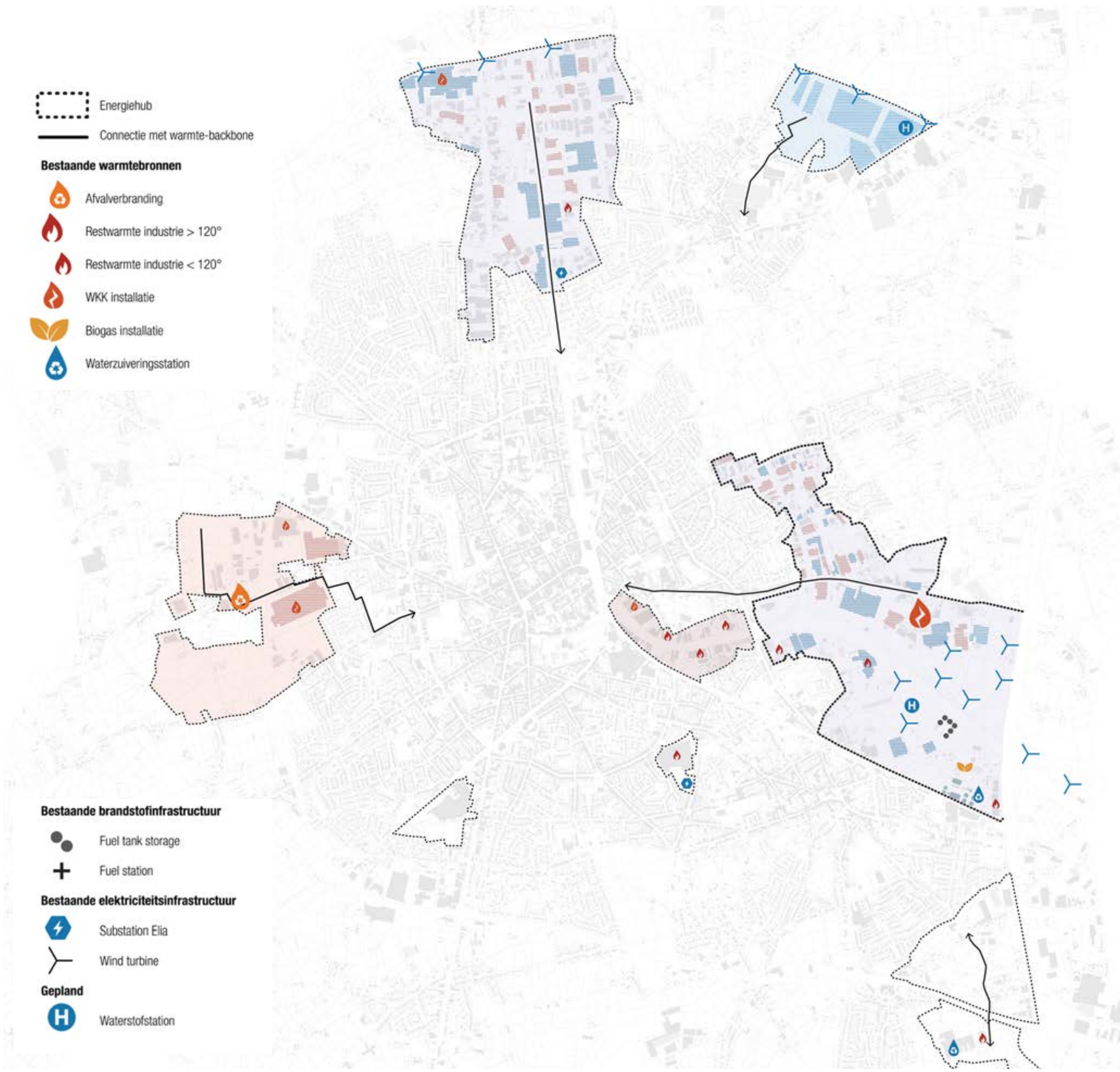


Figure A.21. Industrial areas as 'energy hubs'.
Source: author based on workshops.

Figure A.22. District heating backbone in relation to planned urban projects.
Source: author based on interviews and workshops.

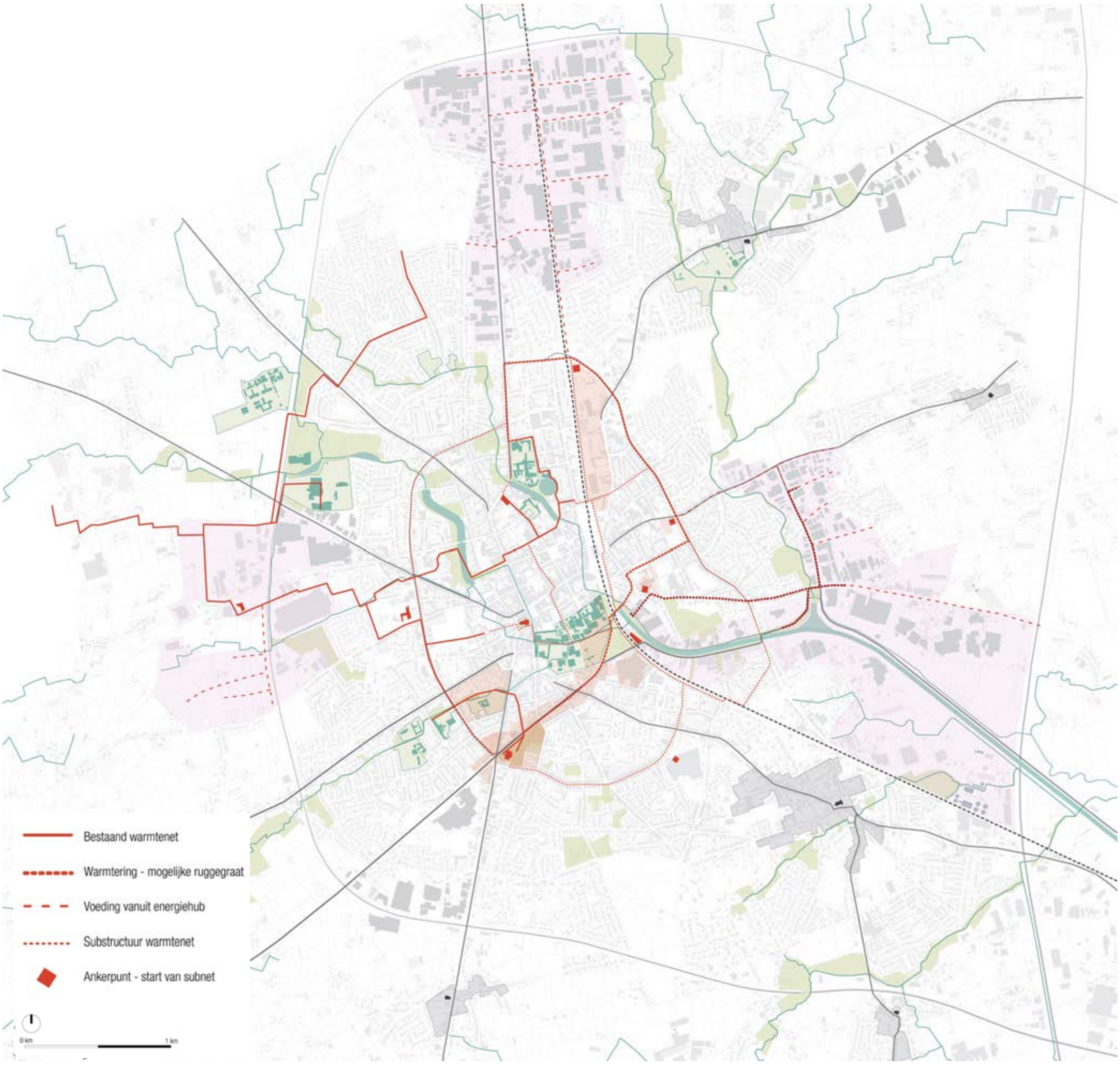
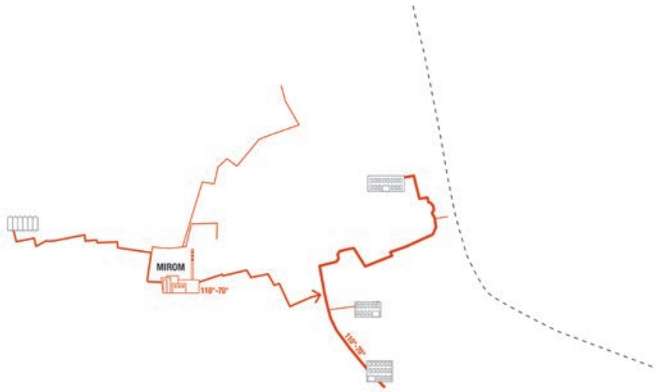


Figure A.23. The district heating network as backbone for strategic urban projects.
Source: author based on workshops.

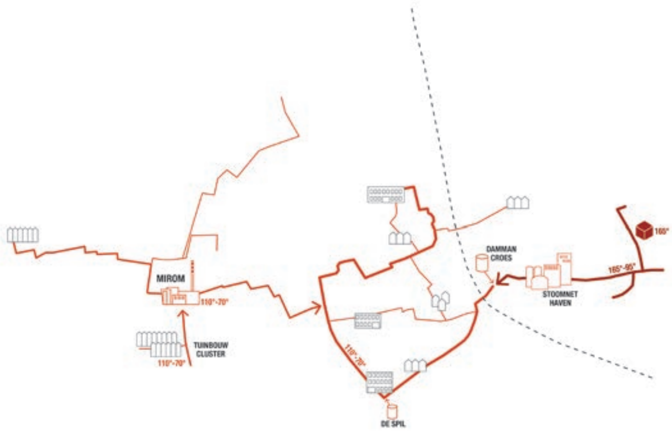


PHASE 0

Existing situation: MIROM waste incinerator as heating source - network serves public buildings, high heat-demand activities and new residential development.

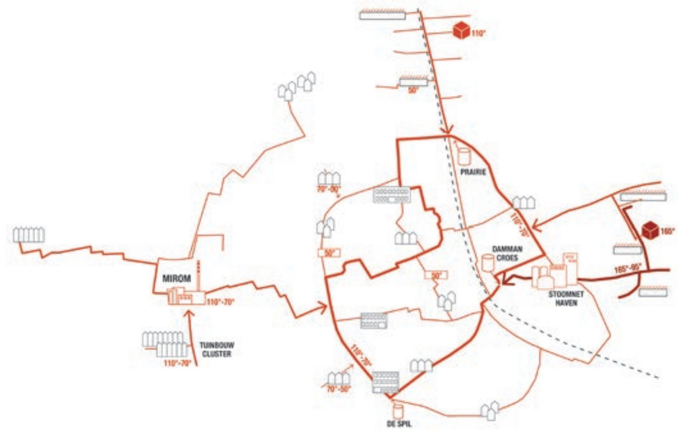
PHASE 1

Extension of the network, with pilot projects to connect existing housing and integrate heat storage. Connection of horticulture cluster and reuse of return heat as heating source. New activities can connect until Mirom maximum capacity is reached.



PHASE 2

Extension of the network into harbour and Krottegem areas. Connecting new heat sources (residual heat from industry) and reducing heat demand by improving efficiency of existing users and creating heat cascades.



PHASE 3

Conclude heat 'ring' and connect heat production at industrial areas in the urban fringe. Connecting renovated neighbourhoods on return pipe and lower-temperature heat sources (solar collectors, residual heat supermarkets).

Figure A.24. Possible phasing for the extension of the district heating system.
Source: author based on workshops.

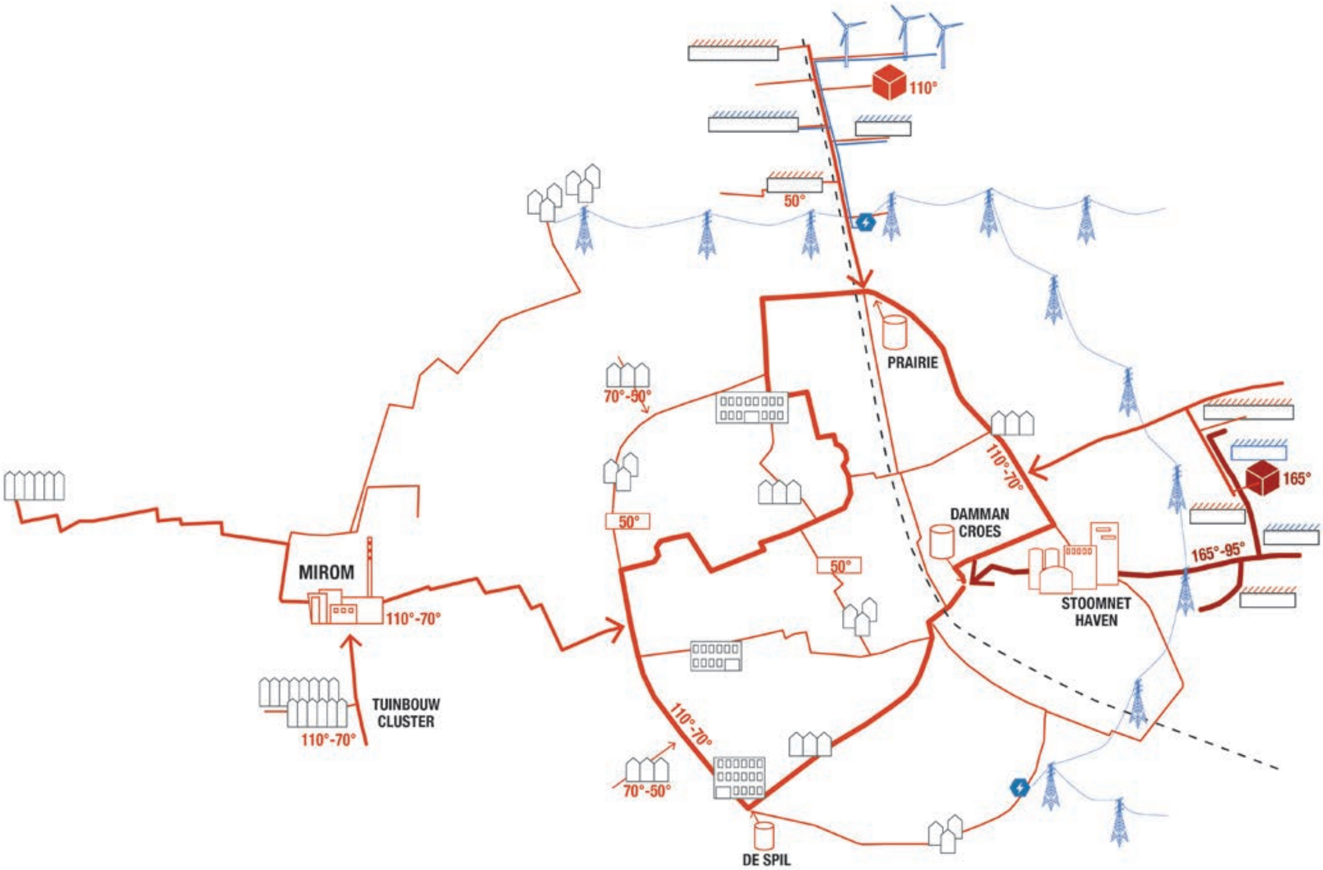


Figure A.25. Long-term heating strategy, indicating different temperature regimes and connection points with high-voltage electricity grid.
Source: author based on workshops.

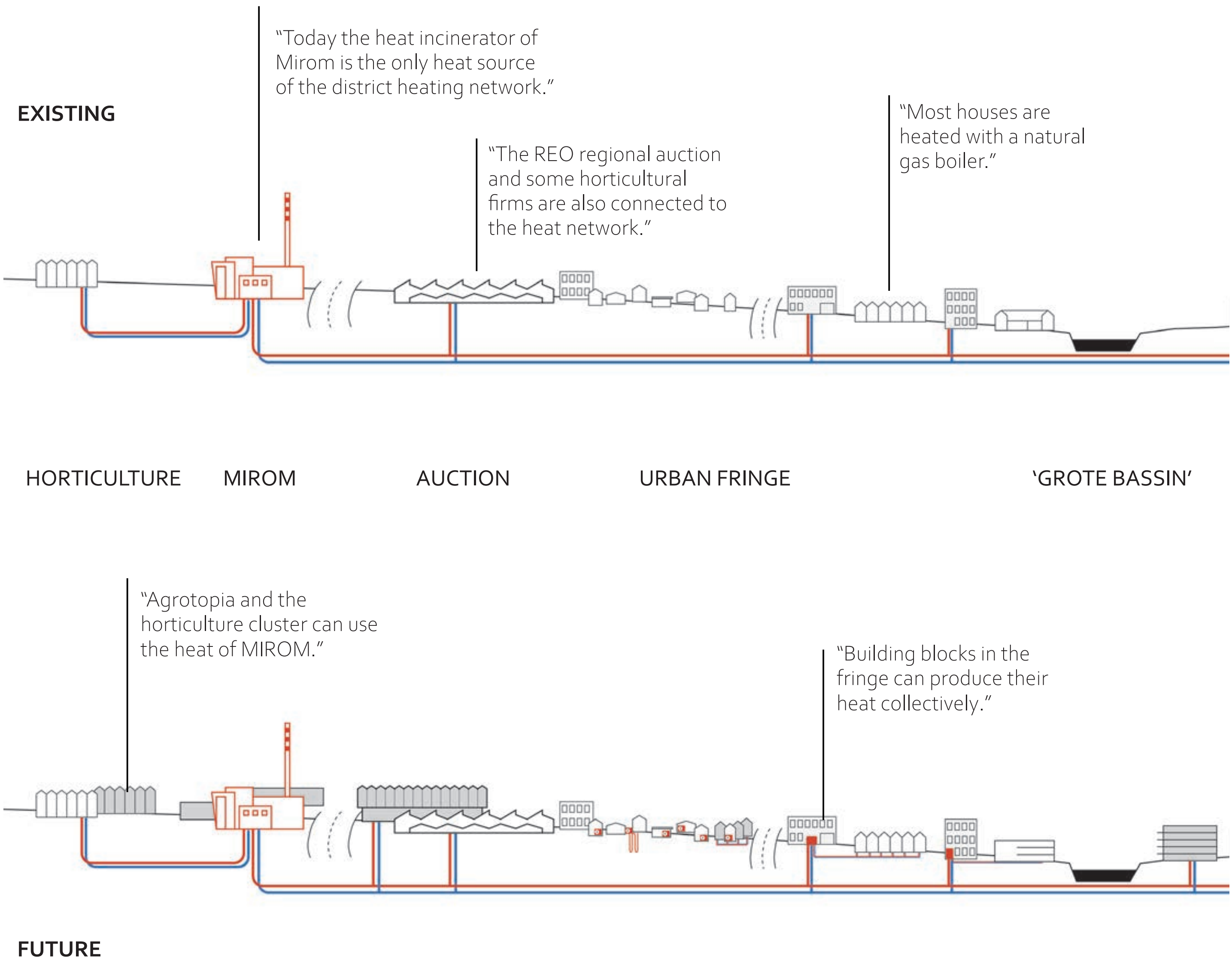
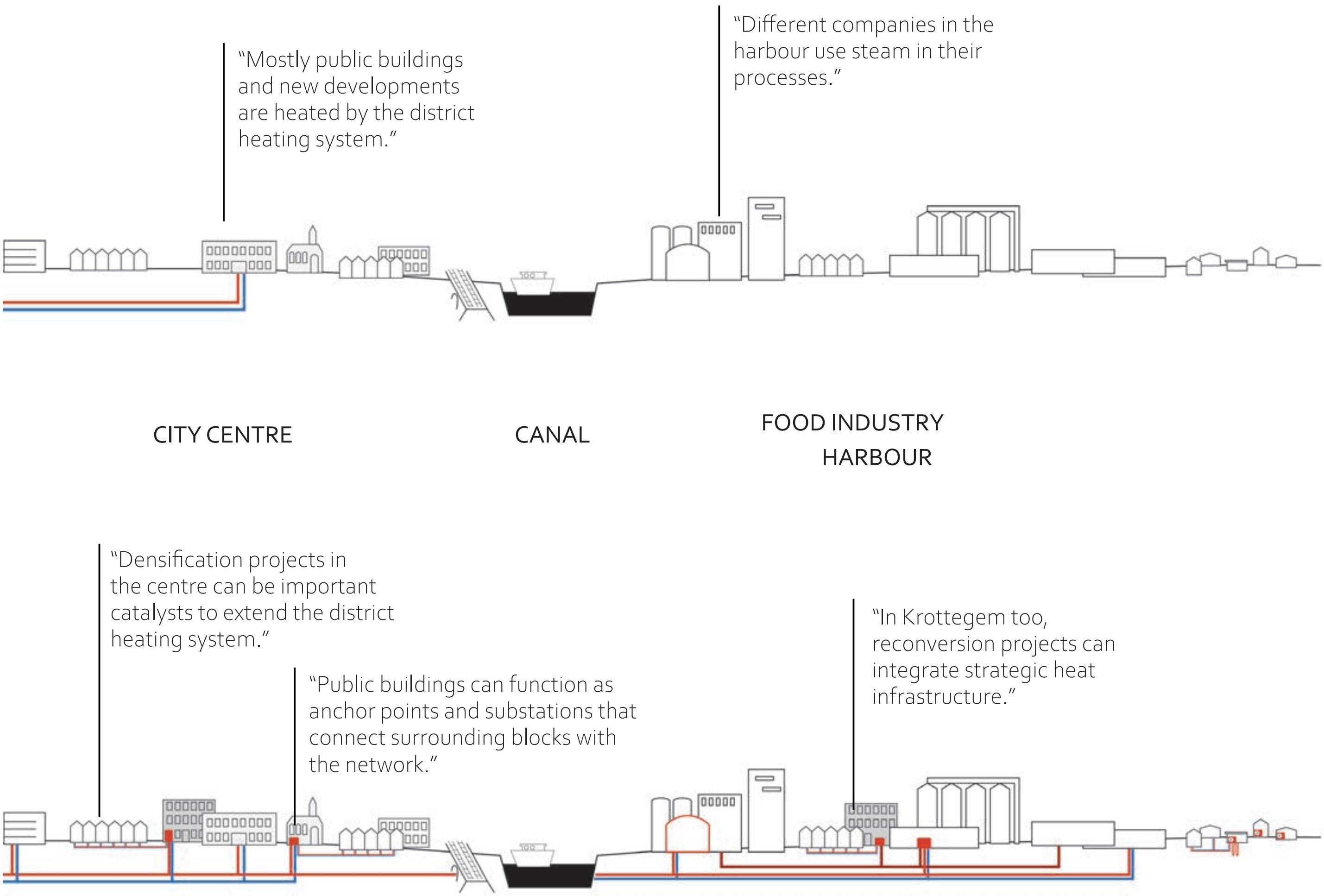


Figure A.26. Existing situation (top) and possible heating solutions for different parts of Roeselare (bottom). Source: author based on workshops.


"Mostly public buildings and new developments are heated by the district heating system."
"Different companies in the harbour use steam in their processes."
CITY CENTRE
CANAL
FOOD INDUSTRY
HARBOUR
"Densification projects in the centre can be important catalysts to extend the district heating system."
"Public buildings can function as anchor points and substations that connect surrounding blocks with the network."
"In Krottegem too, reconversion projects can integrate strategic heat infrastructure."

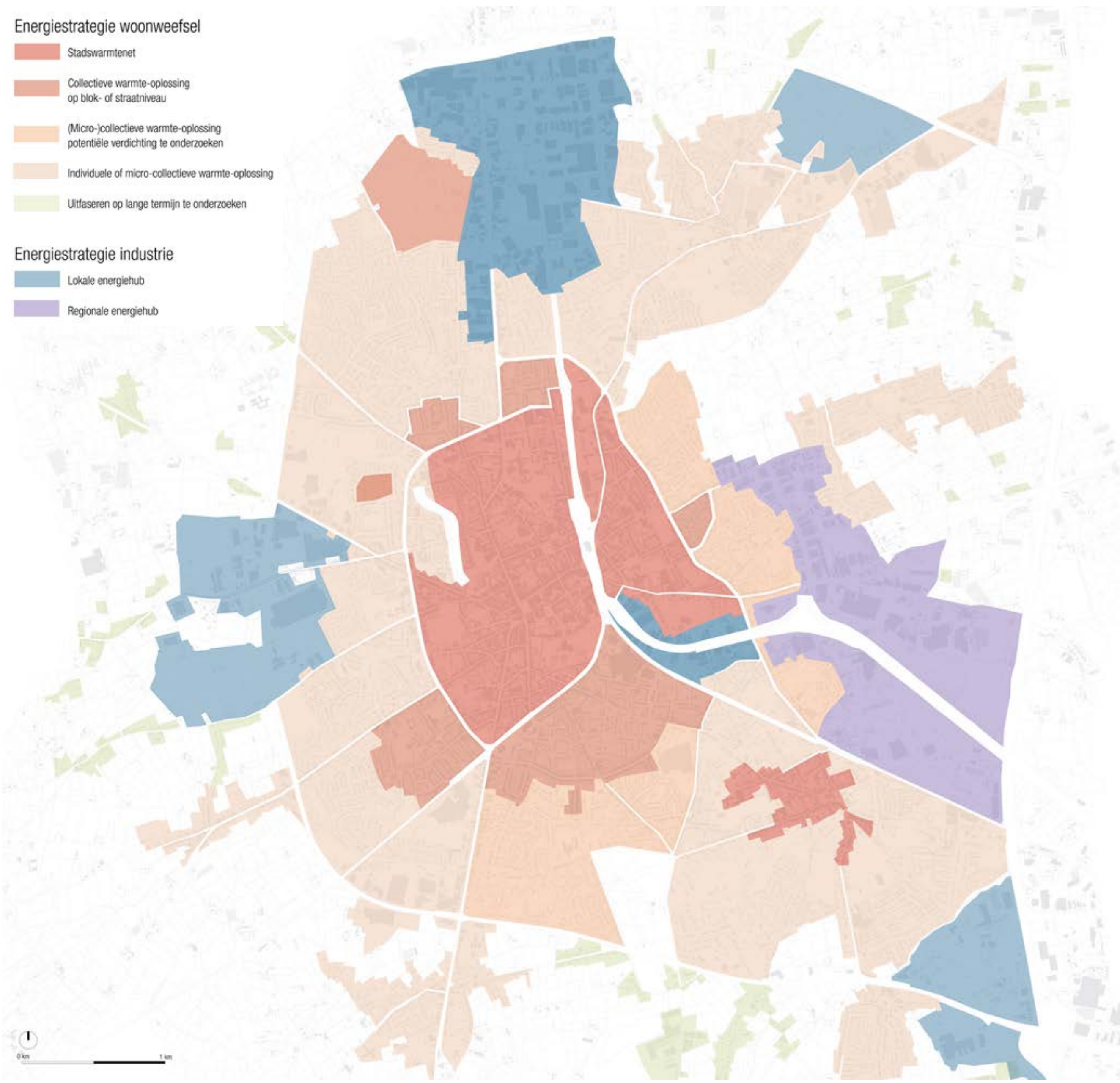


Figure A.27. Typology of neighbourhood types and heating strategy.
Source: author based on municipal data, study Kelvin Solutions, own interpretation.

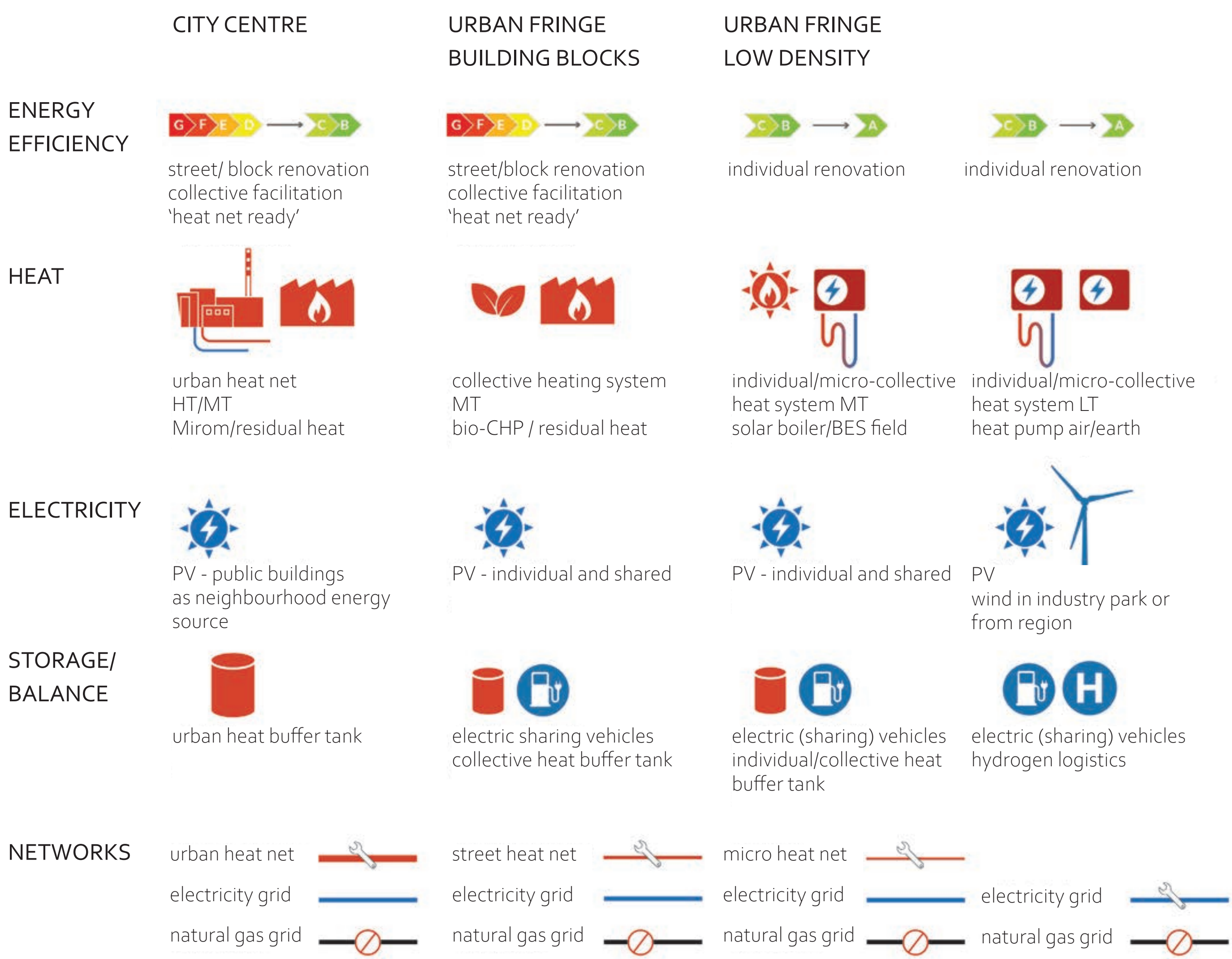
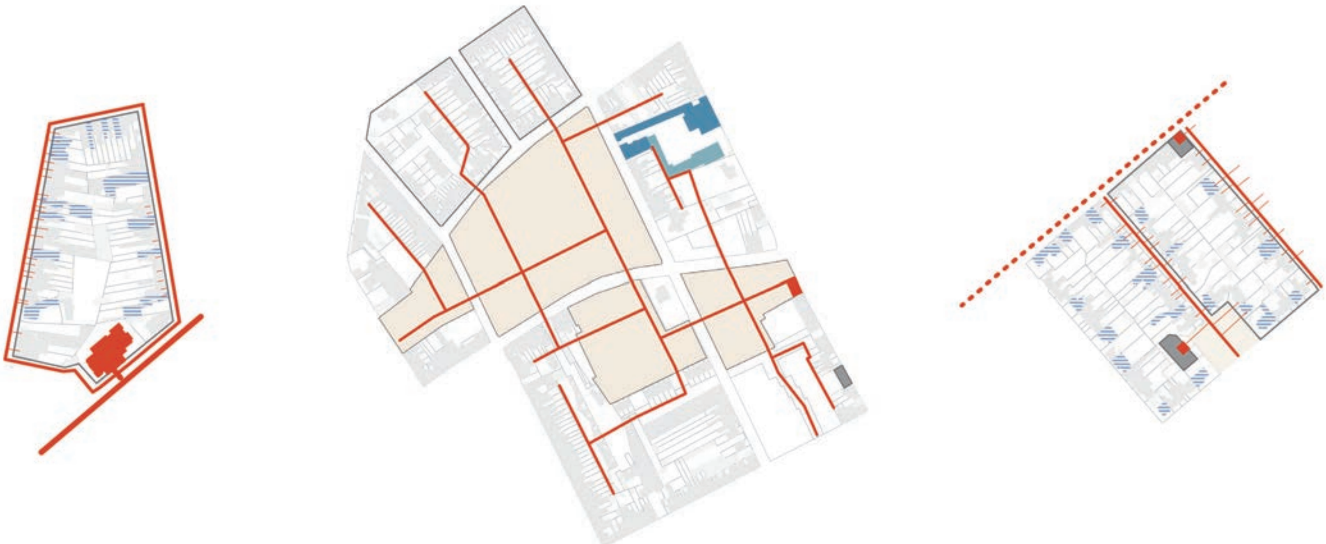


Figure A.28. Energy solution by neighbourhood type.
Source: author based on workshops.

URBAN CENTRE
URBAN HEAT NET

URBAN FRINGE BUILDING BLOCKS
COLLECTIVE



'public building as anchor point'

To extend the main district heating network into a fine-mazed system for the urban centre, large (public) buildings can serve as 'anchors' or 'substations'. A technical space with a substation for the heat grid can be the starting point for a local pipe, potentially on a lower temperature. This can supply heat to surrounding buildings. Such public sites, such as schools, 'RSL op Post', a vacant church, ... can also become anchor points for the energy system in different ways. They can serve as examples in terms of energy efficiency, or by placing solar panels on the roof, give the opportunity to renters, inhabitants without suitable roof or with less financial means, to invest in renewable energy through a cooperation.

'reconversion project as catalyst'

Larger reconversion projects can be a stepping stone within the broader heat strategy of the city. A local district heating system ('campus grid') can be integrated in such an urban project. But rather than remaining an island, it can also supply heat to surrounding building blocks. On the long term, such a grid can be connected to the urban district heating network. The local heat source can then serve as a complement or backup for the central heat source. Heat storage can also be integrated in this kind of project.

'street heat'

Parts of the urban fringe are composed of a clear building block struckture of terraced housing and appartments. In this tissue the heat demand can be supplied collectively, at the scale of the block or street. In a building that is being renovated or replaced, a technical space can be provided for a shared heat installation (CHP, biomass installation). This way, densification of the urban fringe can be coupled with a more efficient and collective heating system. From this shared installation, a local heat pipe (on medium or low temperature) can be installed to connect, step by step, all inhabitants of the street. Next to a shared technical space, also other collective functions can be added, such as shared bike storage, charging infrastructure for electric vehicles, meeting or atelier spaces, a neighbourhood kitchen or repair hub.

Figure A.29. Heat strategy for each neighbourhood type.
Source: author based on workshops.

URBAN FRINGE LOW DENSITY
INDIVIDUAL & MICRO-COLLECTIVE

'backyard heat'

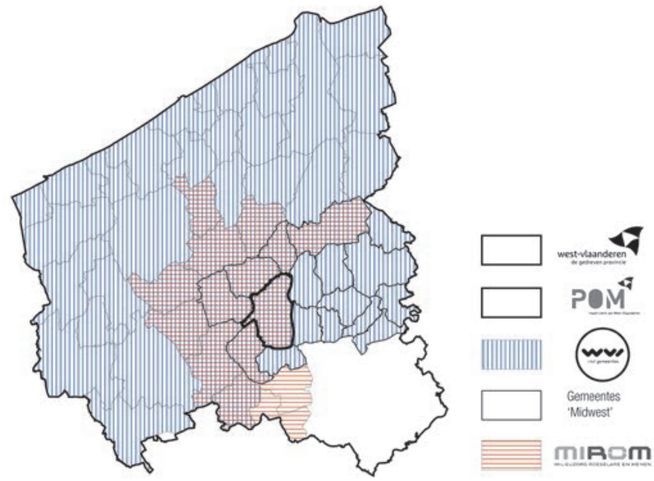
Other building blocks have much space on the backside of buildings. There, a shared heating system can be built via the inside of the block. Moreover, some spaces can serve as a shared garden or soft connection, for example by connecting part of existing back yards, organizing garage boxes more efficiently, or clustering parking elsewhere.

'micro-collective BES'

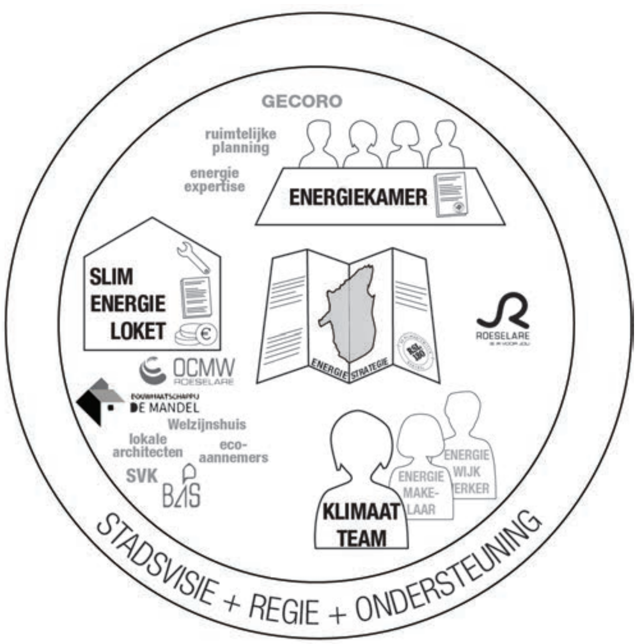
In allotments in the urban fringe, every house can provide its own heat installation (heat pump, solar boiler). That would require a renovation to reduce heat demand and install low-temperature heating systems (floor heating). However, neighbours with an adjacent back yard can also collaborate to share the cost and the impact on the underground of shallow geothermal systems. They could install a shared BES-system and distribute the heat through the gardens. Other spaces can be shared as well, such as a compost bin, foot path, kitchen garden, orchard, playground or wadi. At the same time, workshop participants emphasized that people living in residential allotments are usually not in the habit or do not feel the need to share or collaborate, since they have enough space on their own parcel. Maybe the energy transition can be a motivation to organize collective spaces.

'smart electricity loop'

In other neighbourhoods, 'all-electric' solutions can be developed for both heating and mobility. That requires an adaptation of the local electricity grid to provide enough capacity to inject, exchange and store locally produced electricity. Shared electricity storage and charging infrastructure can be part of such a grid. Shared electric vehicles can serve as buffer for the local grid. By connecting different parcels or replacing detached villa's, other housing typologies (terraced, appartment, cohousing, care housing) can be introduced in these individualized housing environments. This way, changing housing needs (smaller household sizes, aging population, blended families) can be met and existing allotments can slowly be densified.



Existing intermunicipal collaboration, in the domains of spatial and industrial development (WVI), waste management and energy (MIROM)



'spatial energy plan as roadmap'

At the scale of the city, a spatial energy plan can serve as framework and roadmap to guide strategic urban projects and choices around energy infrastructure, but also to guide individual investments and projects.

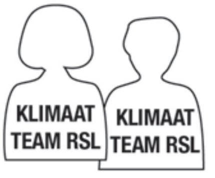
FigureA.30. Goverrnance strategies at the level of the city, neighbourhood, industrial area, and region. Source: author based on workshops.

'energy chamber' or 'energy lab'

An 'energy chamber' could follow up important urban energy and infrastructure projects. This 'quality chamber', in analogy with its use in the domain of architecture, can ensure that energy and sustainability are embedded as essential dimensions in urban development projects, and that energy infrastructure is integrated in the city in a qualitative way, thereby improving spatial quality (for example by redesigning a street profile in a more pleasant and sustainable way). It brings together expertise on spatial quality and urban development, with technical energy expertise, and provides advice to lift urban projects to a higher level.

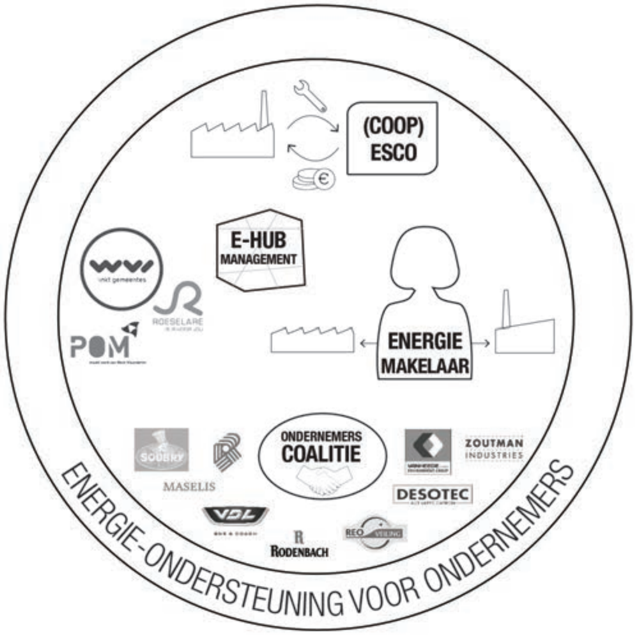
'smart energy hub'

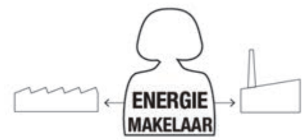
An energy hub brings together information and support for private energy projects: renovation, group purchases or shared heat production. Basically, it is a one-stop-shop that provides information and support about subsidies, procedures, technical information, etc. The hub can have a larger impact by facilitating collective energy projects in different neighbourhoods. The hub is 'smart' in the sense that support is specific for each target group and neighbourhood: not every inhabitant, entrepreneur or organization needs the same kind of support, and not every location benefits from the same energy solution. Importantly, financial support and guidance should be focused mostly on underprivileged inhabitants, who are often not reached today.



'climate team'

Despite its limited capacity, the climate team today plays a key role in developing an urban climate and energy policy and setting up concrete and innovative climate and energy projects, together with a network of interested partners and experts. To structurally develop and upscale these roles, more capacity is required. Building a strong network of local and regional stakeholders, co-creating energy strategies with inhabitants, entrepreneurs and organizations, setting up pilot projects and working on a long-term vision is no easy task. Embedding climate and energy within the urban administration is a key challenge to align different policy domains. The team could be expanded with an 'energy ambassador' and a 'neighbourhood energy worker' (see further).



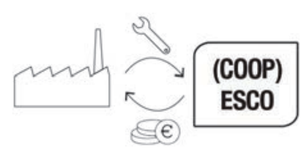


'energy broker'

An energy broker searches for connections between companies (and their surroundings) to exchange energy and collaborate to build energy infrastructure. To ensure openness and neutrality, this person does not need to be a civil servant, but can be a contact point between energy initiatives by entrepreneurs, and the vision and projects of the city. For an example, see the project 'DOEN' by province East-Flanders.

'EHUB management'

Collective governance of industrial areas can form the basis for initiatives around collaboration, sustainability and energy. Managing industrial areas today already involves many tasks, from signage to maintenance of green spaces, collective waste collection, exchanging knowledge to group purchases for energy or reusing water. This kind of parc management can be extended to investigate opportunities to exchange energy and materials between companies, producing electricity and heat collectively, sharing energy infrastructure, setting up sustainable logistics systems (cargo bikes, electric vehicles, hydrogen, transport by canal), and optimizing use of space (densification, shared facilities for meeting and administration). An EHUB manager can also be a point of contact for the urban administration to collaborate and share information.



'cooperative ESCO for companies'

For entrepreneurs, an ESCO formula (energy service company) can be an interesting way to invest in energy efficiency and energy production. For many small SME's energy is not the main priority, or there is not much internal expertise about the topic. A commercial or cooperative ESCO then takes care of the technical development and the investment - for example in energy production, optimizing the production process, renovation of buildings - and the company repays these investments on the longer term via the reduction of the energy bill.

'neighbourhood energy ambassador'

The neighbourhood ambassador or climate team is an engaged inhabitant or organization, that wants to work with neighbours on climate and energy. The ambassador is the contact point for the city, and is supported, for example by the 'smart energy hub' with guidance and expertise about setting up neighbourhood energy projects.

'(cooperative) ESCO formula'

An ESCO, or 'energy service company' provides 'energy services'. It can be a commercial firm, but also a citizen cooperative, that invests in the renovation of (residential) buildings. The renovation cost is then repaid over time, through the resulting energy savings, so that an owner does not have to make the full investment at the start. You could apply the same principle for investments in collective heat production, grids or PV-projects in the neighbourhood. It can produce a snowball-effect whereby the profits of the ESCO can be re-invested in other neighbourhood projects.

'(CLT-) neighbourhood renovation'

With a neighbourhood renovation, a specific support process is set up to support inhabitants in a neighbourhood, street or building block throughout the energy renovation of their home. This support can be technical guidance, combined with social support or financial help, for example by organizing a 'group purchase' for contractors (see Wijkwerf, Energent) or prefinancing the renovation (see DampoorT KnapT OP).

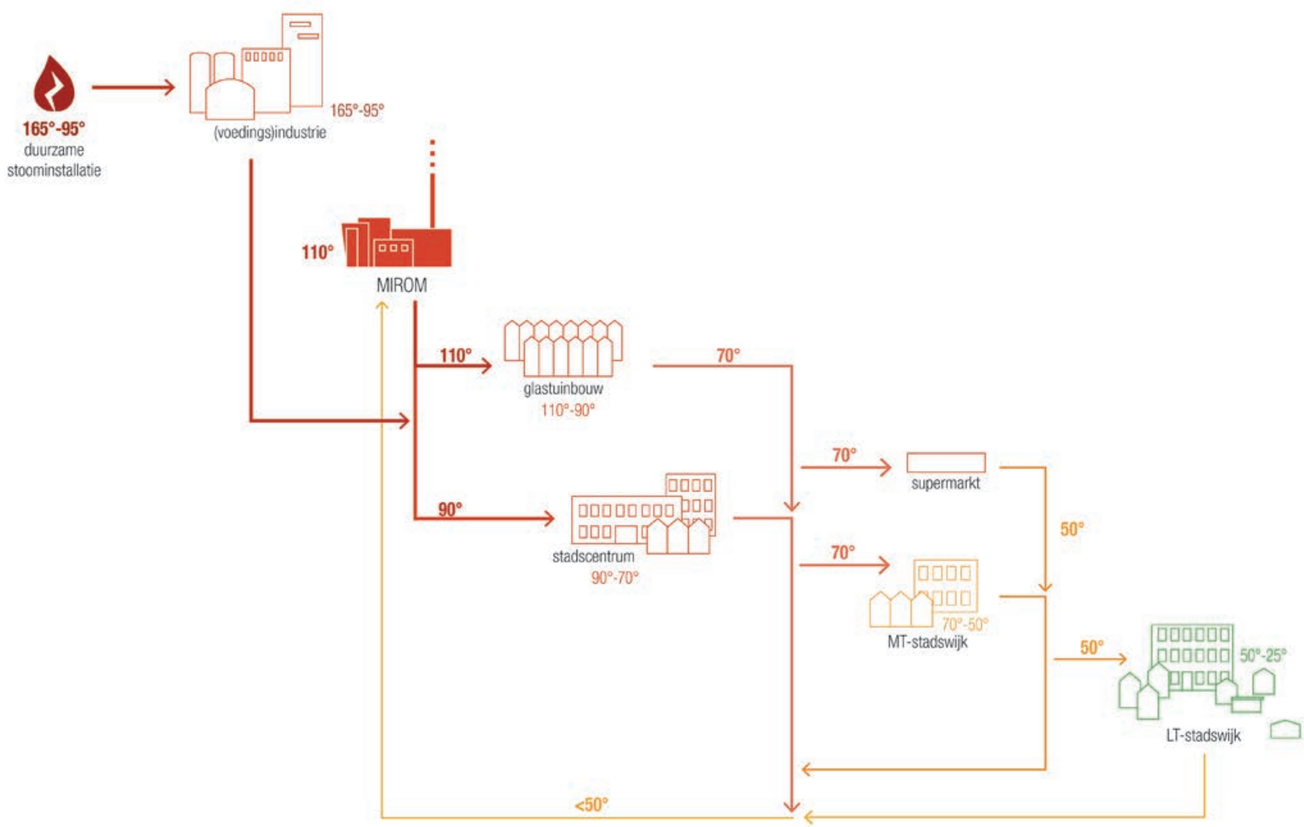


Figure A.31. Heat cascading principle for different activities and neighbourhoods in Roeselare.
Source: author based on workshops.

Figure A.32. Zoom 3: Groenpark, De Spil: collection of design workshop ideas for a neighbourhood energy strategy. Source: author based on workshop.

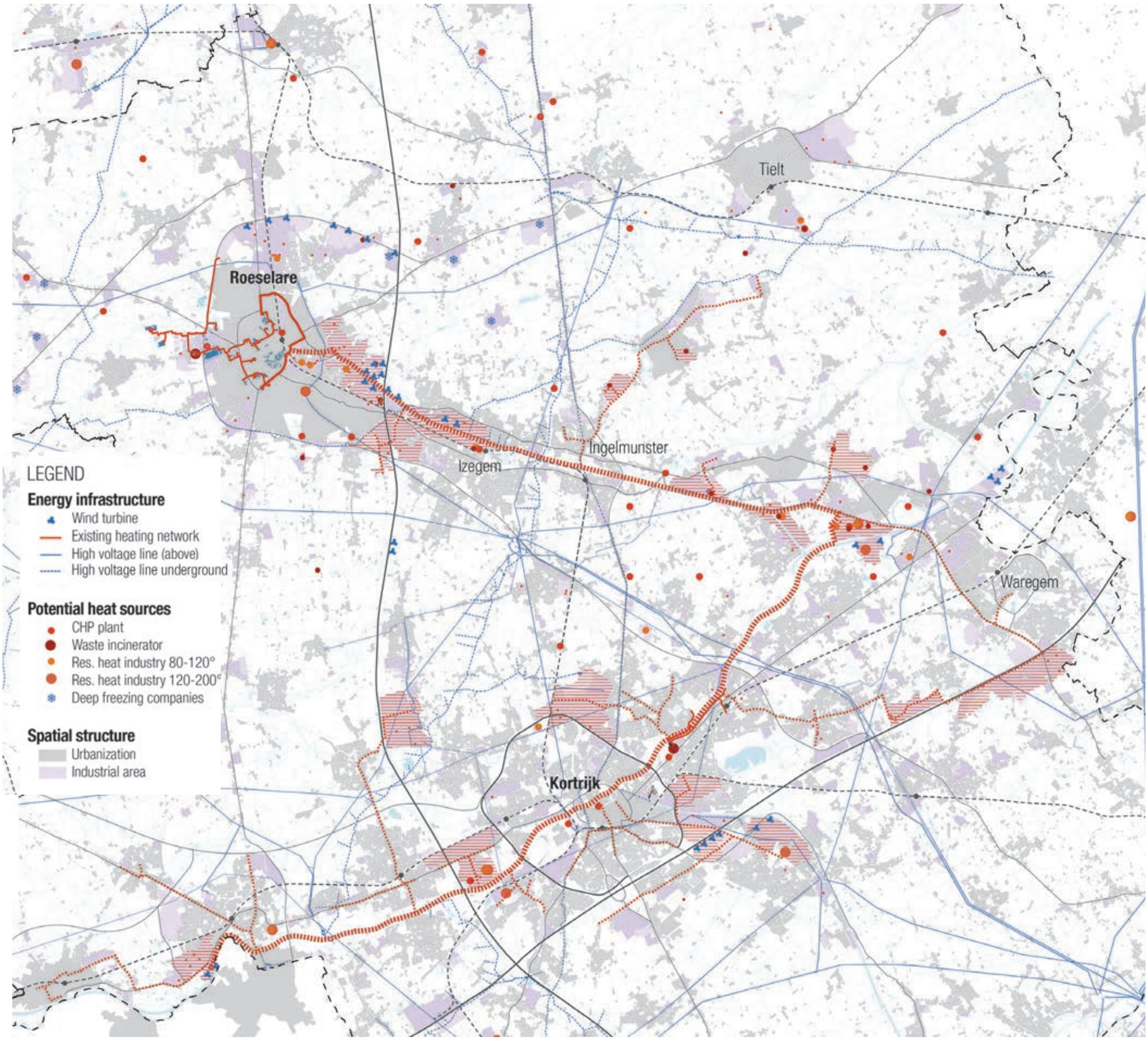


Figure A.33. Possible structure for a regional district heating network or 'heat boomerang'.
Source: author based on maps by Leiedal.

Chapter 3

Addressing transition politics through spatial energy planning? An exploration of 4 regional energy visions in Flanders

Abstract

While transitions are inherently political processes, critical contributions to transition literature have pointed out how this political character tends to be obscured in transition management practices. At the same time, planning and design theory highlight the integrative character of space and spatial design, the potential of design as a tool for negotiation and of coproduction as an empowering practice. This research analyzes four cases of regional energy planning in Flanders and explores how these processes address the politics of transitions, as generic energy ambitions are spatialized in a concrete socio-spatial context. It shows how, although these planning initiatives create valuable arenas for meaningful discussion among regional stakeholders in Flanders' complex governance setting, these processes develop in a relatively consensual way. Regional visions successfully connect energy strategies with other spatial challenges characteristic for Flanders dispersed territory, but social and governance dimensions around energy concepts are addressed rather implicitly. The analysis zooms in on wind energy as the most contested element in these visions and explores how frictions around wind energy locations lead to different planning outcomes depending on the regional landscape characteristics, institutional setting and planning approach.

1. INTRODUCTION

There seems to be a broad consensus about the need for a transition towards a more sustainable energy system, in an effort to mitigate global climate change. Even multinational fossil fuel companies are increasingly investing in renewable energy development (Pickl, 2019). With the Green Deal, the EU aims to become the first climate neutral continent by 2050, and has set targets to reduce emissions with at least 55% by 2030 as compared to 1990 levels, reach 40% renewable energy, and 36-39% energy efficiency improvements by 2030 (European Commission, n.d.). Setting these objectives involved difficult negotiations whereby the often conflicting interests between different sectors and nations needed to be weighed. Translating these European policy goals into national and regional legislation proves at least as contested. Belgium's recent failure to reach an agreement about a division of climate objectives between the federal regions before the COP26 in Glasgow, serves as a disappointing example (Coalition Climat, 2021). Clearly the energy transition is a highly political question, whereby difficult considerations have to be made about where, how, by and for whom energy systems should be transformed (Coutard and Rutherford, 2010; Shove and Walker, 2007).

With energy transition high on the policy agenda, it is also increasingly a concern for spatial planning across European countries (Späth and Rohracher, 2010; Stoeglehner, 2020; Stremke et al., 2012; Wächter et al., 2012). Spatial energy visions usually aim to translate energy and climate objectives into context-specific spatial strategies and to build support among key stakeholders for a shared energy vision. As in the Netherlands and Austria, different supra-municipal regions in Flanders, the northern part of Belgium, have designed regional spatial energy visions. They explicitly approach the energy transition as a spatial (planning) question. On the one hand, renewable energy production and infrastructure to distribute, transform and store energy has a spatial footprint. On the other hand, energy demand is related to the built environment in terms of energy used as heat, electricity or transport fuel (Owens, 1986). These spatial explorations also show how the transformation of the energy system is closely intertwined with questions of landscape quality, urbanization patterns, regional economic development, or housing and mobility practices.

Energy transitions can then be understood as processes of fundamental societal change that include important spatial and socio-political dimensions. However, these are often overlooked in a policy context focused on quantitative targets for energy production, efficiency and emission reduction, or in applied research aiming for technological innovation. As regional spatial energy visions aim to spatialize generic energy targets, socio-spatial questions around energy transitions tend to become more tangible and often contested. This paper analyzes four regional energy planning initiatives in Flanders, in the regions of Denderland, Leiedal, Pajottenland and Waasland, to explore how spatial energy concepts are designed in response to specific regional landscapes, governance contexts and stakeholder settings. The research unravels whether and how regional visions address political dimensions of energy transitions, and what tensions emerge in relation to the spatial strategies these visions propose for wind energy production. First, I bring together insights from transition studies and spatial planning and design literature to set the stage for a critical examination of how regional energy planning processes might address the political character and transformative potential of energy transitions. Then, I shortly explain my methodological approach to the four regional case studies as a combination of participant observation, interviews and document analysis. The empirical section starts with an introduction of the energy region as an ambiguous supra-local governance setting within Flanders' fragmented institutional context for energy and spatial planning policy. Next, I describe the territorial and governance characteristics for each regional case and trace what scope the planning process and spatial vision offer to address political transition dimensions. Finally, I focus on wind energy production, and unravel how contestation plays out differently in each case depending on the regional landscape context, institutional setting and planning approach. This account shows how regional energy strategies evoke tensions not only between municipalities and other regional actors, but also between local planning initiatives and a lacking Flemish policy framework. I conclude that regional energy planning processes successfully visualize the spatially transformative potential of the energy transition, but could more fully recognize its political character by explicitly addressing social and governance dimensions of transitions.

2. LITERATURE AND CONCEPTUAL FRAMEWORK

To analyze the political dimensions of energy transitions and how they are addressed and spatialized in different energy regions in Flanders, this paper will combine insights from transition studies and planning and design theory. Critical contributions to the transition literature have emphasized not only the inherently political character of transitions and revealed how these politics of transitions tend to be understated in transition (management) processes (Coutard and Rutherford, 2010; Kenis et al., 2016; Meadowcroft, 2009; Shove and Walker, 2007). Geographical contributions also inspired a 'spatial turn' in transition studies, highlighting the need to understand how transitions play out differently in different socio-spatial contexts (Bridge et al., 2013; Coenen et al., 2012). Spatial planning and design theory has this spatial perspective as a central focus, and draws attention to the integrative capacity of space and spatial design, but also to the role of conflict and coproduction in strategic planning processes, and to the limits of spatial energy planning. Bringing together both strands of literature to study regional energy planning projects is relevant, because they offer similar and complementary perspectives about imagining and governing processes of sustainable transformation.

2.1. Transition theory

While transition theory studies processes of fundamental societal transformation (Fischer-Kowalski and Rotmans, 2009; Geels, 2005; Paredis, 2014), transition management (TM) is a reflexive and participatory approach to guide complex transitions towards a more sustainable society (Block and Paredis, 2012; Rotmans and Loorbach, 2009). In a transition management process, a group of frontrunners is brought together in a 'transition arena' to cocreate a long-term future vision, elaborate a multiplicity of possible transition pathways, and set up concrete transition experiments (Loorbach and Rotmans, 2010). Critical contributions to the transition literature have pointed out the need to address power relations and contestation in transition processes to better understand the politics of transitions (Block and Paredis, 2012; Meadowcroft, 2009; Shove and Walker, 2007). Using the transformation of energy systems as an example, Meadowcroft describes how transitions are inevitably conflictual processes, where social and political struggles emerge as societal actors start to think about the kind of transition they envision and become concerned about their own place in future arrangements (Meadowcroft, 2009, p. 328). Based on these perspectives, Coutard and Rutherford define energy transitions as "*political processes in/through which ideas and interests diverge, socio-technical choices can never be unanimous, and the policies which are decided upon and implemented always necessarily produce 'losers' as well as 'winners'.*" (Coutard and Rutherford, 2010, p. 714). These critical contributions also reveal how this political character of transitions tends to be obscured in transition management processes and raise fundamental questions about the possibility of guiding societal transformations and about the framing, legitimacy and inclusivity of TM approaches. Shove and Walker question the authority of 'transition managers' and the assumption that a shared future image exists. They draw attention to how the policy, goal or system is defined, to the complex, multiple and always contested commitments that go into making future visions, and the need to recognize fundamental conflicts behind seemingly consensual notions of sustainability (Shove and Walker, 2007). Kenis, Bono and Mathijs (2016) mobilize the work of political theorists such as Mouffe to challenge core principles of TM and argue that TM processes fail to account for what Mouffe has called 'the political'. This refers to a discourse which recognizes the existence of power, conflict and contingency, as opposed to 'politics' or the ensemble of practices, discourses and institutions that organize potential conflict in human coexistence (Mouffe, 1999). Kenis et al. argue that transition management practices don't fully acknowledge power relations, radical pluralism, and the possibly constitutive role of conflict in society (Kenis et al., 2016). They expose key characteristics of transition management as post-political: its deliberative approach to collective decision-making and its belief in a long-term consensus, its tendency to 'overcome' or 'instrumentalize' conflict, its selective approach to participation which calls to question the representativeness and legitimacy of TM processes, and its failure to question the liberal market model within which it operates. While democracy starts by making power, conflict and decision visible and acknowledging the need to transform them, depoliticization occurs when the contingent and contestable nature of decisions gets obscured (Mouffe, 1999). In Mouffe's view, consensus and compromise are possible but should be seen as provisional, as a temporary stabilization of power that always entails some form of exclusion (Mouffe, 1999).

Geographical perspectives on transitions have emphasized the spatial dimensions of sustainability transitions, asking if and how spatial contexts matter for transitions, addressing the territorial embeddedness and institutional particularities of transition processes and studying transitions as multiscalar processes (Bridge et al., 2013; Coenen et al., 2012; Faller, 2016; Hansen and Coenen, 2015). Bridge et al. (2013) introduce the six concepts of location, landscape, territoriality, spatial differentiation, scaling and spatial embeddedness to describe the geographical implications of a sustainable energy transitions. 'Landscape' refers to how energy transitions can be experienced as – often contested – landscape transformations, while 'territoriality' concerns the way energy systems may be governed through different scales and arenas of political action and 'embeddedness' relates to how energy systems are part of a spatial, but also economic, material and cultural context (Bridge et al., 2013). Generally, these studies emphasize the need to study how transitions play out differently in different spatial, socio-cultural and governance contexts.

Overall, these political and geographical perspectives on transition, draw attention to how the politics of transitions are addressed in regional energy planning processes, and how these processes play out differently in different regions. They invite to ask how the project question and ambition are framed, who guides and participates in the planning process, how the process is situated within the broader governance setting and what its legitimacy is, and what role and scope there is for conflict and contestation. They encourage to explore how regional energy planning processes and visions differ depending on the specificities of the regional landscape, actors and governance context.

2.2. Planning and design theory

For the disciplines of spatial planning and design, space and spatial transformation are central concerns. While transition studies usually conceptualize space as a 'background' for transition processes, spatial design disciplines consider space not merely as a 'receptor' for social activities, nor simply as an 'instrument' for social change. Instead, they recognize the interrelation and interaction between social forces and spatial patterns, as captured in Heynen's concept of space as a 'stage' that frames but is also co-produced by social dynamics (Heynen, 2013). Planners and designers often engage with the territory through (research-by-)design, as a learning-by-doing approach to understand and rethink complex territorial challenges (Cox, 2014), and as a knowledge-producing tool that includes operations of conceptualization, description and future exploration (Viganò, 2016). Viganò shows how, particularly in contexts of dispersed urbanization, designerly approaches of schematic representation, mapping and scenario exploration are valuable ways to understand and visualize the territorial consequences of contemporary socio-ecological challenges (Viganò, 2016). Reflecting about experiences with Strategic Structure Planning across the world, Loeckx et al. go even further when they describe design not only as a way to read urban landscapes and to reframe problems, but also as a tool for negotiation and a synthesizing frame for pacts and agreements (Loeckx *et al.*, 2004, p. 164). Building on Heynen's understanding of space as a 'stage', they consider design a "*[medium for negotiation], as an active and* *evolving instrument through which suggestions are absorbed, processed and incorporated, alternatives generated, and conflicts resolved*" (Loeckx *et al.*, 2004, p. 194). European planning literature has also highlighted how spatial strategies are often visualized in abstract drawings and explored what role such 'fuzzy' spatial representations play in mobilizing support, brokering agreement and building consensus. In a critical case study on Danish strategic planning, Olesen and Richardson show how the absence or presence and the fuzziness of spatial representations does not only reflect the nature of contested spatial politics in consensus-seeking strategic spatial planning processes, but might even be used in a conscious attempt to depoliticize spatial strategy-making and camouflage spatial politics (Olesen and Richardson, 2011).

Literature about strategic spatial planning has often focused on the planning process, including questions of power and conflict (Albrechts, 2013; Healey, 2003). Strategic spatial planning emerged as an alternative to comprehensive land-use planning, aiming to provide a more effective approach to complex spatial problems (Albrechts, 2004). Although it is not a single concept or tool, Albrechts argues it can be described as a public-sector led but co-productive socio-spatial process through which visions or frames of reference, the justification for coherent actions, and the means for implementation are produced that shape, frame and reframe what a place is and might become (Albrechts, 2013). A common concept is the three- or four-track approach - with which the transition management approach shares obvious similarities - that includes (1) the design of a future vision, (2) short- and long-term actions, (3) involvement of key actors, and (4) a broader involvement of the public in major decisions (Albrechts, 2004; Loeckx et al., 2004). Exploring ways to revive planning as a more critical theory and praxis, Albrechts proposes the following building blocks: conflict, co-production and legitimacy (Albrechts, 2015). Referring to Mouffe, he underlines it is not the aim of planning nor is it in its power to eliminate conflicts, but it is in its power to create the practices, discourses and institutions that would allow those conflict to take an agonistic form (Albrechts, 2015, p. 107). He also emphasizes co-production as a political strategy to empower and mobilize citizens to engage in counter-hegemonic struggles, challenge the status-quo and change policies (Albrechts, 2013, 2015). Other scholars, however, have pointed out how participation also risks to be co-opted by or legitimize neoliberal and post-political logics. This puts planners in a difficult position, as they aim to sustain a critical position while navigating influential decision-making processes (Kaethler et al., 2017). At the same time, Devos illustrates how forms of contentious action can also occur within or on the borders of a local government apparatus when governmental actors collaborate with critical planning practitioners to challenge institutionalized methods, procedures or instruments (Devos, 2021).

Discussing planning in a climate change context, Bulkeley and Betsill note how planning can function "*to bring tensions between the economic, social and environmental dimensions of sustainable development to light*" (Bulkeley and Betsill, 2005), and act as a site of contestation between different conceptions of the public good (Campbell, 2006; Cowell, 2010). Regional energy visions then allow to situate energy ambitions in a specific physical and socio-economic context, not only rendering them more concrete and attuned to local conditions (Coutard and Rutherford, 2010; de Boer and

Zuidema, 2015), but potentially also evoking tensions between different interests and values. Indeed, especially in the domain of wind energy, a 'social gap' often exists between the broad societal consensus about an urgent need for decarbonization of the energy supply chain on the one hand, and the significant local opposition to renewable energy projects on the other (Gonzalez et al., 2016). As illustrated by the number of publications on this issue, planning continues to struggle to meaningfully address landscape qualities as well as public contestation in the selection of suitable areas for wind energy production, and to build support for the implementation of such projects (Cowell, 2010; Gonzalez et al., 2016; Leibenath et al., 2016; Verhoeven et al., 2022).

More generally, planning's potential to accommodate contestation is not necessarily realized in practice. Energy visions are often developed in a rather consensual and conflict-avoiding way, tending to gloss over potential conflicts or avoiding contentious issues (Späth and Rohracher, 2010; Trutnevyte, 2014), and working towards a widely shared imaginary for the future (Wächter et al., 2012). Späth and Rohracher show how in the case of Murau in Austria, the regional energy vision does not directly confront the interests of powerful incumbent actors, nor aim at radical socio-technical changes. They explain this consensus-oriented approach as a pragmatic response to the limited regional capacities to achieve radical changes, and its being grounded in a broad social agreement with the visions' general goals of renewable fossil-free energy production and efficiency (Späth and Rohracher, 2010, p. 456). They also draw attention to the fact that many regional visions come about in what they call an 'institutional void', without a formal mandate from a democratically elected or formally legitimized institution, raising questions of democratic legitimacy, responsibility and accountability for regional energy visions (Späth and Rohracher, 2010). Coutard and Rutherford touch upon a similar issue in the context of Paris, asking where the work of regional policymakers is located in policy circles, and how it intersects with the diverging positions and practices of other public and private actors (Coutard and Rutherford, 2010). In a critical analysis of wind energy planning practices in Ireland, González et al. even suggest that devolving wind energy planning responsibilities to a local scale is part of a deliberate depoliticizing strategy to displace a contentious public policy issue (Gonzalez et al., 2016).

The energy planning literature is also critical about the capacity of spatial planning to address territorial dimensions of climate change (Bulkeley and Betsill, 2005; Campbell, 2006), characterizing planning as a 'highly imperfect process', and recognizing how spatial structures are shaped by a multitude of social and economic forces (Owens, 1992; Williams, 2013) and adapt only slowly to planning measures (Grosse et al., 2016). Indeed, the implementation of regional energy visions often proves challenging. A first reason is that energy and spatial planning competences are often fragmented and even incoherent between different government levels. Municipalities or regions might have jurisdiction over local planning or climate policy but depend on supportive measures at higher policy levels, e.g. building regulations or fiscal policies, to support the implementation of regional policies (Grosse et al., 2016; Zanon and Verones, 2013). In many cases, a clear division of tasks and responsibilities between different actors and policy levels is missing. Second, energy planning is often not well-integrated with spatial planning, both at national or regional scales and at municipal level (Asarpota and Nadin, 2020; Blanchard, 2019; Bulkeley and Betsill, 2005; Cajot et al., 2017; Zanon and Verones, 2013). Thirdly, energy and planning policy often struggle to translate visions or objectives in effective policy tools and instruments. Some authors observe an overabundance of policy tools (Zanon and Verones, 2013), while others note a tendency to add policies rather than transforming existing ones (De Pascali and Bagaini, 2019). Transforming existing institutional structures and decision-making processes is generally considered extremely difficult (Wächter et al., 2012). Fourth, a lack of resources and expertise at (inter)municipal level are also considered crucial constraints for local climate action (Cajot et al., 2017; Roger-Lacan, 2019; Williams, 2013; Zanon and Verones, 2013). Finally, a key challenge is to ensure political commitment and build effective partnerships between local and regional authorities and private actors (Grosse et al., 2016).

Overall, these insights from planning and design draw attention to the kind of spatial strategies that are proposed in regional energy visions, to the processes' institutional context and legitimacy, and to the role of conflict and contestation in the visioning process. They inspire to explore what spatial concepts are developed in relation to specific regional territorial and landscape characteristics, how they are visually represented, and what tensions emerge around these concepts. They ask how regional visions are situated in a broader policy context, and how they relate to existing planning instruments and procedures. They also critically caution against the limits of regional planning processes and highlight several factors that challenge the implementation of regional visions.

3. METHODOLOGY

Empirically this research focuses on 4 regional spatial energy planning processes that took place in Flanders between 2017 and 2021, in the regions of Denderland, Leiedal, Pajottenland and Waasland. These were initiated by public actors such as provinces or intermunicipal companies and intend to develop a shared long-term vision for the regional energy system. These four cases were selected because they represent four different approaches to how spatial planning and design can be used to spatialize regional energy ambitions in a specific spatial-institutional context. To explore the spatial strategies proposed in each of these visions, and to understand to what extent these visions address the political dimensions of regional energy transitions, I combined participant observation in two of the planning processes with a series of in-depth interviews and an analysis of vision documents (Flyvbjerg, 2006; Hay, 2016; Yin, 2009). This approach allowed to understand the energy planning processes within their real-life context and to construct a rich picture of each of the cases.

First, I participated in two of the four energy planning processes (Leiedal and Waasland) to gain a deeper understanding of the regional planning context and approach, and to observe how different perspectives on the regional transition were represented and interacted (or not) during key design moments. For the Leiedal case, I participated in multiple meetings and in 6 (out of 7) three-to-five-day design workshops that each addressed the opportunities for one or two of the region's municipalities. For Waasland, I participated in several meetings with the provincial administration and in three workshops that focused respectively on the regional landscape, the ambition framework, and the energy building blocks. As the Waasland process is still ongoing at the moment of writing, the findings about this case can only be considered preliminary reflections but are still relevant to include in the discussion. As a participant observer I gained a privileged insight into both planning processes, and aimed to contribute as a reflexive outsider and critical ally, for example by drawing attention to social dimensions of the regional energy transition. [A visual timeline of the planning processes and my involvement as participant observer can be found in interlude C.] Second, to gain a deeper understanding of the planning process and the reasoning behind the spatial strategies, I conducted a series of 22 interviews with 23 relevant stakeholders. The interviews were semi-structured, took place between summer 2020 and fall 2021, were conducted online due to covid restrictions, and took between 1 and 1,5 hours (Dunn, 2016). I selected not only stakeholders involved in the four selected planning processes that could provide an 'insider' perspective, but also other interviewees that could offer a relevant external reflection about regional transitions, for example the Flemish spatial planning administration, 'social' energy experts and economic actors. This allowed to understand how different stakeholders had experienced or perceive regional energy visions, and to understand potential barriers for implementation. Third, I analyzed the proposed regional visions and other relevant policy documents for each of the 4 selected regions, to understand what ambitions were formulated, which spatial concepts and strategies were proposed, and what approaches towards implementation were developed.

4. FINDINGS

The following paragraphs first describe how regional energy planning in Flanders is ambiguously situated in a complex governance context of spatial planning and energy policy, with a particular focus on the wind energy planning framework, and compare this context with other cases in Europe. Secondly, I will introduce the four cases of regional energy planning, with specific attention to the regional governance setting and landscape characteristics, how the energy transition question was framed, and which stakeholders were involved in the visioning process. I will also explain what spatial concepts and strategies were developed in each vision, how they are visually represented, and what elements the visions include towards implementation. Throughout these accounts I aim to understand to what extent these visions address the politics of transitions, and what scope these processes offer for dialogue, contestation and integration of different interests and perspectives. Thirdly, I will focus on spatial strategies for wind energy production as the most contested elements in three of these regional visions. I will analyze whether design supports a dialogue between different interests, what tensions emerge around wind production, and how they lead to different planning outcomes.

	INTERVIEWEES	DOCUMENTS
GENERAL	• Flemish Department Environment - policy advisor • Labour union – policy advisor climate and energy • Samenlevingsopbouw – energy poverty expert • Energy cooperative – project manager • Flux50 innovation cluster – energy sector expert	• *'RRES – Ruimtelijke Regionale Energie Strategie' – Draaiboek, bijlagenbundel en adviesnota*
DENDER LAND	• Province of East-Flanders – energy landscape coordinator • Province of East-Flanders – spatial energy planner • Denderland landscape designer • Denderstroom energy cooperative	• '*Energielandschap Denderland, een ruimtelijke gebiedsgerichte visie'* – final public report
LEIEDAL	• Intermunicipal company – spatial designer energy • Intermunicipal company – project manager energy • City of Kortrijk – spatial planner • City of Kortrijk – climate director • City of Kortrijk – district heating ambassador • City of Harelbeke – policy advisor • City of Menen – alderman climate	• '*Een ruimtelijke energiestrategie voor Zuid-West Vlaanderen, samenwerken aan de energietransitie'* – final internal report and final public report • Final presentations of each workshop
ANTWERPEN	• Province of Antwerp – spatial planner & project leader	• '*Ruimte en Energie. Een onderzoek naar provinciale energielandschappen' - Eindrapport*
PAJOTTEN LAND	• Province of Vlaams Brabant – project coordinator • Opgewekt Pajottenland - energy consultant • Opgewekt Pajottenland - landscape designer	• '*Hernieuwbare energie als hefboom voor een klimaatbestendig Pajottenland. Startnota*' • '*Landschapsstudie hernieuwbare energie Pajottenland*''*Opgewekt Pajottenland*' – final report as a website with 5 chapters
WAASLAND	• Province of East-Flanders – energy landscape coordinator • Province of East-Flanders – spatial energy planner • Samenlevingsopbouw East-Flanders – energy and housing expert • Director social housing company • Provincial Development Company – project manager ehubs • Fluvius – network management	• '*Energielandschap 2050 Waasland - Een regionale ruimtelijke visie & strategie. Procesnota*' '*Energielandschap 2050 Waasland – Ambitiekader*' • '*Energielandschap 2050 Waasland – Bouwstenen*'

Table 3.1. Overview of empirical materials – interviewees and documents for each case.

4.1. Situating regional energy planning in Flanders within its governance context

Regional energy planning in Flanders takes place in an ambiguous governance context as there is no dedicated supra-local policy level, and an ambitious policy framework at Flemish level is missing. In Belgium's federal state structure, energy and spatial planning competences are distributed between the federal, Flemish, provincial and municipal levels[1]. Moreover, as in many other cases, energy and planning are considered separate policy domains (Asarpota and Nadin, 2020; Blanchard, 2019; Bulkeley and Betsill, 2005; Cajot et al., 2017), although the Flemish government is increasingly integrating energy and climate, and spatial planning administrations (Dep. Environment, interview, 2020). At the municipal level, climate plans (SECAP) and strategic spatial visions are usually separate policy plans, as illustrated by Zanon and Verones also for the Italian case (Zanon and Verones, 2013). Especially in Flanders' territorial context of a very dispersed urbanization pattern, the energy transition cannot be separated from the need to rethink this energy-intensive spatial morphology (Juwet and Ryckewaert, 2018). However, Flemish spatial planning traditionally struggles to control the dispersed urbanization of the region (De Meulder et al., 1999; Leinfelder and Pisman, 2009). The Flemish Spatial Policy Plan (*Strategische visie Beleidsplan Ruimte Vlaanderen*, 2018) addresses energy as an important question, and emphasizes the need to reduce additional land use, protect open space, and to concentrate development near collective mobility nodes and services. However, to date this strategic vision has not been translated into a concrete policy framework on energy (Dep. Environment, interview, 2020).

For wind energy, the legislative framework relies primarily on a 'circular' (*omzendbrief* RO/2014/02), and the procedures for permit applications and environmental assessment are described in a book of guidelines and a 'wind turbine manual'. The circular emphasizes the intention to cluster wind turbines (in groups of at least three) and specifies that "*a spatial concentration of wind turbines should be pursued, in seaport areas, industrial areas or in the vicinity of prominent infrastructures in the landscape, such as roads, railroads, rivers, canals, high-voltage power lines. It is also possible to connect with urban areas and rural centres [...]*" (*omzendbrief*, 2014). Important to note is that as a legislative tool, a circular is drafted and circulated by the relevant minister, but not democratically validated in parliament and therefore has limited democratic legitimacy. Although a circular has only guiding value but no legal power, this 'wind circular' is often interpreted by licensing authorities as a basis to evaluate permit applications. The wind permit procedure includes the development of an environmental impact assessment or – screening and a localization study. Currently the provincial or Flemish level are the licensing authorities while municipalities have an advisory role, although the present Flemish government intends to devolve this responsibility to the municipal level (Corens, 2021; spatial designer Denderland, interview, 2021).

1 See also introductory chapter: nuclear and offshore wind energy, energy transmission and maritime spatial planning are for example competences of the federal government, while the Flemish government has the authority over decentral energy production, energy distribution and spatial planning in Flanders. Provinces also have spatial planning competences and develop climate policies, and municipalities decide about local spatial planning and formulate climate policy under the Covenant of Mayors framework.

In this fragmented policy context and without clear policy framework at Flemish level, provinces and intermunicipal associations have recently taken the initiative to develop regional energy visions for supra-municipal 'energy regions'. These regions have very weak planning power because there is no formal government or institutional tier at this scale in Flanders.[1] This is similar in for example the Austrian context, where a multiplicity of regional visions has taken shape since the 1990s at the scale of both *Bundesländer* and districts, for example under the '*Klima- und Energie Modellregionen*' programme funded by the Austrian '*Klima und energiefonds'* (Home - Klima- und Energie- Modellregionen, n.d.; Späth and Rohracher, 2010). By comparison, the institutional context is much more clear in the Dutch case. The national government has a clear ambition to phase out fossil fuels and the national 'Klimaatakkoord' (signed in 2019) obliges regions to develop regional energy strategies by 2021, specifies a procedure for biannual revision and set up the '*Nationaal programma RES*' as a support and funding platform (*Regionale Energiestrategie*, n.d.). Such a clear planning framework and support programme for regional energy planning does not exist in Flanders, although the Department of Environment recently presented a 'guidebook for Regional Spatial Energy Strategies' based on the first experiences, as a first effort to coordinate regional energy planning initiatives (Custers et al., 2021).

Situated in-between the municipal and provincial scale, regional energy visions aim to bridge a gap, between the Flemish and municipal policy level, between climate ambitions and practice, and between energy and spatial planning policies. On the one hand they intend to concretize federal, Flemish or provincial climate objectives as formulated in the National and Flemish Energy and Climate plans, the Flemish Spatial Policy Plan, or the provincial Climate or Spatial Policy plans. On the other hand, they provide a strategic (but not legally binding) framework to draft climate plans, evaluate permit applications and initiate projects at the municipal scale (Declerck et al., 2019; Dep. Environment, 2020). Moreover, regional energy planning processes support the often limited energy planning capacity and financial resources at municipal level (Cajot *et al.*, 2017; Roger-Lacan, 2019). As elsewhere, Flemish municipal competences far outweigh municipal resources and expertise. Even in intermunicipal and provincial organizations, developing and structurally embedding spatial energy planning capacity remains a continuous struggle (Custers et al., 2021; Leiedal 2, interview, 2020; Province Antwerp, interview, 2020; Province Vlaams-Brabant, interview, 2021).

At the same time, regional visions aim to address issues that transcend or even conflict with municipal interests (Grosse et al., 2016). The location of large wind turbines is typically an energy question with a supra-local impact, as well as the development of (regional) district heating

1 The scale of these supralocal energy regions resembles that of the multiple co-existing intermunicipal companies and collaborations that for example deal with waste management, energy distribution or regional development, and that of the thematic regions such as the care regions (introduced since 2003), transport regions (introduced in 2019) or housing regions (under research (De Craene and Ryckewaert, 2020). In an effort to reduce this administrative complexity, the Flemish government recently agreed to divide Flanders into 13 'reference regions'. The aim is to homogenize the multiple structures for intermunicipal collaboration that currently exist, but not to set up an extra governmental level at the regional scale.

systems, the location of energy-intensive industries or waste incinerators, or mobility and logistics. In that sense, the current Flemish governments' intention to devolve competences over wind energy permits to the municipal level should be critically evaluated. While this is motivated by the hope that municipalities, being closer to local inhabitants, would be able to resolve potential contestation more easily (Corens, 2021: 115), this research shows that on the contrary, municipalities often view regional visions as a way to avoid difficult political discussions at the municipal scale. How planning responsibilities are scaled and re-scaled then becomes crucial to understand how the politics of transitions are addressed or displaced, as González' et al. also argued in their critical account of wind energy planning in Ireland (Gonzalez et al., 2016). In Flanders, several interviewees expressed the expectation that regional visions can become a sort of 'umbrella' to shield local politicians from potential resistance against ambitious energy actions, such as wind energy projects (Harelbeke, 2020; Province Antwerp, 2020; Province Vlaams-Brabant, 2020; spatial designer Denderland, 2021, interviews). One interviewee specifies that "*I think it is often more comfortable for municipalities to say: 'no that is our regional energy strategy, which we made with the province.' Otherwise it is difficult for them to go against what their citizens prefer*." (Province Antwerp, interview, 2020). Economic players appreciate the idea of a regional framework for energy transition, for a similar reason: "*Mayors are not always the most objective person to make such analyses. I appreciate that these questions are addressed at the regional scale, because then you can remove some of the subjectivity that occurs when you need to serve a local hinterland*" (Flux50, interview, 2021). Constructing a regional energy framework then does not simply displace local contestation, but repositions the discussion to a regional planning arena and potentially provides a stronger substantiation for siting choices of wind energy. However, the regional visions that were developed in Flanders so far, have no legal power, so real contestation might only emerge in the project development phase and during the permit application process.

Indeed, regional energy visions are not formally binding documents but retain the status of 'research-by-design' guidelines. In terms of democratic legitimacy, there's no direct political representation at the level of the energy region, but regional visions are usually approved by the province or the intermunicipal company, and by the municipal authorities. Similar to cases in Austria and elsewhere, even in this ambiguous institutional position and without legal power, regional visions aim to align municipalities and other regional stakeholders behind a shared ambition which can obtain commitment as a 'moral imperative', and strengthen support for energy policies (Späth and Rohracher, 2010; Trutnevyte, 2014; Williams, 2013).

Ultimately, despite their ambiguous position in Flanders' fragmented policy landscape, regional energy planning processes provide unique arenas to address energy transition challenges. They create a potential site for political discussion and courageous policy-making which is missing at both the Flemish and municipal levels. By approaching regional energy transitions explicitly as a spatial question, they connect climate and energy policy with spatial planning, whereby the transformation of the energy system can not be seen separately from the sensitive challenge of mitigating Flanders' dispersed territorial structure. The following sections will explore how

	DENDERLAND	LEIEDAL	PAJOTTENLAND	WAASLAND
PROJECT	*Energielandschap Denderland*	*Ruimtelijke energiestrategie voor Zuid-West Vlaanderen*	*Opgewekt Pajottenland*	*Energielandschap Waasland*
INITIATOR	Province of East-Flanders	Intermunicipal development company Leiedal	Province of Flemish Brabant	Province of East-Flanders
KEY STAKE-HOLDERS	Municipalities: Aalst, Denderleeuw, Ninove, Geraardsbergen, Haaltert, Lierde, Roosdaal, Liedekerke, Affligem	Municipalities: Anzegem, Avelgem, Deerlijk, Harelbeke, Kortrijk, Kuurne, Lendelede, Menen, Spiere-Helkijn, Waregem, Wervik, Wevelgem en Zwevegem	Regional Landscape Pajottenland & Zennevallei + Klimaatpunt vzw Municipalities: Bever, Galmaarden, Gooik, Halle, Herne, Lennik, Liedekerke, Pepingen, Roosdaal en Sint-Pieters-Leeuw	Intermunicipal company Interwaas Municipalities: Beveren, Kruibeke, Lokeren, Moerbeke, Sint-Gillis-Waas, Sint-Niklaas, Stekene, Temse, Waasmunster, Zele, Hamme, Zwijndrecht
FUNDING	Province of East-Flanders – Strategic Project Denderland as context	Flemish Department of Environment – Strategic Project Zero Regio And EU Interreg project HeatNet	Flemish Department of Environment – Strategic Project Opgewekt Pajottenland	Province of East-Flanders
TIMING	2017-2018	2019-2020	2018-2021	2020-2021
DESIGN TEAM	Buur, Sweco, Common Ground	Leiedal Consultancy: Antea, Beauvent, Kelvin Solutions, Buur	Endeavour, LAMA Landscape Architects, Bura Urbanism, Zero Emission Solutions	Sweco, Endeavour
AMBITION	Energy neutral 2050	Climate neutral 2050	Energy neutral and climate resilient 2040 Ambition framework with 10 ambitions	Energy neutral 2040 Ambition framework with 1 main ambition and 8 secondary ambitions

Table 3.2. Main characteristics of the four selected regional energy planning processes.

regional visions differently address the spatially and politically transformative dimensions of a regional energy transition within their specific institutional setting and landscape context. They illustrate how participation, design and contestation unfold in different ways throughout each of the four analyzed visioning processes.

4.2. Introducing four regional energy planning cases

Denderland

'Energy Landscape Denderland' (*Energielandschap Denderland*) was the first regional spatial energy vision in Flanders, and was initiated by the province of East-Flanders. The province is a pioneer regarding energy planning in Flanders and could rely on its previous experience with the Provincial Policy Framework for Wind Energy in 2009 (Debergh and Smitz, 2009), which was later refined in spatial implementation plans ('*Ruimtelijke uitvoeringsplannen*' – plans with regulatory power) for the areas Eeklo-Maldegem-Kaprijke and the highway E40 between Aalter and Aalst. The energy vision fits into the province's ambition to become '*Klimaatgezond*' or climate and energy neutral by 2050. Although it responded to the need of the Denderland municipalities for a shared spatial framework to evaluate permit applications for wind turbines, it aimed to go beyond wind and provide a comprehensive energy strategy. 9 municipalities were involved in the visioning process as members of the 'steering committee' (Custers, 2018). The Denderland region is characterized by a historical landscape of scattered villages that developed into a dispersed settlement structure and gave rise to the associated mobility challenges. The river Dender forms the backbone for a volatile water system, but also for valuable ecosystems and a characteristic recreational landscape (Custers, 2018).

The project ambitions were formulated by the province, which aspired to explore what it means spatially to realize an energy-neutral region, and how the energy transition could be a lever for other spatial and societal challenges. The focus was on the integration of large-scale renewable energy infrastructures in the regional landscape, while social and governance dimensions were addressed only to a limited extent. Throughout the project a number of workshops were organized that brought together a broad group of stakeholders, such as municipalities, (energy) project developers, experts, civil society, and some local inhabitants and companies. Nevertheless, for most of these stakeholders the involvement in the visioning process remained relatively limited. Throughout the process, design was used as an important tool for communication and explanation, rather than as a tool for negotiation. The vision proposed two strategic and spatially structuring concepts: the 'winning area', a productive landscape dedicated to the production of renewable energy, and the 'ehub', selected industrial areas where energy can be collected, used, converted, stored and redistributed. These concepts are developed in two time frames, a 'scenario 2030' that takes into account current legislative conditions, and a 'scenario 2050' that goes beyond what is possible within existing conditions and visualizes a desired future energy landscape (Custers, 2018). The final vision map [Figure 1] represents these strategic concepts in an abstract but geographically recognizable way. Despite their radical spatial impact and transformative potential, these concepts and scenarios were approved without much contestation by the boards of mayors and aldermen of the Denderland municipalities. Reflecting about this, the province's spatial energy planners commented that this was a lucky outcome, adding that "*it was an all or nothing process. If contestation would have emerged, the whole vision could have been retracted because there was nothing to fall back on. Luckily we ended with 'all' rather than 'nothing' in the end*" (Oost-Vlaanderen 2, interview, 2021). The final vision did not include concrete projects or policy measures for implementation, but meanwhile, the province has continued to work on regional development through a learning trajectory '*BRV Proeftuin*' that explored how to move from vision to implementation, and by

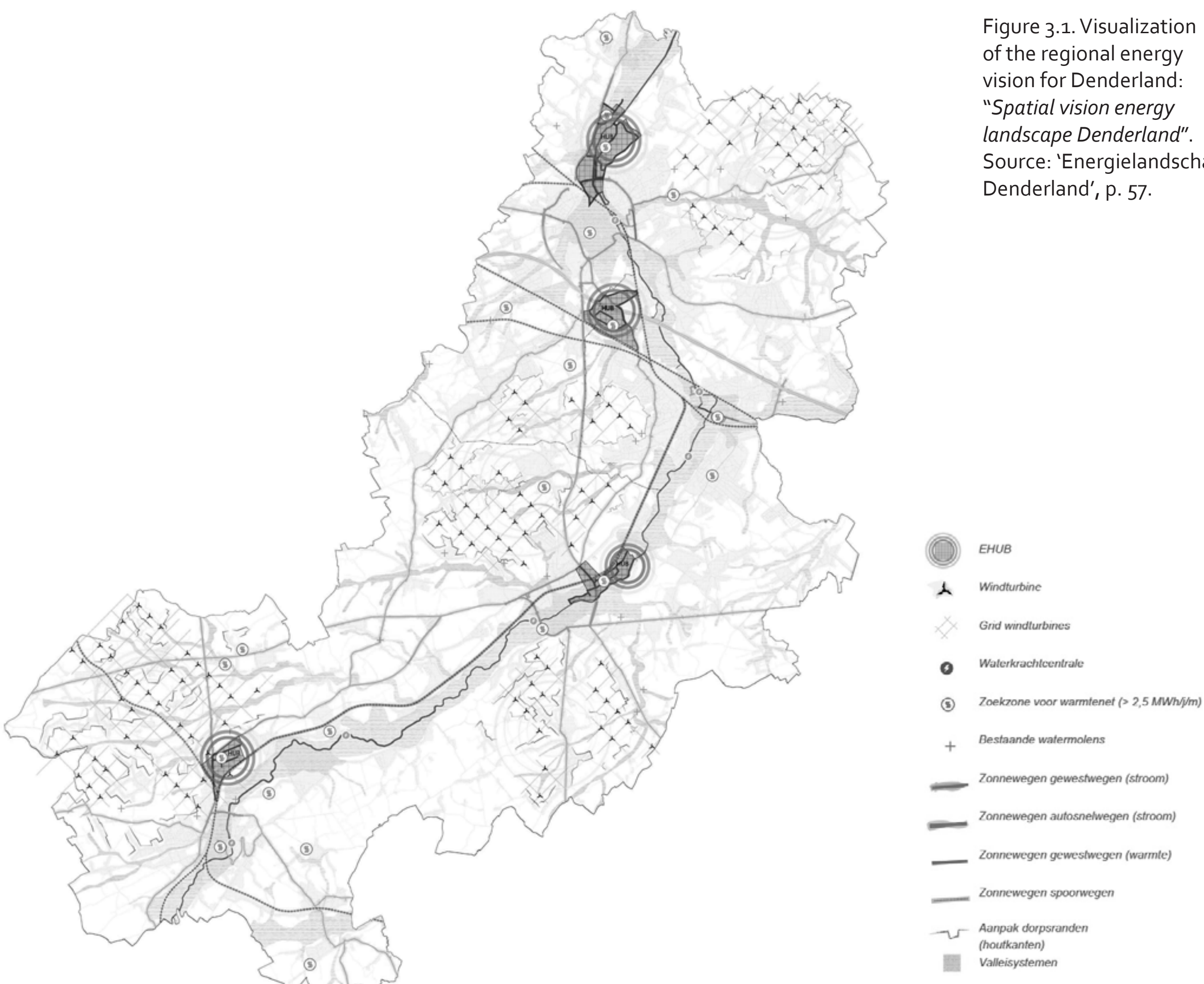


Figure 3.1. Visualization of the regional energy vision for Denderland: "*Spatial vision energy landscape Denderland*". Source: 'Energielandschap Denderland', p. 57.

facilitating several pilot projects (L'Ecluse et al., 2020). It also set up a territorial development programme (*T.OP Dender*) for the region, and initiated the development of an 'action programme' to implement the regional energy vision (Oost-Vlaanderen 2, interview, 2021).

Leiedal

Intermunicipal company Leiedal developed a regional energy vision '*Ruimtelijke energiestrategie voor Zuid-West Vlaanderen*' in 2019-2020 (Cox et al., 2020). Leiedal is composed of 13 municipal shareholders in South-West Flanders, and is responsible for services in the domains of spatial planning and economic development. The intermunicipal company had previously worked on energy planning, and presented a first study for a regional energy strategy in 2012 (Vandewiele, 2017). The regional vision was developed in the context of the European Interreg project 'HeatNet NWE', which focuses on 4th generation district heating, and the Strategic Project 'Zero Regio', which is funded by Flanders and explores the realization of a climate neutral and climate adaptive Leiedal region by 2050.
Leiedal is a dispersedly urbanized region, with a mix of urban and industrial areas along the bundle of road and railway infrastructure in the Leie valley, and a more open landscape in the *interfluvium* between the Leie and Scheldt rivers.

With this vision, Leiedal aimed to explore spatial energy strategies and opportunities to realize a climate neutral region, and explicitly connected energy infrastructure with other spatial challenges around climate adaptation, densification or landscape development. Most social and governance dimensions of energy remained implicit throughout the visioning process. In practice, however, Leiedal actively supports energy governance alternatives, for example by initiating a regional energy cooperative (*Vlaskracht*), exploring models for Energy Communities, and supporting renovation for vulnerable households.

The regional energy vision is based on a series of 3- or 5-day design workshops that were specifically oriented towards Leiedal's constituent municipalities. During these workshops, mapping and design were used to visualize local knowledge about energy opportunities and planned projects. Both administrative and political representatives of these municipalities were invited, and the aim was to support and develop municipal energy planning capacity. However, not in all cases the political representatives attended the work sessions and some municipalities were not able to attend the design workshops at all. The regional vision was also repeatedly discussed during Leiedal's board meetings where all municipalities are politically represented. A municipal civil servant remarks that "*a serious problem is that there is no real political support for a regional energy strategy*", and claims that Leiedal itself should have more decision-making power (Harelbeke, interview, 2020). Next to planners and designers from Leiedal, the workshops also involved external energy experts and spatial designers. This relatively narrow focus on municipalities instead of a broader stakeholder participation can be seen to reflect Leiedal's position as an intermunicipal company. The regional vision could only be communicated to a broader audience after it was approved by all municipal councils.

Leiedal focused on the development of regional strategies for wind and solar energy, and devoted much attention to fossil-free heating. The final vision listed concrete project opportunities and policy measures for each municipality. Leiedal proposed strategies such as the 'wind winning area', 'district heating clusters' and 'climate axes'; selected roads where energy infrastructure, climate adaptation measures and soft mobility can be integrated. The location and potential clustering of wind turbines in open parts of the regional landscape (as in Denderland), was strongly contested by a few municipalities that wanted to protect the open interfluvium landscape (Leiedal 1, interview, 2020). This strategy was ultimately abandoned because no consensus could be found among the municipalities. Working in a relatively urbanized context, Leiedal identified opportunities for district heating in 10 of the 13 regional municipalities. However, some of the municipalities doubted the feasibility of realising these opportunities due to their limited financial capacity and expertise, and strongly depend on Leiedal to further facilitate potential energy projects. Leiedal did not produce one final map that summarizes all aspects of the regional vision, but visualized a regional district heating 'backbone' as a long-term aspiration [Figure 2]. The vision was approved by Leiedal's board of directors, and by the municipal councils of all 13 municipalities.

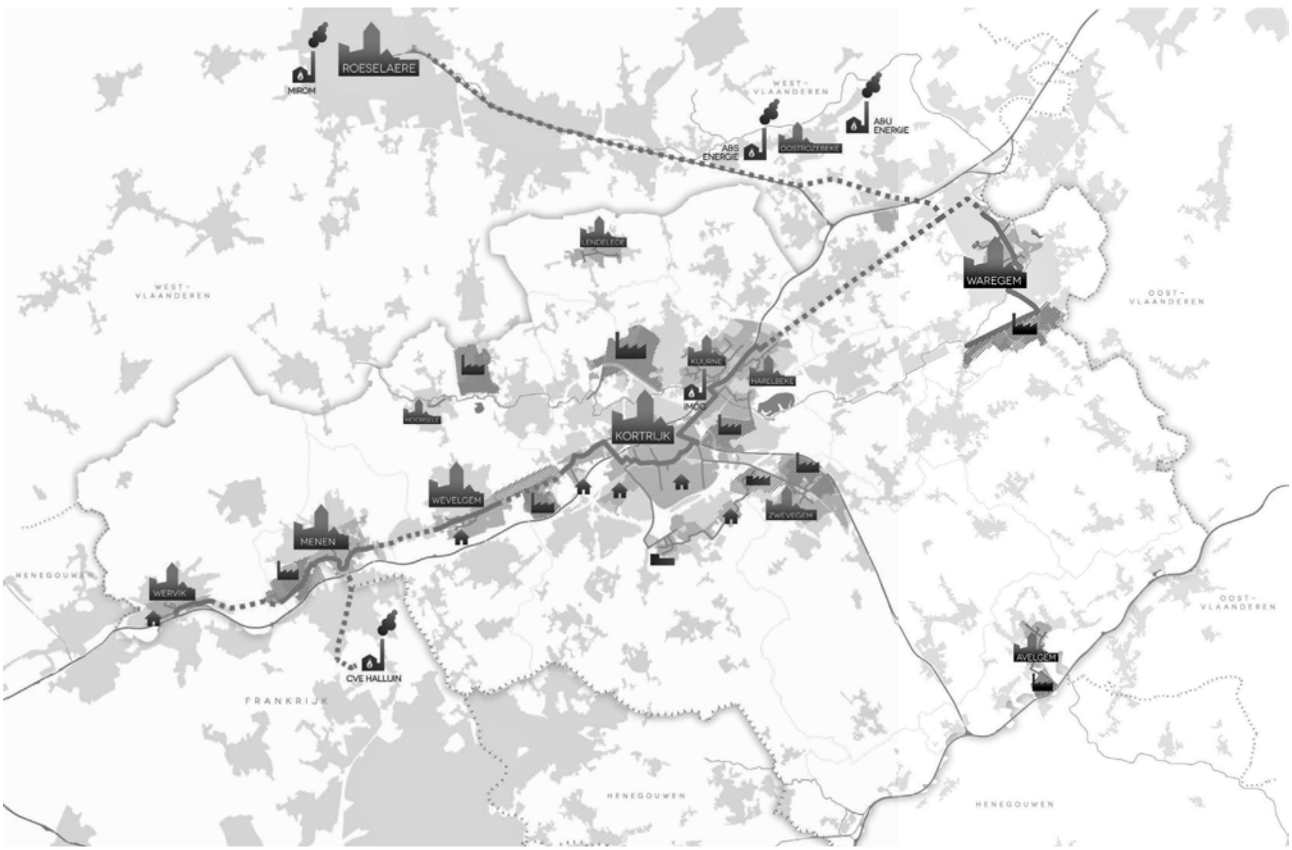


Figure 3.2. Visualization of the regional district heating strategy for Leiedal: *"a regional district heating infrastructure as string of pearls"* .
Source: 'Een ruimtelijke energiestrategie voor Zuid-West Vlaanderen', p. 18.

Pajottenland

With the project '*Opgewekt Pajottenland*', the province of Vlaams Brabant aimed to develop a shared vision for renewable energy in the Pajottenland region. It fits into the province's ambition to become climate neutral in 2040 (Provinciaal Klimaatbeleidsplan 2040). The project built upon the insights from a study about renewable energy potential , commissioned by the province in 2015 ('Energiekansenkaart', (Van Esch et al., 2016)), which identified the Pajottenland as a region with substantial wind energy potential, but did not yet take into account landscape conditions. The province strongly focused on landscape identity and societal support for renewable energy. These aspects are also reflected in the project partners, as the province collaborated with the regional landscape organization ('Regionaal Landschap Pajottenland & Zennevallei') and a local energy and climate ngo ('Klimaatpunt'). The 10 local municipalities were also involved as active partners. A consortium of landscape and spatial planners, designers and energy experts developed an energy system analysis, landscape study and participation process. The Pajottenland region, historically known as the backdrop of P. Breughels paintings, is characterized by a unique and hilly landscape situated between the Zenne and Dender river valleys. At the same time, this relatively intact rural landscape is threatened by urbanization dynamics from the neighbouring Brussels capital region, and from developments in the Dender valley (Devos et al., 2021). This unique spatial context explains the need for a thoughtful landscape approach to renewable energy infrastructure, as a basis for societal support. The province set up a broad participation process and information campaign to build awareness and public support for a regional energy transition. This included diverse public events, thematic and project-based workshops, and an online 'Energiemix' tool. A diverse range of actors were involved, including professional and supralocal actors, local entrepreneurs, youths and the general public. Notably, critical voices engaged in the process, as explained by the project coordinator: "*I think we have more critical voices than positive ones, but that is very interesting. Obviously when you start from a different understanding of the problem, the solutions will also be very different*"(Province Vlaams-Brabant, interview, 2020).

From the start, three thematic foci ran throughout the project and were addressed holistically: space for renewable energy, town centre development, and climate adaptive open space. Throughout the visioning process, an 'ambition framework' was co-created with the stakeholders, which includes spatial and social energy dimensions ('lever for a powerful landscape in all its glory', 'an energy transition with, for and by everyone') (Devos et al., 2021). The landscape vision identifies four characteristic landscapes, and proposes an adapted energy strategy for each of these spatial units: a small-scale energy production landscape around the Ninoofsesteenweg as 'energy and mobility axis', a dynamic energy production landscape in the urbanized Zennevalei, adapted and collective energy concepts for building clusters and 'energetic' villages, and phasing out ribbon development and dispersed housing while developing energy-producing farmyards in the rural interior (Devos et al., 2021). The vision maps visualize how these energy strategies fit into the region's distinctive landscape areas [Figure 3]. Unsurprisingly, the location of wind turbines was the most contested element of the vision, although critical reactions also emerged around the categorization of town centres in relation to future urbanization potential, and around the use of local biomass as a renewable energy source. Thanks to an intensive involvement of the municipalities throughout the whole planning process, the vision was approved not only by the committee of mayor and alderman, but by the entire municipal council of each municipality (Vlaams-Brabant, interview, 2021). Throughout the process, design was a crucial tool to visualize the specificity of the Pajottenland landscape, and explain the spatial dimensions of different energy infrastructures. Reflecting about the process, the landscape designer observed "*of course, as soon as you start drawing on a map, it all becomes very sensitive. [...] we worked on a coherent landscape story and carefully explained each step so that everyone understood all the considerations about the spatial choices we made*" (Landscape designer Pajottenland, interview, 2021). In combination with the design drawings, an energy calculation tool was a crucial basis for dialogue with different stakeholders.

While the intention was to develop energy pilot projects, this turned out to be unfeasible within the scope of the Strategic project, although some smaller initiatives, such as a regional bike route, have been realized. Moreover, the final landscape vision includes 9 detailed thematic roadmaps that propose actions and projects on the short, middle and long term and indicate possible partners and best practices (Devos et al., 2021). This way, the vision aims to provide a broad foundation for bottom-up initiatives in the region.

Waasland

Building on the experience with the Denderland Energielandschap, the province of East-Flanders started a similar process for 'Energielandschap 2050 Waasland' in 2020 and plans to do so for the 'Oost-Vlaams Kerngebied' region in 2022. 12 Waasland municipalities and intermuncipal company Interwaas are project partners and represented in the steering committee.

Characteristic for the Waasland region are the Schelde and Durme valleys with open marshlands and polders, the vast landscape of the Moervaart valley, several forested areas, and farmlands defined by hedgerows and rows of trees. These traditional landscapes were strongly impacted by the urbanization and industrialization of the last 50 years, in particular by the development of the Antwerp harbour. Open landscapes and small landscape elements are being replaced by road infrastructure and ribbon development.

Based on a critical evaluation of the Denderland process, the province designed an adapted visioning process for Waasland. Both political and administrative representatives of municipalities are involved more closely throughout the process. The province also built in several decision moments (process intention, ambition framework, vision and strategy) as milestones to fall back on. Moreover, the province designed a more targeted participation approach whereby specific stakeholders, such as a citizen panel, municipal representatives, professional actors, captains of industry or energy project developers are involved at dedicated moments throughout the

Figure 3.3. Visualization of the regional energy vision for Pajottenland: "*hard map: renewable energy and infrastructure*" (top) and *"soft map: nature, landscape and water*" (below). Source: 'Landschapsvisie 2040 Opgewekt Pajottenland'.

planning process (Callens et al., 2020). Interestingly, the involved municipal representatives and citizens were invited to participate in a masterclass about spatial energy planning to ensure a shared understanding of key concepts and challenges.

The project does not only aim to reduce carbon emissions, use 100% renewable energy by 2040, and to create spatial and societal value for the Waasland region. More than in the Denderland case, the vision will be based on a detailed reading of Waasland's characteristic landscape features, and on an explicit ambition framework. The ambitions were co-created with input from municipal authorities and citizens and include spatial and societal energy dimensions (e.g. 'building shift and multiple use of space', 'sustainable mobility', 'sustainable agriculture' and 'collective', 'just', 'affordable'). Obtaining municipal approval for this ambition framework was not very easy, as it raised fundamental questions, for example about the need to produce renewable energy as much as possible locally. Although it was finally approved by all municipalities' mayors and aldermen, the province's energy planners expect more discussion in coming phases of the process, when spatially specific energy scenarios will be designed and evaluated. The vision will also include an evaluation framework and a detailed action programme (Callens et al., 2020).

As described in the literature (Späth and Rohracher, 2010), these regional energy visions are developed in a relatively consensual way. In Denderland and Leiedal, regional energy ambitions were not explicitly questioned or co-created with stakeholders. In Pajottenland and Waasland, explicitly developing an ambition framework, allowed to unravel and discuss the spatial and societal dimensions of a regional transition with the involved stakeholders. This facilitated more reflection about the social dimensions of an energy transition, for example related to justice, governance or affordability. Still, the processes also evoked some contestation. According to the interviews, tensions emerged not so much between different types of regional stakeholders, but rather occurred between involved municipalities on the one hand, and between municipal, regional and Flemish government levels on the other hand. A particularly important friction voiced by municipalities in all cases is the lack of a clear policy framework the Flemish level, and the need for instruments and resources to realize regional energy ambitions. Overall and in line with the literature, defining suitable locations for wind energy production turned out to be the most contested part of these regional visions and will be studied in depth in the next section.

Regional stakeholders were included differently in each case: while Leiedal as an intermunicipal company focused exclusively on the municipalities, diverse actors were involved relatively superficially in Denderland, but the participation approach in Pajottenland and Waasland were more elaborate. In Pajottenland, the province of Vlaams-Brabant aspired to a broad participation and communication process in an effort to build support and stimulate local initiatives. In Waasland the planners designed a targeted process which includes a citizen panel and a selective involvement of specific stakeholders at dedicated steps of the visioning trajectory. In both cases, a shared learning process formed the basis for meaningful participation. In Pajottenland, this was achieved through a thorough design process whereby each decision was carefully explained and spatially visualized. In Waasland, municipal politicians, civil servants, and selected citizens were offered a training about spatial energy planning at the start of the planning process. In these processes, design was not primarily a tool for negotiation, as described in the literature (Loeckx et al., 2004). Mapping, design and spatial visualization were mostly used as tools to harvest local knowledge in stakeholder workshops, to communicate and build capacity by explaining the spatial dimensions of energy infrastructure, and as a way to contextualize energy ambitions within a characteristic regional landscape. Each of the visions includes spatial energy concepts that respond to the regional spatial structure and connect energy with diverse other territorial challenges, such as densification and redevelopment of local centres, phasing out dispersed housing, strengthening productive landscapes, and climate adaptation. On the other hand, possible relations between energy and agriculture are usually only minimally addressed by spatial energy strategies. Regarding the institutional position of these regional visions and the legitimacy of their initiators (Coutard and Rutherford, 2010; Kenis et al., 2016; Shove and Walker, 2007), the provincial and intermunicipal planners coördinating these processes emerge as key agents. Each in their way they push the boundaries of their role as civil servants (Devos, 2021), with an ambitious agenda and a critical attitude, while aiming to ensure political commitment to a shared regional vision. In Leiedal, the knowledge of the regional context, the energy expertise and the design competences of the regional planners were an important basis for municipal capacity building. In the case of Pajottenland, the effort of the provincial energy planner to involve all layers of municipal government throughout the process was a key for success. In the East-Flemish cases, the provincial planners' experience with energy planning and ambitious agenda strongly influence the regional energy visions. At the same time they adopt a reflexive attitude whereby each successive process is evaluated to provide learning lessons for follow-up regional energy visions. Experiences and spatial concepts are also exchanged between the different regions as they learn from one another, and because several design and consultancy firms were involved in more than one regional process. Implementing these regional energy visions remains a difficult struggle, as described at length in the literature (Asarpota and Nadin, 2020; Bulkeley and Betsill, 2005; Cajot et al., 2017; Grosse et al., 2016; Williams, 2013; Zanon and Verones, 2013). This can be prepared in the visioning stage by engaging key stakeholders such as the network operator or economic actors, identifying opportunities and possible coalitions, and visualizing possible actions and policy measures, as in Leiedal's municipal overviews or the Pajottenland roadmaps. Especially when actions are defined, attention to social justice is crucial and social energy actors should be involved more strongly.

Apart from the dimensions described above, the way conflict is addressed, is crucial to understand how regional energy visions approach the politics of transitions (Kenis et al., 2016). Therefore, the following section focuses on wind energy, and reveals how in three of the cases, the strategy of concentrating wind turbines in specific locations, while keeping other areas free of large wind energy infrastructure, is formulated and contested in different ways.

4.3. Tracing controversies around regional spatial strategies for wind energy production

Denderland

In the vision for *Denderland Energielandschap*, the 'wind winning area' is designed as a productive landscape where wind turbines are concentrated, while other parts of the region are kept free from wind energy development [Figure 4]. These wind areas are selected on the one hand by excluding restriction zones in terms of noise, shadows, safety, nature and landscape protection, and on the other hand by selecting areas where adding a layer of 'energy production' might reinforce landscape characteristics and even create a new landscape identity (Custers, 2018: 19–20). The vision mentions that wind energy profits can contribute to a landscape fund, to be reinvested in small landscape elements such as hedgerows. In an ambitious 'scenario 2050', dispersed housing in such wind production areas is even phased out to allow for the construction of more wind turbines (Custers, 2018). Behind this concept lies the intention to integrate energy in a compact and structuring way into the landscape (spatial designer Denderland, interview, 2021). The visions' designer considers the coupling of wind energy development with the reduction of dispersed urbanization, the redevelopment of the landscape, and the protection of open spaces, a response to Flanders' characteristic territorial morphology (spatial designer Denderland, interview, 2021).

Surprisingly, this ambitious strategy was accepted without much contestation. Looking back, the province's spatial energy planner admits that "*We were quite lucky. The vision was approved by all municipalities, except in Aalst, even in an election year*"(Oost-Vlaanderen 2, interview, 2021). Even Lierde, a rural municipality where one of the wind winning areas would be located, finally accepted the regional plan. Some disagreement with the city of Aalst arose because Aalst developed its own perspective on wind energy and preferred a number of locations that were not included in the Denderland vision. According to the provincial planner, a better involvement of both administrative and political representatives of the municipality, could have avoided this friction (Oost-Vlaanderen 2, interview, 2021). Reflecting about the role of design in the visioning process, Denderland's spatial designer remarked: "*That was the most astonishing of all, we had a large number of allies in that proces. I think it is because for the first time, we visualized this question very well spatially. We spent a lot of time on communication. [...]*" (spatial designer Denderland, interview, 2021). Overall, a positive regional dynamic, the municipalities' clear will to collaborate, the experience and motivation of the provincial planners, and the communicative visualizations by the vision's designer, allowed the radical regional framework to be accepted. At the same time, the spatial designer critically observes: "*We built the Denderland vision with stakeholders that all had something to do with energy or were politicians, while inhabitants were not really involved. Otherwise, it could have been a completely different story.*" (spatial designer Denderland, interview, 2021). Indeed, given the relatively superficial involvement of regional stakeholders, the process did not become a site where diverging perspectives on a regional transition were discussed in depth. Moreover, the project coördinator acknowledges: "*The limited amount of opposition, makes me suspect that the possible impact of the vision was not considered very big. [...] Also the wind developers, I think they were really waiting to see what would happen*" (Oost-Vlaanderen 1, interview, 2021). There was an agreement to suspend all wind energy permit applications during the planning process.

Also economic actors seem to appreciate Denderland's ambitious framework. Network operator Fluvius integrated the main ambitions of the regional energy strategy into its investment plans for the coming years (Fluvius, interview, 2021). The company's director of network management remarked that Oost-Vlaanderen's strong spatial energy policy is the reason this province has more realized wind projects than any other Flemish province (Fluvius, interview, 2021). Several interviewees agreed that wind project developers appreciate a clear spatial energy framework, even if it excludes certain areas from development (Energy consultant, 2021; Fluvius, 2021; Flux50, 2021). Some wind developers used the vision report as a basis to obtain land rights in the designated wind areas (Oost-Vlaanderen 1, interview, 2021). However, the realization of the wind winning areas strongly depends on the legislative conditions at Flemish level (Flux50, interview, 2021; union, interview, 2021). A representative of the energy sector fears that the credibility of the vision may be undermined if its promises cannot be fulfilled because of these conditions at higher policy levels (Flux50, interview, 2021). Pro-actively formulating a spatial framework for wind energy production reverses the reactive logic of current environmental policy whereby project developers first secure land rights and only then assess environmental impact and apply for building permits (union, interview, 2021). This approach leads to lengthy and costly permit applications and regularly ends in an appeal procedure before the federal Council of State (Fluvius, interview, 2021). In that sense, the limited regulatory power of regional energy visions is problematic, as illustrated

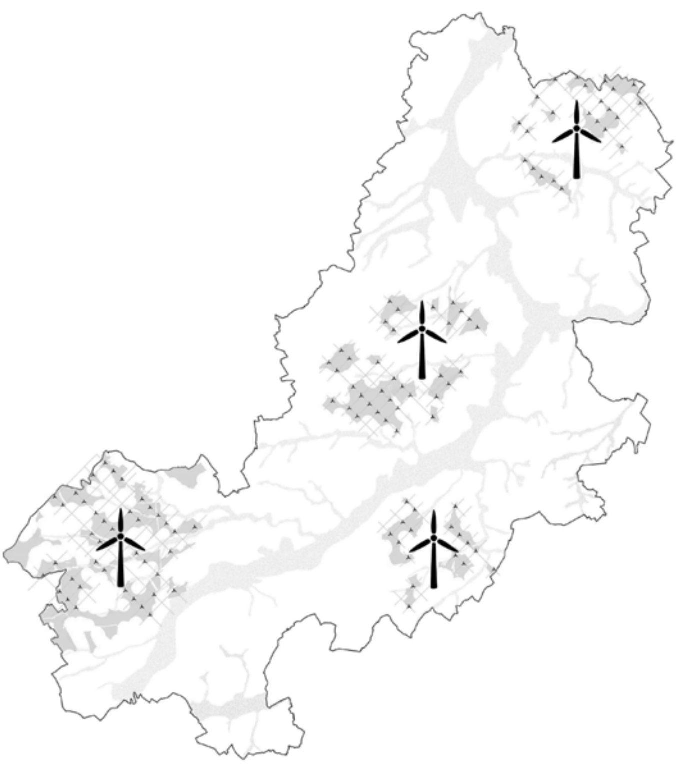


Figure 3.4. "*Wind winning areas*" ('windwinningsgebieden'). Source: 'Denderland Energielandschap', p. 41.

by the following anecdote. According to the provincial planner (Oost-Vlaanderen 1, interview, 2021), when two project developers presented wind project proposals, based on *Denderland Energielandschap*, to the Flemish department of Environment to evaluate their compatibility with spatial planning policy, the response was negative because they didn't follow the guidelines of the wind energy circular (*Omzendbrief*, 2014). Generic guidelines in a document that was never democratically validated, apparently take precedence over a participatively formulated regional vision. This situation on the one hand means that the formulation of spatial guidelines for wind energy is depoliticized, while on the other hand contestation takes the shape of legally challenging permit applications by protest groups rather than that of an agonistic debate.

Leiedal

Although the focus of the Leiedal energy strategy was on fossil-free heating solutions and the development of 4th generation district heating, most disagreement revolved around the location of wind energy in the region (Leiedal 1, interview, 2020). The intermunicipal company explored two possible approaches: clustering wind along important infrastructures (in line with the prevailing guidelines of the 'circular'), or concentrating wind turbines in selected open landscapes, in analogy with the Denderland concept of 'wind winning areas' (Cox et al., 2020). In the second approach, three open space locations were selected based on the elimination of different spatial restrictions, such as buffers around local airports or protected nature areas.

However, this second option raised quite some opposition, particularly from several 'open space municipalities' that aimed to protect the Interfluvium between the Scheldt and Leie rivers from wind energy development. A Leiedal planner observed that unfortunately, the municipalities with spatial opportunities to create wind production areas, were politically most opposed to wind energy. One municipal spatial planner remarked that, even though wind energy is a very promising regional resource, this lack of political support, compelled the region to make other choices (Kortrijk 1, interview, 2020). Indeed, Leiedal's setup as an intermunicipal company requires an agreement among the municipalities before decisions can be approved. Another civil servant argues this lack of political support and the limited political power of Leiedal are a serious hinderance to develop regional energy policy. "*Can we only put wind turbines in the municipalities that say 'yes'? It wouldn't be very wise to distribute them based on 'who wants and who doesn't want', instead of based on knowledge and infrastructure and landscape*" (Harelbeke, interview, 2020). This indicates a need to negotiate between municipalities about the locally differing opportunities for, limits to and perspectives on wind energy production.

Yet, the reality of the energy workshops limited the possibility for inter- and intra-municipal discussion, as each workshop addressed only two specific municipalities with similar energy profiles. At the same time, the vision was also discussed in other fora which allowed for more regional discussion, such as a regional conference of mayors or Leiedal's board of directors. Moreover, Leiedal discussed the energy balance (the current demand and the opportunities for local energy production) on the scale of the region, but then specified the energy demand, energy production potential and possible actions for each municipality individually. The focus on municipalities also limited the potential to create a better understanding and stronger support among other regional stakeholders and inhabitants. The vision might therefore have missed opportunities to create stronger political commitment and public support, although some municipalities would most likely keep opposing wind energy projects. Nevertheless, reflecting about the approval process in the board of directors, Leiedal's spatial designer commented that "*it seems that the mayors always disagree a bit in the beginning, but finally there is solidarity and they understand that some have more spatial opportunities than others*" (Leiedal 1, interview, 2020) Finally, the contested map with potential wind winning areas was left out of the public vision document but remained part of the larger internal report about the research-by-design process that was shared with the municipalities.

Pajottenland

In the '*Opgewekt Pajottenland*' vision, 'wind opportunity areas' (*windkansgebieden*) are identified, whereby wind energy production would mostly be situated in the dynamic landscape of the urbanized Zenne valley (Devos et al., 2021). In the context of the Pajottenlands' unique rural landscape, the integration of wind turbines was a sensitive question. Wind projects had been contested in the region before, which was one of the motives behind the creation of a regional energy vision. Nevertheless, throughout the visioning process, strong support was built among the participating municipalities and other stakeholders about the selection of wind production areas (Landscape designer Pajottenland, 2021; Vlaams-Brabant, interview, 2021). As in Denderland, permit applications for wind projects were put on hold during the planning process.

Looking back, the landscape designer of the vision attributed this support to the search for a strong landscape identity as basis for a spatial framework, the effort spent on visualizing and explaining each choice, and the focus on a positive narrative about where wind production infrastructure could be integrated instead of starting from restrictions. Finally, wind production would be located in small pockets along the edges of the Pajottenland region, near locations with a high energy demand, while the rural interior of the region, where the energy demand is low, would focus on small-scale solar and biomass energy production [Figure 5]. The province deliberately avoided to communicate the energy balance at the level of the individual municipalities. The project coordinator explains: "*Solidarity was an essential part of the exercise. It is not '10 energy neutral municipalities in the Pajottenland', but 'an energy neutral Pajottenland, composed of 10 municipalities'. It is a story of the region*" (Vlaams-Brabant, interview, 2021).

Finally, the selection of wind energy locations in Pajottenland is very close to the guidelines of the Flemish 'circular' that link wind energy production to large linear infrastructures and industrial areas, and less radical than in the Denderland vision. An energy consultant argues: "*the largest difference is the landscape* an sich*. You can't compare the Dender region with the Pajottenland and its valuable agricultural landscape*" (Energy consultant, interview, 2021). The landscape designer adds that "*the Denderland vision is very straightforward, rather top-down. In the Pajottenland we aimed to find and install a broad foundation and try to be agile from there*" (Landscape designer Pajottenland, interview, 2021).

Most contestation came from stakeholders that were less involved during the process. When presenting the vision to the different municipal councils, a recurring reaction was: "*That's easy, you make an energy vision for Pajottenland and push everything to the edges!*" (Vlaams-Brabant, interview, 2021) The project coordinator largely associated this criticism with the local political-ideological opposition by the Flemish nationalist party NV-A. Other critical reactions were voiced in Drogenbos, a municipality just accross the regional border where one of the wind energy areas was situated, while in other bordering municipalities opportunities for collaboration were identified. This illustrates the difficulty of aligning energy visions between neighbouring regions and the need for coördination at a higher scale level.

Figure 3.5. "*Opportunity areas for wind*" ('windkansgebieden'. Source: Landschapsstudie hernieuwbare energie Pajottenland, p. 66-67.

Waasland

At the moment of writing, the Waasland energy planning process is still ongoing. A number of 'building blocks' for the energy vision have been composed, but different scenarios for the region still have to be elaborated in the next planning phase. Therefore, no meaningful insights can be deduced at this point about the regional wind strategy and potential associated frictions.

Tracing frictions around wind energy production accross the regional cases clarifies how the politics of transitions play out differently depending on the regional governance context, landscape qualities and the organization of the visioning process. A combination of ambitious planners, communicative design visualizations and a momentum in regional collaboration, enabled the approval of a spatially transformative wind energy vision in Denderland. In Leiedal, wind energy clusters were perceived as an infringement on the open interfluvium landscape and a lack of political support from some municipalities lead to a retraction of a regional wind energy map. A convincing landscape narrative and an intensive involvement of regional stakeholders built support for a regional wind strategy in Pajottenland, with critical reactions mostly from 'external' actors or party-political opposition. At the same time, it also became clear that real contestation about sites for wind energy production might not take place in regional planning arenas, but rather play out in the form of legal disputes during the permit application phase at project level. The limited regulatory power of regional energy visions means that prevailing principles to evaluate wind projects are based on the legislative instrument of a 'circular' which is drafted and circulated by the minister without participation and therefore de facto depoliticizes these spatial choices. Combined with the abstract character of regional energy visions, this might also cause key stakeholders to adopt a wait-and-see attitude.

5. CONCLUSIONS

This analysis has explored how the politics of transitions are addressed in four cases of regional energy planning in Flanders, by investigating how energy regions are ambiguously positioned in Flanders' complex governance context, tracing how generic energy ambitions are spatialized in a specific socio-spatial context, and unraveling how contestation around wind energy plays out differently in each case.

An important quality of these regional energy visions is to show how energy ambitions can become concrete, whereby the proposed spatial strategies respond not only to the characteristics of the regional urban landscape, but also to the sensitivities of the involved stakeholders. Typical for the Flemish context is to combine energy system transformation with strategies to remedy Flanders' dispersed urbanization, for example by concentrating wind energy in specific locations and coupling it with the protection and redevelopment of open landscapes or with the phasing out of dispersed buildings, by proposing collective heating systems in combination with town centre redevelopment and densification, or by integrating them in street profiles that support climate adaptation and soft mobility.

The studied processes didn't fully recognize and address the political character of regional transitions. Particularly the societal and governance dimensions of proposed energy arrangements were not explored in-depth, and 'social' energy stakeholders were only minimally included. However, the practice employed in the Pajottenland and Waasland processes of co-creating an ambition framework that unravels not only possible spatial but also societal dimensions of the regional transition is promising and can set the stage for a deeper interaction about its multiple transformative potential.

Transition and planning literature emphasized the need for agonistic debate where conflicting interests can be expressed (Albrechts, 2015; Kenis et al., 2016; Shove and Walker, 2007), and design theory highlighted the potential of design as a tool for negotiation and integrating diverse perspectives (Loeckx et al., 2004). However, rather than supporting an arena where the politics of transitions were discussed, design in these cases functioned as a valuable tool to harvest local knowledge, contextualize energy ambitions for a specific regional landscape, and build capacity among regional stakeholders as a basis for meaningful dialogue.

As regional visions only propose strategic concepts, most spatial and socio-political implications of regional energy choices will only become clear during implementation. It remains to be seen how ambitious spatial intentions, such as phazing out dispersed buildings or investing in landscape elements, can be realized. Similarly, social energy questions remained rather abstract at the regional scale, but potential approaches for a more inclusive and democratic transition could materialize when concrete policy actions and projects are identified. However, that is also where the socially transformative potential of the vision risks to be lost if it is not explicitly recognized. Therefore it seems crucial to include social energy actors, such as energy cooperatives or organizations that work on energy poverty, housing rights and renovation support at that stage of the process. Additionally, clear criteria should be defined, in line with the regional ambition framework, to evaluate and prioritize policy actions and projects that question to what extent this action contributes not only to more sustainable spatial development patterns, but also to a more just and inclusive transition.

Lastly, the credibility and feasibility of these visions crucially depends on a more courageous Flemish policy framework around spatial energy planning, and the translation of energy visions in planning instruments with stronger regulatory power. Following the Dutch approach, the Flemish government should formulate clear middle- and longterm climate objectives (e.g. about phasing out natural gas), make regional energy planning compulsory, provide inter-regional coördination (e.g. about the division of emission reduction or renewable energy production objectives), stimulate the Flemish network operator to be involved more pro-actively, and offer appropriate support for regional energy planning through funding, legislative frameworks, and effective planning instruments.

Regional energy visions can be anchored in spatial planning policy in the form of an 'energy policy framework' (Beleidskader Energie). Specific aspects, in particular wind energy locations, can be translated in a regulatory spatial instrument such as a spatial implementation plan (RUP) (Custers et al., 2021). Opportunities for district heating can be integrated in municipal heat zoning plans. Regional visions, rather than the generic guidelines of the 'circular', should also become the foundation for wind permit applications, for example by integrating regionally specific criteria in the environmental impact assessment procedure (spatial designer Denderland, 2021; Landschappelijke inpassing van energie in het Vlaamse landschap, forthcoming).

To conclude, in a policy landscape and public debate dominated by technocratic energy discourses, regional energy planning initiatives offer promising arenas to imagine an integrated energy transition. However, stronger regulatory power, more resources for implementation, and a greater attention to social and governance dimensions of energy strategies are needed to realize spatially and socially transformative energy strategies.

Interlude B

Participant observation – Revealing and amplifying missing voices around the energy visioning table

When I walked into the lobby of the conference venue, what struck me was that the room was full of men. Men in suits, drinking coffee and greeting acquaintances. I seemed to be the only one to notice. As I kept looking around to find a familiar face in the crowd, they continued to chat as we waited for the conference about district heating to start. [Antwerp, 22-11-2018, District Heating Conference]

After this occurrence at an energy sector event, reading Laura Nader's reflection about a similar experience in the late 1970s strongly resonated with me. Although the energy sector has progressed since that time, her critical reflection is still relevant and illuminating. As an anthropologist, Nader was invited to participate in a conference to develop and evaluate different future energy scenarios for the US. The findings of that CONAES study are published as 'Energy choices in a democratic society' (Nader, 1980). She describes the setting for the study as follows: "*The group itself was very limited – all but three were men; all of us were white; and aside from two social scientists and two lawyers, the rest were engineers and physicists.*" (Nader, 2010, p. 198) She goes on to explain how the technical background of these participants, and the specific assumptions they shared, constrained the way they thought about possible energy futures, whereby they exhibited a strong belief in growth, a resistance against energy conservation, and a belief in numbers and in technological solutions. Moreover, she points out how crucial dimensions of the energy transition were not discussed: "*Solar was never mentioned by anybody other than myself, literally not mentioned. [...] The social and political consequences of nuclear power were not discussed. Nobody used the word 'safety'.*" These ethical and socio-political aspects of energy could not be captured in the type and format of reporting that was expected by policy-makers: "*While we were working, no matter what we sent to Washington, we would be asked for more table and less prose.* [...] *For people who want it all in tables, I ask: "How do you talk about freedom in tables? How do you talk about democracy in a table? How do you talk about most of the things we care about in a table?"* [...]" (Nader, 2010, p. 201). Nader's insights introduce at least two elements I want to reflect upon in this interlude. First, her account evokes a consciousness of how positionality – aspects of identity in terms of race, class, gender, and other attributes that mark relational positions in society - is a critical factor in participant observation, and how it affects research course and outcomes (Chacko, 2004). Second, it reveals how, in the energy research setting she participated in, certain types of knowledge and certain types of output were clearly favoured over others, while other perspectives and concerns remained absent.
In this interlude, I reflect about my own positionality as participant observer in energy planning settings in Flanders, about what perspectives and types of knowledge were missing or underrepresented, and what meaningful contribution I could make as a researcher to identify and enhance these voices. A visual overview of (my participation in) these planning processes can be found at the end of this interlude.

Luckily, experiences as the ones described above, of events where women are extremely underrepresented, were relatively rare during my research trajectory. However, the energy sector is still characterized by a strong gender imbalance. Although women represent 48% of the global labour force, they only account for 22% of the workforce in the oil and gas sector, and 32% in renewables (Johnstone and Silva, 2020). While the balance seems slightly better in the renewable energy sector, it's important to take a deeper look at the kind of jobs women perform: only 28% of STEM jobs, and 35% of non-STEM technical jobs are performed by women, compared to 45% of administrative jobs within the renewable energy sector (Boyd et al., 2019). On average, only 15% of board members in energy companies tend to be female (Johnstone and Silva, 2020). Organizations such as the Global Women's Network for the Energy Transition and the International Energy Agency largely attribute this imbalance to the under-representation of girls and women in STEM-related education and professional disciplines. They emphasize the importance of diversity for industry performance and innovation (Johnstone and Silva, 2020), and the need to 'harness talent in all its forms' in order to realize a transition towards sustainable energy (Boyd et al., 2019). However, as Allen, Lyons and Stephens (2019) show, intersections between gender diversity and inclusion, and climate and energy, are much more complex and multifaceted. Literature on gender, climate and energy has mainly taken two directions. One has, as illustrated above, focused on women's careers in energy industry by looking at women's involvement in energy system ownership, investing and decision making. The other has used a gender and development perspective to understand inequalities in access to energy and climate change impact (Allen et al., 2019). Going beyond this existing scholarship, Allen, Lyons and Stephens explore how gender intersects with energy justice and democracy in practice, by studying the role of women's leadership in energy transition movements.

Wondering about what perspectives are missing around the table in energy planning processes, and what mechanisms are at play that exclude certain perspectives from energy transition debates, in this interlude I particularly reflect about the 'procedural' dimension of energy justice, which focuses on inequities in energy governance and decision-making processes. This reflection touches upon intersections between multiple axes of difference, including gender, education and profession, and socio-economic position. I look back upon my own experience as a participant observer in spatial energy planning processes, particularly in the Leiedal and Waasland regions. How could I navigate these planning processes as a participant observer, how should I introduce and position myself during energy workshops, and what could I meaningfully contribute as a researcher to these processes? To what extent was energy treated as a matter of technical expertise and engineering, what perspectives were missing around the table, and why should we care?

Interestingly, the settings of the regional energy planning processes I studied were already refreshingly different from the dominant technocratic discourses in mainstream media or at other energy sector events. Perhaps it was no coincidence that each of those regional processes was led by a very competent and inspiring female coordinator. At the same time, also in these processes the typical patterns of participation could be observed where women were often underrepresented and certain voices dominate the discussion while others remain unheard. In Leiedal, the workshops explicitly aimed to explore spatial strategies for a regional energy transition, and therefore energy infrastructures were discussed in relation to the spatial context, planned public projects and local opportunities. Reflecting this ambition, the invited participants were mainly spatial designers, technical energy experts, and civil servants. I myself also participated as a spatial designer, and always introduced myself as a researcher to the other participants. Sometimes the workshop turned into a discussion about different technological options or economic feasibility, with energy experts juggling cost estimations and Gigawatt hours. Obviously these technicalities are crucial to discuss when imagining spatial energy strategies and by then I had gained a basic understanding of technologies, which was crucial to participate in such workshops. Nevertheless, I often found it challenging to engage in such conversations, and even more difficult to introduce other concerns into the debate, such as the need to think about how to include vulnerable groups in local energy strategies, or about the role of citizens in energy governance. How could I harness the insights from my research to make a more meaningful contribution in these energy planning processes?

At the start of the Waasland trajectory, I discussed with the energy planners of the province what my role as researcher could be and how we would collaborate. We decided I would participate in the visioning workshops as an observer without intervening too strongly, because I was not a Waasland stakeholder and therefore did not have similar stakes in the energy vision as a local inhabitant, organization or entrepreneur, or as a public partner or energy developer. At the same time I shared my interest in the social and political dimensions of the energy transition, and the province seemed interested to explore which 'social' energy actors could be involved, and how. The province had commissioned the office Endeavour to evaluate and improve the design of the planning and participation process. As a complementary contribution, I suggested to interview 'social' energy actors to better understand how they could or wanted to be included in the regional visioning process. As it turned out, it was not easy to identify actors in the Waasland region that could provide a 'social' perspective on the regional energy transition. I ended up interviewing different experts and stakeholders, in and beyond the region, such as a policy expert in energy poverty and a local community worker of Samenlevingsopbouw (a community development ngo), a representative from a citizen energy cooperative, an energy expert from a labour union, and a director of a social housing company in the region. Striking about the interviews with both staff members of Samenlevingsopbouw, was their humble and doubtful attitude about their own potential contribution to a regional energy vision. One of them has over 14 years of experience, but hesitated when I proposed to refer to her as an 'energy poverty expert': "*I'm not sure whether you can call me an expert, we're not used to that in the social sector, I'm usually called a social worker*" (Samenlevingsopbouw, interview, 2021a). She explained that climate and energy transition are relatively new concerns in the social sector. The other interviewee, who had worked with vulnerable inhabitants to identify challenges around water and energy, said: "*I don't know how useful it will be to interview me, I'm not entirely clear on what a social energy transition should look like to be able to help you, I think*" (Samenlevingsopbouw, interview, 2021b). I ensured her that nobody knows exactly what a regional transition should look like and that figuring this out together was exactly the point of the regional visioning process. Interestingly, research shows that women underestimate their knowledge about climate change to a greater degree than men, although they express higher concern and possess greater scientific knowledge about climate change (contrary to expectations from scientific literacy research) (McCright, (2010), cited in Allen et al., (2019)). Both interviews yielded a wealth of insights about the barriers vulnerable households experience in terms of access to qualitative housing and sustainable energy, and about relevant actors to include in a regional energy vision. At the same time, it became clear that because of the high work pressure they experience, few social workers (across the sector) would be able to commit to structural participation in a regional visioning process. These interviewees also emphasized that involving vulnerable inhabitants directly in an energy planning trajectory would require an adapted and sensitive approach: "*Don't underestimate their feeling of inferiority. When you participate in an online workshop, with 25 participants and you're the only one living in poverty, try speaking out in such a setting!*" and "*You can't expect people to speak policy language if they don't have any such experience*" (Samenlevingsopbouw, interview, 2021a). Given my privileged position as a researcher, being able to dedicate time to participating in these processes, I also felt responsible to pass on their message, and presented the main insights from these interviews to the province's energy planners. An important conclusion was that embarking on a regional energy transition from an energy poverty or energy justice perspective, would mean a shift in priorities and policy choices. It would mean that housing quality, and therefore energy efficiency, should become a central issue, because access to decent housing is an essential concern for many vulnerably households, and it is where climate ambitions and social justice overlap. Only when that basic need is met, would it be meaningful to propose schemes for gaining access to sustainable energy sources, for example through affordable shares of energy cooperatives. The province's planners were very receptive for these insights but also indicated that there are limits to the scope of a regional planning process. They agreed it would be valuable to include social actors at the phase of defining an action programme, to ensure a 'social check' when designing concrete projects and policy measures.

As a participant observer, I was simultaneously a privileged insider, and a critical outsider to these planning processes. Observing first-hand how regional energy planners struggle to build support for ambitious energy transition visions, how citizens voluntarily commit to get involved in a citizen panel, how civil servants and other professional actors dedicate valuable time to participate in these processes, gave me a strong sense of responsibility to do justice to the qualities and valuable contributions of these planning initiatives. At the same time, as a critical ally I attempted to identify what was missing, who was missing, and how these processes could be improved. Writing up my insights about regional energy planning, I tried to bring to the fore the social and political dimensions of regional energy transitions that remained underexplored during the processes I analyzed. My insights are undoubtedly biased and incomplete. In fact, any contribution towards such a complex societal challenge is bound to be partial and imperfect, which is why only a combination of diverse perspectives can lead to meaningful responses.

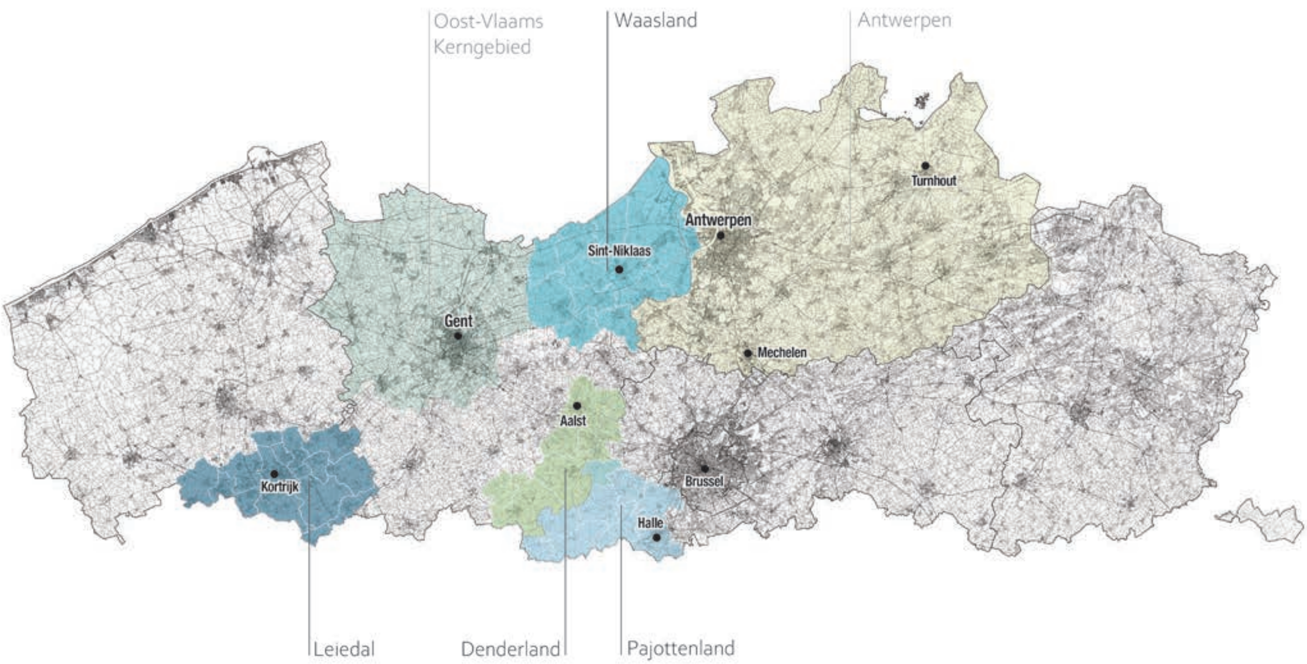


Figure B.1. Location of regional energy planning initiatives in Flanders.
Source: author.

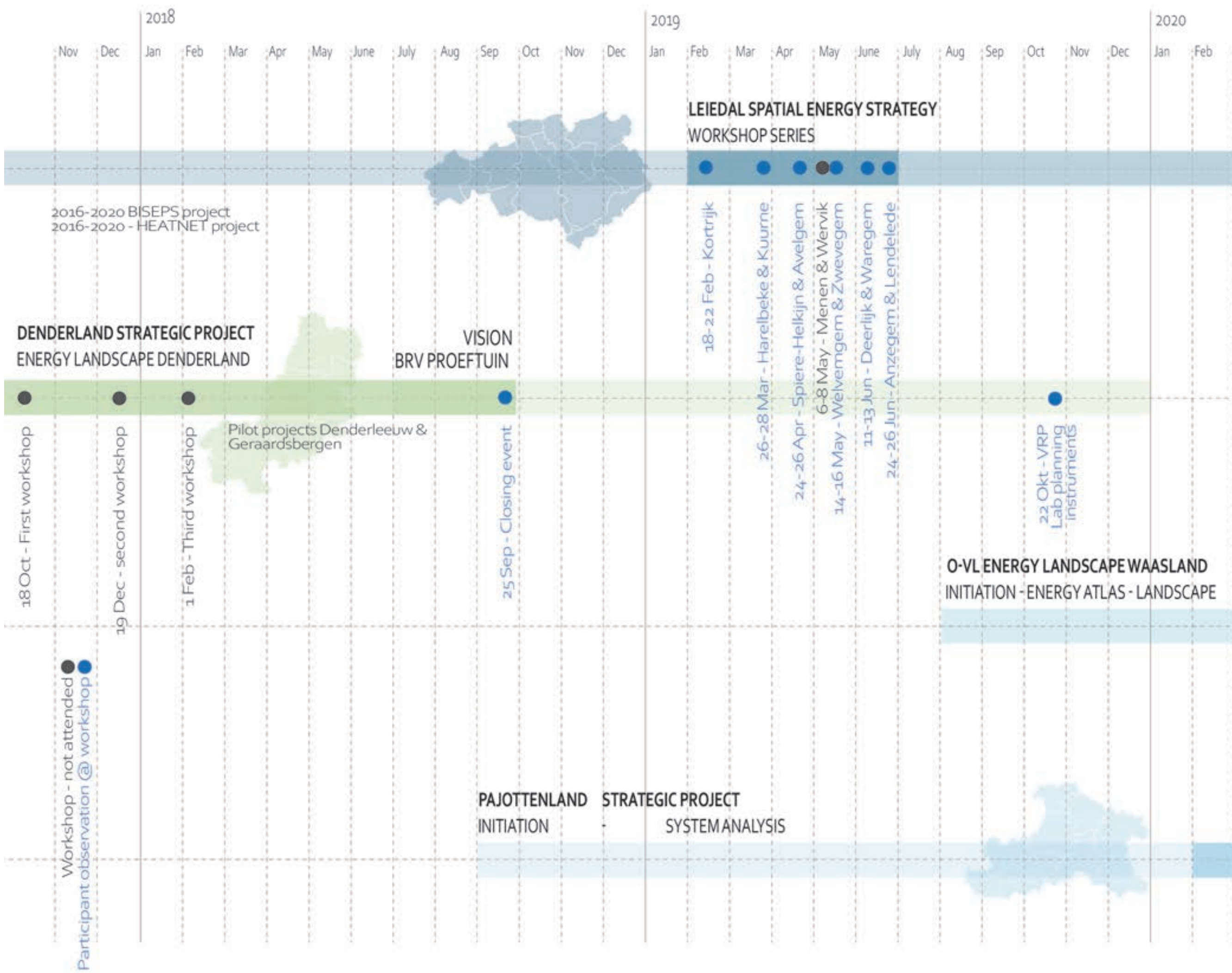
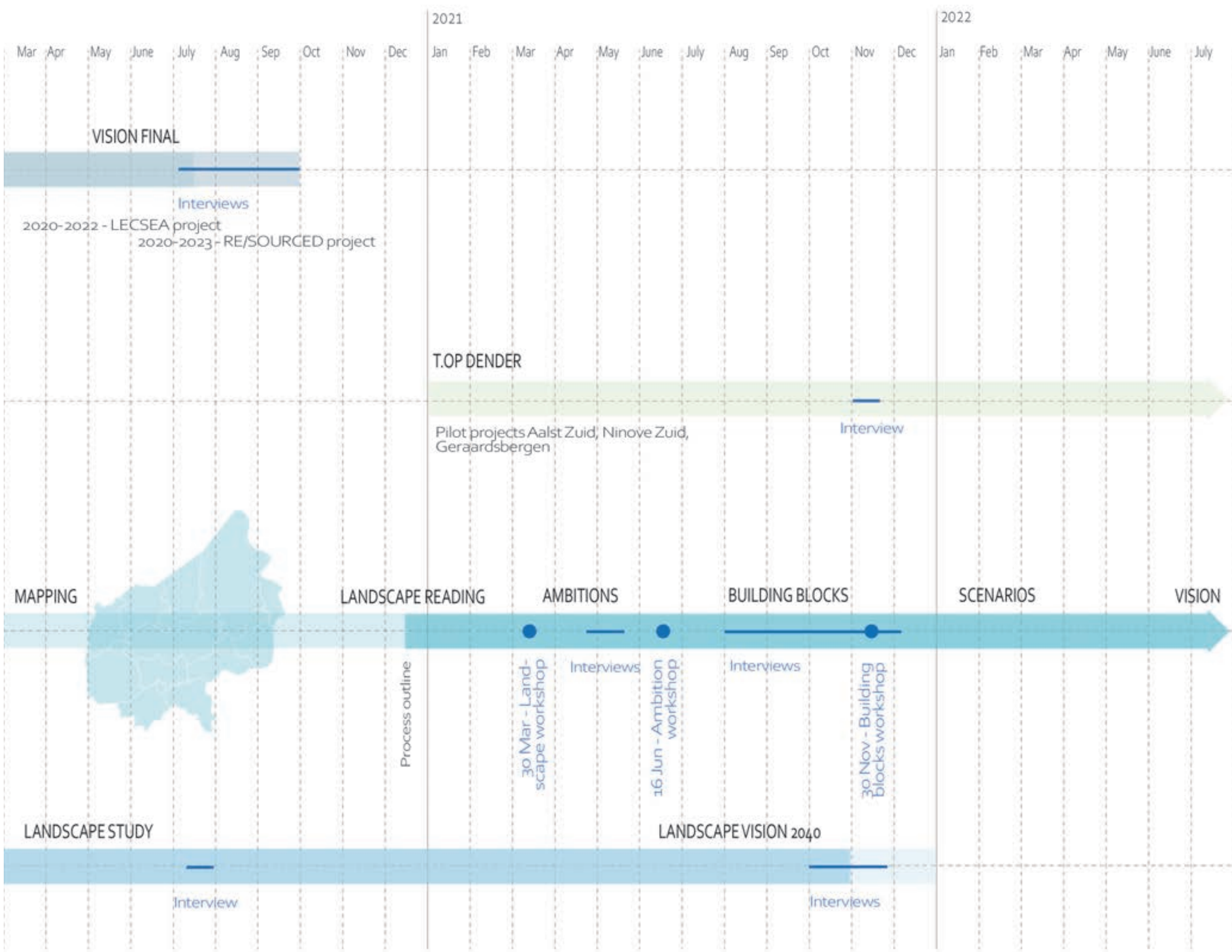


Figure B.2 Planning process regional energy planning in Denderland, Leiedal, Pajottenland and Waasland, indicating participation of author and timing of interviews.
Source: author.


2021
2022
Mar Apr May June July Aug Sep Oct Nov Dec
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Jan Feb Mar Apr May June July
VISION FINAL
Interviews
2020-2022 - LECSEA project
2020-2023 - RE/SOURCED project
T.OP DENDER
Pilot projects Aalst Zuid, Ninove Zuid, Geraardsbergen
Interview
MAPPING
LANDSCAPE READING
AMBITIONS
BUILDING BLOCKS
SCENARIOS
VISION
Process outline
30 Mar - Landscape workshop
Interviews
16 Jun - Ambition workshop
Interviews
30 Nov - Building blocks workshop
LANDSCAPE STUDY
LANDSCAPE VISION 2040
Interview
Interviews

Chapter 4

Territorial and institutional obduracy in regional transition: politicising the case of Flanders' energy distribution system

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It was part of a special issue entitled 'Regional foundations of energy transitions', edited by Coenen, L, Hansen T, Glasmeier, A, and Hassink, R.

The special issue takes stock of the growing field of geographical contributions to energy transition research, and brings together diverse place-based perspectives on regional energy transitions. It addresses the changing roles and responsibilities of actors involved in regional energy transitions, focusing in particular on the need for incumbents to reconfigure traditional business models and on changes in energy value chains. It also looks into energy policy and politics, focusing on the complex interrelations between inter- and supranational actors, the increasing attention to energy justice, and important countertendencies such as remunicipalization. The special issue also raises fundamental questions about the opportunities and limitations for regions to achieve energy transitions.

Author contributions: G.J. and L.D. conducted the empirical research together. In dialogue with L.D., G.J. took the lead in constructing and developing the article. L.D. provided feedback on multiple drafts of the article, which was included by G.J.

Abstract

This case study unravels the ambiguous position of public energy distributor Fluvius in dealing with strategic regional transition challenges. It enriches current understandings of spatial transition dimensions and of public regime actors' roles in transitions, by unraveling the territorial and institutional embeddedness of regional energy distribution systems. We disentangle three controversies in Flemish energy distribution, centered around the spatial concepts of density, spatial selectivity and socio-spatial redistribution. This spatial lens reveals the implicit spatial logics and inherently political character of transforming regional distribution systems. We conclude that a fundamental energy transition requires more inclusive governance, and an ambitious spatial transition vision.

1. INTRODUCTION

Regional energy distribution systems are key elements in the transition towards more sustainable and democratic energy solutions, but their transformation is complex as they are embedded in existing territorial and institutional contexts. In the Flemish region of Belgium, energy supply networks are embedded in a dispersedly urbanized landscape, which is reaching its ecological and societal limits. Network governance is part of a fragmented institutional context with competences distributed between municipal and regional governments. This case study analyzes the ambiguous role of public distribution company Fluvius in the regional energy transition. Since the unbundling of the supply chain, Fluvius manages Flanders' electricity and gas distribution networks, and is not involved in the liberalized market of energy production and supply. This research explores the tensions between Fluvius' strategic role in the regional transition, and its position as operational actor with vested interests in the existing gas and electricity grid. By using a spatial analytical lens, we reveal the implicit spatial logics and inherently political character of transforming the energy distribution system. The evolution from territorially homogeneous networks to spatially diverse energy systems raises fundamental questions of socio-spatial justice, and calls for the rethinking and re-politicizing of energy distribution governance.

1.1. Transforming urban infrastructure and the role of public regime actors

To grasp the territorial and institutional embeddedness of regional energy distribution, this paper mobilizes insights from social technology studies, geographical approaches to transitions and studies on the role of public regime actors in transitions. Social studies of technology conceptualize infrastructure networks such as energy distribution as 'socio-technical systems', emphasizing the interdependence between technologies and society. In the context of climate change, urban infrastructures are increasingly considered a key site of social, ecological, political and territorial change (Bulkeley et al., 2014). However, studies of infrastructure transformation emphasize the inertia or obduracy of socio-technical systems (Hommels, 2005; Markard, 2011). Some scholars have explored this inherent complexity as a starting point for fundamental transformation (Frantzeskaki and Loorbach, 2010). Frantzeskaki and Loorbach (2010) explore whether 'infrasystems' (societal systems that include the physical component of infrastructure and the regulating and managing institutions) are inhibitors or facilitators of societal transitions. They emphasize infrasystems' tendency for incremental change, due to large sunk costs, social dependencies, and the impossibility of a sudden shift to an alternative system. This incremental 'optimization' can lead to a lock-in, or develop into a slow but radical system change. Markard (2011) identifies seven dimensions affecting infrastructure transformation. Barriers to transformation are infrastructure's high capital intensity, asset durability and high degree of 'systemness', that is the interdependencies and complementarities among system components. On the other hand, a negative environmental impact, regulation intensity, competition intensity and the strong role of public organizations can in some cases become sources for change. While these infrastructure studies offer valuable insights into the mechanisms that contribute to the obduracy of networked infrastructures, they underestimate the importance of their spatial embeddedness, and offer little guidance for an in-depth understanding of the specific governance conditions that shape the role of public actors in utility networks.

Geographical approaches to transitions recognize how spatial processes shape energy systems and influence their capacity for transformation (Bridge et al., 2013). They have emphasized the socio-spatial embeddedness of transition processes (Truffer et al., 2015) and analyze their place-specificity in terms of regional visions and policies, local institutions, natural resources, technological and industrial specialization, and regional markets (Hansen and Coenen, 2015). Bridge et al. (2013) propose six concepts to analyze the spatiality of transitions: location, landscape, territoriality, spatial differentiation, scaling and spatial embeddedness. These provide starting points to address aspects of territorial morphology that have often remained underexplored in transition studies (Juwet and Ryckewaert, 2018).

Transition studies also explore the changing roles and responsibilities of state and private actors in regional energy systems. Particularly the variation of regimes across space and the role of regime players in network industries is receiving increasing attention (Geels, 2014). Both in Europe and the USA, energy distribution historically developed as part of vertically integrated geographic monopolies that were either state-owned or privately owned (Joskow, 2008; Wollmann et al., 2010). Since the 1980s, many countries have implemented reforms to liberalize, unbundle and (re-) regulate the electricity sector with the aim to open up monopolistic structures, introduce market competition, increase system efficiency and reduce retail prices. The UK was a forerunner and initiated market liberalization in 1989, with North-American states such as California, New York, Pennsylvania and Texas following in the 1990s. In the European Union (EU) the energy market was reformed through successive directives from the mid-1990s onwards. Such liberalization efforts yielded varying results in terms of market competition, service quality and retail prices, depending on the model and degree of implementation, and remain an ongoing process in many countries. In the USA, the vertically integrated model continues to exist alongside liberalized wholesale and/or retail electricity markets (Joskow, 2008). Wollmann et al. (2010) show how the role of municipalities in energy distribution changed in different European countries as dynamics of liberalization and unbundling involved processes of de- and remunicipalization, and have rescaled and re-territorialized governance arrangements around energy provision. Today ownership of energy distribution networks differs, with private ownership being dominant in some countries (UK, Italy), largely national ownership (France, Austria), municipal ownership (Belgium, Norway, Sweden) or a combination of municipal and regional or provincial ownership (Netherlands, Germany, Switzerland) (Rullaud and Gruber, 2020). Large investor-owned utilities dominate the US energy market, but publicly owned utilities and cooperatives also serve a substantial share of consumers (Chen, 2019). Mühlemeier (2018) focuses in particular on the role of public regime players in regional transitions, and highlights the ambiguous position of urban and regional public utility companies (Stadtwerke, Kantonswerke). These combine an economic role in the energy market and a socio-political embeddedness in the urban or regional public governance system.

Public ownership of urban infrastructure is also a topic of public debate and contestation. In Germany, for example, debates on energy democracy and re-municipalization have pointed out how local governments and communities can contribute to more inclusive and sustainable energy governance (Becker et al., 2017). These movements reclaim the socio-political potential of transitions, and tie in with repeated calls to study transitions as inherently political processes, involving diverging and often conflicting interests and ideas, and producing 'losers' as well as 'winners' (Meadowcroft, 2009; Monstadt, 2009; Rutherford and Coutard, 2014). Geographical approaches to transitions (Truffer et al., 2015) and energy justice literature (Bickerstaff et al., 2013) have also drawn attention to issues of inequality and uneven development.

1.2. The case of Fluvius: conceptualizing and situating in EU context

This article contributes to these ongoing debates in transition studies by unraveling the particular spatial and governance structure of Flemish energy distribution.

The Flemish territory is characterized by a very dispersed form of urbanization, as can be found in regions such as the Italian Veneto, the German Rein-Ruhr area or the Dutch Randstad (Viganò et al., 2018). Therefore, the region provides a useful case to study the relation between a transition in energy distribution, and territorial morphology. Inspired by the early conceptualization by Bridge et al. (2013) the case study engages with the regional energy landscape and its dispersed urbanization morphology, the territoriality and scaling of energy governance fragmented between the regional and municipal levels, and the spatial differentiation of energy infrastructure investments and distribution tariffs. We also mobilize insights from urban design theory to understand the role of technical networks in supporting and reproducing dispersed urbanization patterns. The relation between transport infrastructure and the industrialization and urbanization of Belgium has been studied extensively (Van Acker, 2014). However, various supply networks have only recently received attention. Bruggeman showed how Belgium's historical electrification was part of the nation's modernization. These networks facilitated and reproduced dispersed patterns of urbanization (Bruggeman and Dehaene, 2017). This perspective underlines how territorial morphology contributes to the spatial obduracy of regional energy networks.

At the same time, Belgian energy distribution is part of a complex governance structure, whereby distribution networks are owned by the municipalities, but political authority for energy matters is fragmented between the federal, regional (Flemish/Brussels/Walloon) and local level. In that sense, it is in alignment with other federal states such as Germany, Austria or Switzerland (Mühlemeier, 2018). Mühlemeier proposes six analytical categories to describe public incumbents, which are also useful in understanding Fluvius' position in the Flemish energy transition. The company's role is to provide public services and to achieve profitability (providing a return to municipal shareholders) (1). Its governance structure reflects a need for democratic control (municipal representatives) and to be competitive (technocratic management) (2). The company is expected to pursue both corporate and public entrepreneurship (3). Local governments take up multidimensional roles, as shareholder, permitter and partner in energy projects (4). Different governance levels of the federal system represent multiple political goals and means (5), and Fluvius operates the infrastructure network as a natural monopoly that is strongly regulated at the regional level (6).

Noting these similarities with other federal countries, the Flemish case also differs from them in several ways. Unlike many urban utility companies, Fluvius only operates the distribution network. Since Fluvius does not produce or supply energy, the company is not exposed to the competitive forces characterizing these markets. Moreover, the German urban utility companies (Stadtwerke) are often full-service utilities that manage not only energy but also water or public transport networks. While Fluvius is involved in sewage or tv cable in some municipalities, the electricity and gas network remain its core activities. Whereas Stadt- or Kantonswerke are strongly embedded in their local governance context, energy distribution governance in Flanders has 'scaled up' over time and become relatively removed from the local government sphere. This upscaling process shows similarities with the evolution of the French governance model. Poupeau (2004) describes how energy distribution in France, originally a local competence, since World War II was slowly nationalized and remains in the hands of the national state even under EU liberalization policies. The gradual unification of energy tariffs in France reveals tensions between rural and urban interests, an opposition that also appears in Flemish debates about tariff differentiation and redistribution.

Importantly, municipal ownership of energy distribution in Flanders is more an outcome of ownership legacies and the vertical unbundling of the Flemish electricity system than the deliberate result of policy decisions or public debate. In that sense, our case engages with the critique by Becker et al. (2015) that public ownership in itself is no guarantee of achieving a more sustainable or democratic energy system, but requires political contestation. Furthermore, this case study examines the socio-spatial questions that emerge with the shift from a 'modern infrastructure ideal' of territorially and politically integrated energy systems (Coutard and Rutherford, 2016) to energy systems that are spatially diverse and context-specific. By revealing how the operational and technocratic governance of the Flemish energy distribution system depoliticizes these socio-political questions, it connects with critiques of the post-political condition of sustainability politics (Kenis and Lievens, 2014).

2. METHODOLOGY AND STRUCTURE

This case study is based on a theoretically-informed inductive approach using two key methods: the study of secondary documents and in-depth expert interviews [Figure 1]. To ensure internal validity of the single case study, we refined these methods iteratively, and triangulated findings utilizing different data sources (Yin, 2009). A preparatory study of relevant policy and media documents provided initial insights in the challenges of transition by highlighting key issues regarding energy distribution governance. Subsequently, we conducted 21 expert interviews with 24 key stakeholders, which were selected utilizing a snowball sampling design. As the energy distribution system is typically a multi-actor setting (Frantzeskaki and Loorbach, 2010), the interviews were crucial to our understanding of the socio-spatial rationalities behind key actors' behaviour in the energy transition. They revealed diverse, and often conflicting perspectives on the current and desired role of Fluvius in the energy transition. We explicitly articulated this diversity of perspectives in the research findings. The interviews took place between March 2019 and February 2020 and lasted between 1 and 3 hours. We followed a semi-structured interview protocol (Dunn, 2016) and asked interviewees about their role in, or relation with Fluvius, and about the societal, political, spatial and financial aspects of Flemish energy distribution. We iteratively refined the interview questions throughout the data acquisition process based on evolving insights. The interviews were anonymized, transcribed, coded and analysed using MAXQDA, a software tool that allows a researcher to collect, organize and analyse qualitative research data (www.maxqda.com). We used a hybrid coding approach, of pre-defined categories of 'role in transition', or 'governance', 'financial' and 'spatial dimension', and further refining these codes according to emerging topics, such as 'density', 'spatial selectivity' or 'redistribution'. The research findings are reported in two parallel papers, with this paper focusing on the spatial aspects of energy distribution, and a second paper (Deruytter et al., 2022) focusing on the financialization of municipality-owned energy companies.

The following empirical sections illustrate the complexity of a transition in energy distribution, in a context of urban sprawl and fragmented governance. First, we problematize Fluvius' ambiguous position in the regional energy governance structure. The next three sections are then structured around three contemporary controversies in Flemish energy distribution. These reveal three dimensions of obduracy or lock-in of energy distribution in Flanders. The first controversy relates to a study by the Flemish energy regulator exploring the potential differentiation of distribution tariffs based on spatial density. This tariff reform is connected to a sensitive debate about redistributing the societal cost of infrastructure networks supporting urban sprawl, illustrating how the region's territorial structure complicates energy network transformation. The second controversy relates to the spatially selective introduction of decentralized heating solutions such as district heating or all-electric technologies, which risk to cannibalize the existing gas infrastructure. We argue this lock-in originates in the lack of strategic spatial energy planning and of a clear political mandate for the distribution company to phase out natural gas. The third controversy concerns the implicit social and spatial redistribution of transition costs through levies on the energy tariff. It reveals how traditional solidarity mechanisms cannot guarantee a just energy transition. Conceptualizing these controversies from a spatial perspective, using the concepts of density, spatial selectivity and socio-spatial redistribution, allows us to understand the territorial and institutional embeddedness of the regional distribution system.

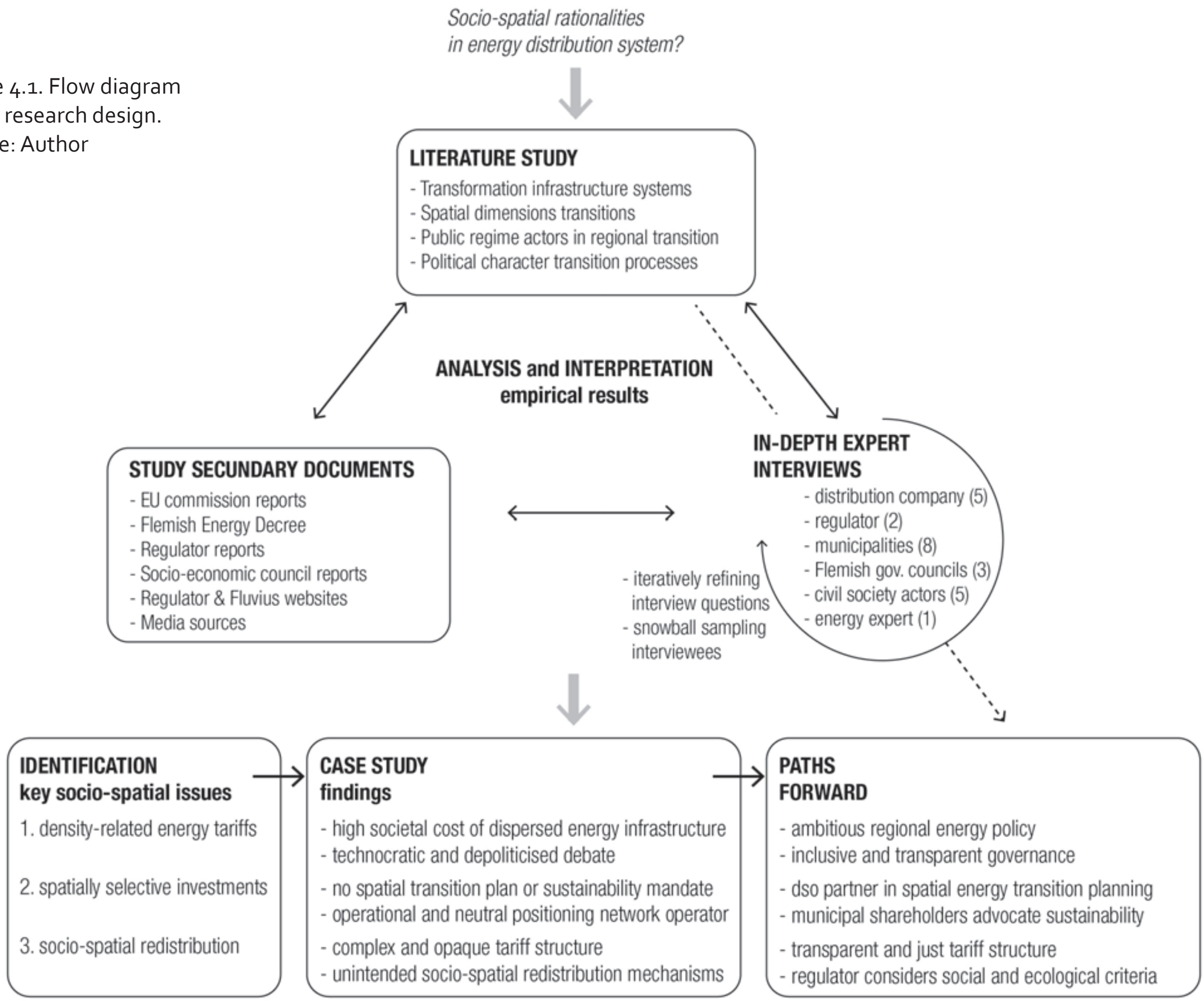


Figure 4.1. Flow diagram of the research design. Source: Author

3. RESULTS

3.1. Historical context and Fluvius' ambiguous position in the regional governance structure

In the early 1900s, municipalities established energy companies or granted concessions to private developers. Over time they started to collaborate as public or public-private 'intermunicipal' energy companies for gas and electricity. Electricity networks became integrated into existing, dispersed and often rural social and spatial contexts. Under the state's impulse, aspiring towards the modernization of the country, provinces promoted the connection of remote areas to the centralized network, by pooling concessions of different types of areas, mobilizing local capital through municipal bonds or direct public financing (Bruggeman and Dehaene, 2017). Bruggeman characterizes this as a process of 'cheap urbanization'. Leaving the initiative to roll out energy supply networks to municipal and provincial authorities allowed the national state to avoid large investments in distribution infrastructure. This made the energy system easy to implement, but it developed over time into a capital-intensive infrastructure that is expensive to maintain (Bruggeman, 2019). Both ecological and societal limits of this dispersed urbanization are becoming increasingly clear.

Today, the 300 Flemish municipalities are still shareholders of the distribution network. Through a process of merging and upscaling, they became organized in 10 intermunicipal Distribution System Operators (DSOs) [Figure 2]. These DSOs assigned network operation to a regional daughter and operating company: Fluvius. Fluvius is the result of a merger that took place in 2018 between the former companies of Eandis (operator for the public-private DSOs) and Infrax (public DSOs). After Eandis had bought out its private shareholder Electrabel in 2014 and the introduction of a new private partner in 2016 was prevented last-minute, all energy distribution companies in Flanders effectively came into public hands (Deruytter et al., 2022). As a key player in the Belgian energy system, Fluvius is confronted with several strategic questions. The company has to implement technological innovation, integrate renewable energy, digitize the distribution system and enable energy storage and balancing. Fluvius also has to navigate ongoing energy market transformations such as EU market integration and unbundling. Changing demands from civil society challenge Fluvius to think about energy democracy and transparency. Most importantly, Fluvius has a key role in facilitating a transition towards a fossil-free regional energy system.

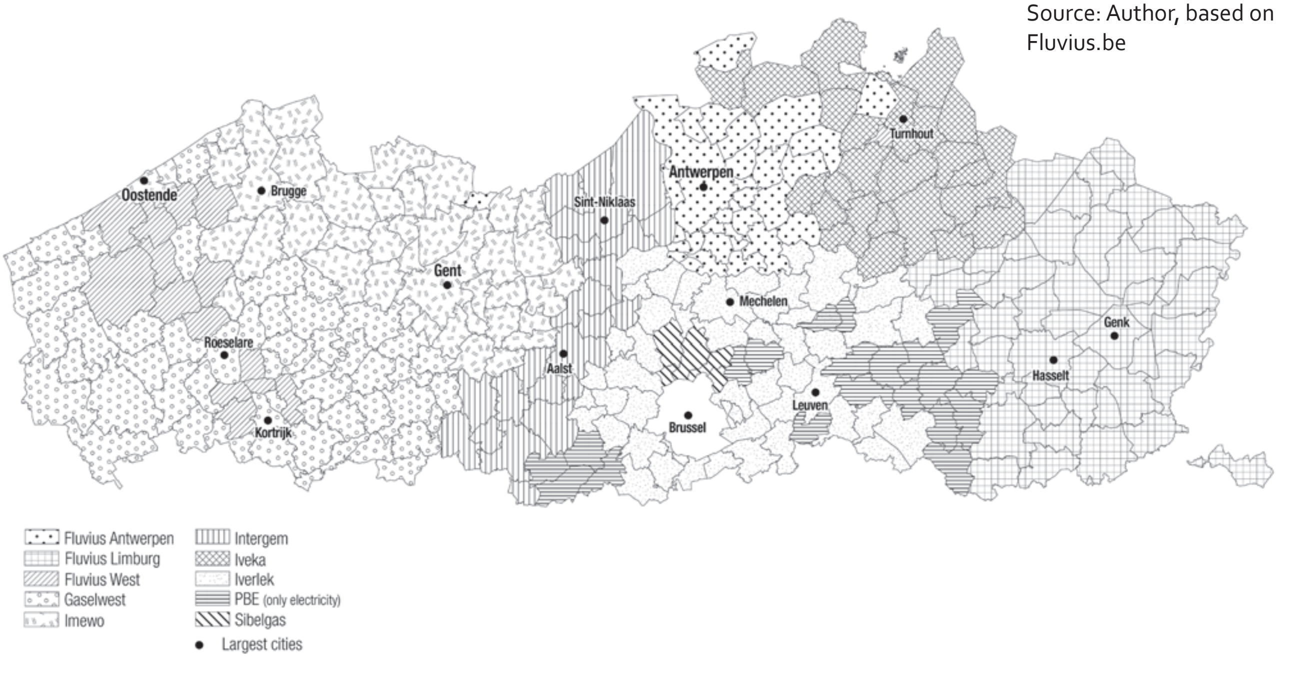


Figure 4.2. Intermunicipal distribution network operators in Flanders. Source: Author, based on Fluvius.be

Meanwhile, competences in energy policy are spread between Belgium's federal and regional government levels. This fragmented governance impedes the development of a coherent energy transition policy. Transmission and centralized production such as nuclear power and offshore wind are federal competences. The Flemish government has the authority over energy distribution, decentralized renewable energy production, and energy efficiency policy. Flanders determines the conditions of Fluvius' operations through the Energy Decree (Energiedecreet 2009), and regulates intermunicipal companies in the Local Government Decree (Decreet Lokaal Bestuur, 2018). The Flemish energy regulator VREG is the independent authority that oversees the electricity and gas market, supervised by the Flemish Parliament. However, the Flemish government shows a wavering engagement with Fluvius, and has not articulated concrete sustainability objectives for the network operator in the Energy Decree, nor does the regulator include transition criteria when reviewing the energy distribution sector. This lack of a clear policy mandate differs from several other countries. In 2005, the Netherlands established a future visioning process (Steenhuisen and de Bruijne, 2015) and the national government set clear objectives about phazing out natural gas by 2050. The UK regulator Ofgem incentivizes network operators to become more sustainable. This absence of a regional transition framework in Belgium leaves Fluvius without clear sustainability obligations or strategic guidelines defining its role as key public actor in the regional energy system.

Ultimately, important responsibilities in energy distribution remain with Flemish municipalities. As shareholders, they are represented in the hierarchical governance structure of Fluvius: local representatives have a seat on regional committees, boards of intermunicipal companies and the board of directors of Fluvius [Figure 3]. Although this structure was historically created according to principles of representative democracy, it is often perceived of as being opaque and ineffective. The board meetings cannot be considered independent of the larger political sphere as key local representatives have political affiliations with the Flemish government. Several interviewees doubt the capacity of local representatives to think strategically about Fluvius' role in the transition, or their ability to challenge Fluvius' mode of operation (Association of municipalities; Energy cooperative 2; Environmental Association, interviews, 2019). Municipalities lack the expertise and capacity to undertake energy planning, unlike other countries such as Denmark which has a long tradition of municipal energy planning (Chittum and Østergaard, 2014). While Flemish municipalities have generally formulated climate ambitions and signed the Covenant of Mayors, they have not historically used their voice as shareholders to formulate energy transition objectives for Fluvius. On the one hand, such sustainability objectives might conflict with municipalities' financial dependence on the yearly dividend they receive from the intermunicipal energy companies. On the other hand, municipalities indicate that the upscaled governance resulting from the creation of the regional actor Fluvius has increased the 'distance' between municipal governance and energy distribution management (Infrax management, interview, 2019). This distinguishes the Flemish situation from the German or Swiss contexts, where urban utility companies are often closely connected with local governments (Mühlemeier, 2018).

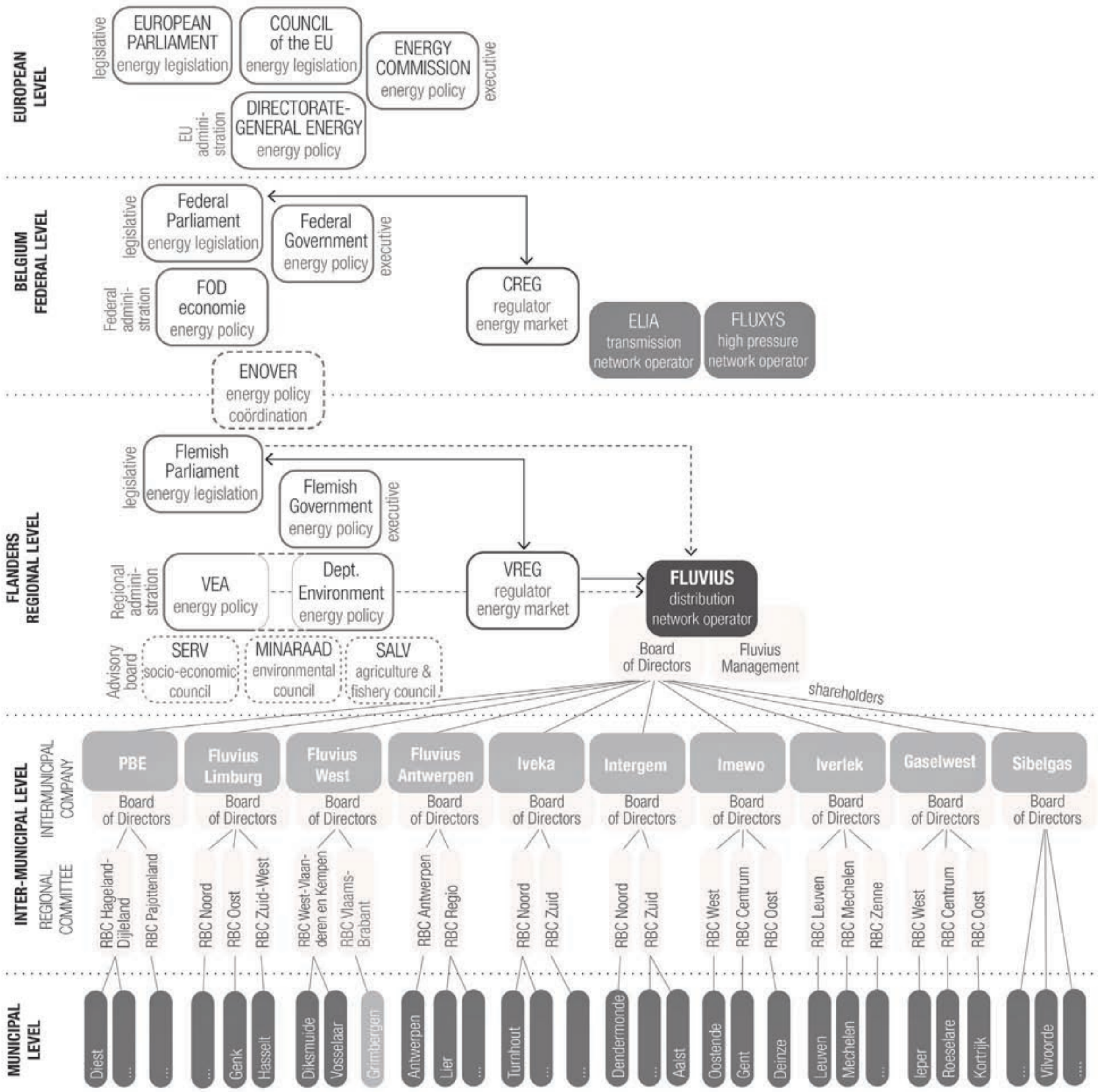


Figure 4.3. Fluvius governance structure.
Source: author.

This governance context leaves Fluvius in an ambiguous position. Crucial regional challenges of addressing the ecological and societal cost of dispersed urbanization, by phasing out fossil-fuel-based energy systems, and organizing a just energy transition, underscore Fluvius' strategic role in a regional transition. Paradoxically, while Fluvius' decision-making structure is tied in with local and Flemish politics, a political locus to discuss these strategic and inherently political issues is lacking. No single institution has the mandate to define Fluvius' role in the energy transition. This agency is distributed between the company's board of directors and different local and regional governments and actors, such as the Department of Environment, the Energy Agency and the regulator. Moreover, although the network is operated at the regional scale, Fluvius' financial structure is connected to municipal finance rather than organized through the regional tax system. The following sections unravel how this paradoxical position plays out in three contemporary controversies about energy distribution in Flanders.

3.2. Density-based energy tariffs and the societal cost of urban sprawl

Increasing awareness about the societal cost of Flanders' dispersed urbanization, is raising questions about the traditional ideal of universal, affordable access to urban services. A recent discussion about the potential differentiation of energy distribution tariffs based on regional variations such as urban density illustrates this tension. Proponents of this reform argue the cost of distribution infrastructure is higher in areas with lower density and should be reflected in the energy tariff. An in-depth analysis shows how this sensitive societal question is treated as a technocratic issue by the Flemish regulator, and reveals the need to re-politicize the debate about mechanisms that support urban sprawl.

The Flemish regulator is currently preparing a tariff reform, from a tariff based on energy use (€/kWh), to a 'capacity tariff' based on the power of the connection (€/kW). Interestingly, the Flemish Energy Decree specifies that "*when introducing a capacity tariff, the tariffs take into account regionally objectifiable differences*" (Energiedecreet 2015, authors' translation). One interviewee specified that "*adding this clause was requested explicitly by the city of Antwerp*" because if energy tariffs would be homogenized in Flanders, "*Antwerp, and other cities probably, would want to keep their comparative advantage of lower tariffs*"(Infrax management, interview, 2019).

To implement this specification in the Energy Decree, the regulator commissioned a study that first established criteria for 'Regionally Objectifiable Differences (ROD) (Vanden Berghe et al., 2018) and then evaluated a series of possible spatial, technical and financial differences for inclusion in the tariff structure (Pruiksma and van Wingerden, 2019). Although morphological characteristics such as 'infrastructure density' and 'connection density' were identified as possible ROD factors, they were not selected because available data were not considered reliable and no additional data were collected. Based on similar arguments, none of the other ROD factors were selected.

The VREG's positioning as an independent regulator with unique competency in tariff matters, is key to understand its technocratic approach to the ROD study. The study relies on limited public consultation and a narrow interpretation of 'objectifiable differences'. In the consultation about the selection criteria, the Federation of Belgian Electricity and Gas Companies (FEBEG), supported this narrow approach: "*Tariffs have to cover the costs of the distribution network operator, they are not a policy instrument*" (Consultatiedocument van de Vlaamse Regulator van de Elektriciteits- en Gasmarkt, 2018). Several interviewees referred to the VREG's neutral position as a consequence of European energy legislation. EU's 'Clean energy for all Europeans' Package indeed dictates that national regulatory authorities should be independent, impartial and transparent, and should be established as a separate and distinct legal entity from the government (European Commission, 2019). However, an interpretative note specifies that government is still responsible for determining the policy framework within which the regulator operates (The regulatory authorities, 2010). Several interviewees criticize the regulator's technical approach to tariff matters and demand a stronger stance by the government. "*The regulator is a bit too independent for my taste. [...] Those objectifiable differences, 'objectifiable' is a word too much for me, you can objectify or de-objectify everything. [...] These things should be determined more by the Flemish government and parliament. Not the technicalities, that should be done by the VREG, but the political choices, should we use density [...]. Sometimes it seems easier to hide behind the regulator. My opinion is: make a political choice and defend it*" (Fluvius Board member 2, interview, 2019). From this perspective, the issue treated by VREG as a technical tariff matter, is connected with a broader societal debate about the cost of dispersed service provision.

A crucial element in this debate is the historical role of local governments in energy distribution. Private actors developed networks in urban centres where it was most profitable, while municipalities and provinces encouraged their extension into the countryside. Today, the societal cost of this extended network is questioned and some actors argue that differentiating distribution tariffs according to density, can discourage dispersed housing choices and support local densification strategies (Fluvius Board member 2; Urban planning officer, interviews, 2019). This argument also appears in spatial planning debates in Flanders about the cost of urban sprawl and the need to rethink financial, legal and other mechanisms that support dispersed urbanization (Ryckewaert et al., 2018).

Other actors question the assumption that energy provision would be cheaper in denser areas. "*My prognosis is that differences will be limited: the disadvantage of being dispersed is compensated for by the complexity in urban areas*"(Infrax management). Although distances are shorter in the city, construction and maintenance costs and risk of damage are higher than in dispersed areas (Energy expert SERV, 2019; Fluvius Board member 1, 2019; Infrax management, 2019). The VREG study remained inconclusive, but a recent study quantifying the cost of urban sprawl in Flanders estimates that the yearly cost of electricity infrastructure per building in dispersed areas (146€) is around three times higher than in urban areas (43,3€) (Vermeiren et al., 2019: 62).

Another issue is the scale on which to measure cost differences in order to diversify the tariff. Today tariffs differ between network operators but are uniform for specific user groups within each region. Most regions are a combination of dense and more dispersed areas, so differences in density would be levelled out on a regional scale (Fluvius Board member 1, 12; Fluvius staff 2, interviews, 2019). "*It would be best to diversify by municipality, or by street. But that is not feasible, we shouldn't make it more complex than it already is*" (Fluvius Board member 2, interview, 2019).

Some actors have more fundamental doubts about the desirability of spatially differentiated energy tariffs. Several interviewees claimed that differentiated tariffs cannot be justified for the communal provision of a basic need (Fluvius Board member 1, interview, 2019) and that public support for such measures would be limited (Energy expert SERV, interview, 2019). A Socio-Economic Council expert questions the idea of using energy tariffs as a spatial planning incentive: "*Would this convince people to make different housing choices? […] Or should we steer spatial planning through spatial planning policy?"* (Energy expert SERV, interview, 2019). These interviewees also highlight that introducing a spatial differentiation factor into the energy tariff would further increase the complexity of the tariff structure. Adding a spatial factor would not result in meaningful tariff variations, making it an ineffective incentive for more sustainable spatial choices (Energy expert SERV; Fluvius Board member 1; Policy advisor SERV, interviews, 2019).

Ultimately, the debate about the potential spatial differentiation of energy tariffs based on spatial density was depoliticized. The regulator positioned itself as a neutral and independent actor, and framed the tariff reform as a technical issue, consultation with relevant stakeholders was limited, and there was no thorough political debate at the Flemish or municipal level. However, the interviews reveal a politically sensitive tension between 'city' and 'countryside', or between the traditional policy of providing universal and affordable energy access, and the need to rethink mechanisms supporting dispersed urbanization and to mitigate its societal and ecological cost.

3.3. Spatially selective energy solutions and the cannibalization of the gas network

The energy transition implies a shift from the homogeneous distribution of centrally produced or imported electricity and gas, towards decentralized electricity production and more spatially selective context-specific heating solutions. Collective systems such as district heating are suitable for denser urban areas, while individual installations such as heat pumps or solar boilers can be used elsewhere. Investments in a specific type of distribution infrastructure are strategic for future renewable energy options and the development of a specific geographic area and for the regional distribution system as a whole. Moreover, the transition to fossil-free heating systems raises questions about the future of Flanders' extensive natural gas network. This next section investigates Fluvius' ambiguous attitude towards planning for these strategic choices. The company usually follows rather than steers development and approaches these decisions as a matter of economic feasibility rather than of a societal challenge to decarbonize the energy system.

Several interviewees point out Fluvius' ambiguous attitude towards fossil-free heating and consider the company's role as operator of the natural gas network as a conflict of interest. "*The crucial factor is that Fluvius has billions in the ground* [in natural gas assets]*, and that is what it is all about.*" (Intermunicipal DSO Board member, interview, 2019) Investing in alternatives risks undermining the value of these assets: "*When these intermunicipal companies implement district heating, they start to cannibalize their natural gas assets.*" (Former Eandis Board member, interview, 2019)

This extensive gas network puts Fluvius in a difficult position and is the result of previous policy incentives supporting gas infrastructure. In 2003, the regional government set targets for the network operators to increase connectivity to gas up to 99% in 'urban areas' and 95% in 'rural areas'. These obligations were lifted in 2017, but operating, retrofitting and extending the gas network are still core activities for Fluvius. As neighbourhoods constructed in the 1960s are "*massively switching from fuel oil to gas*", Fluvius responds by strengthening the gas network in those areas (Fluvius staff 2, interview, 2019). The company will also adapt a substantial part of the network to high-caloric gas because the import of low-caloric gas from the Netherlands will end in 2030 as the Dutch government has decided to phase out natural gas extraction by 2050. These decisions are taken without much debate about the opportunity they might offer to consider fossil-free alternatives. Unlike the Netherlands, Flanders lacks a policy framework that obliges Fluvius to decarbonize the heating system. "*We amortize gas networks over 50 years, so if we need to phase them out before then, they need to tell us who will pay for that.*" (Infrax management, interview, 2019). Other interviewees believe this continued dependence on gas critically inhibits the region's potential to develop more sustainable heating alternatives. Fluvius promotes natural gas as a transition fuel, explaining that phasing out gas is unrealistic as long as there are no alternatives currently available, and emphasizing the possibility to repurpose the gas network for other fuels (Fluvius, 2020, interview, 2019).

Meanwhile, Fluvius also became active in Flanders' emerging district heating sector, where it does not have a regional monopoly. Instead the company competes with other public and private district heating operators. While most interviewees are convinced that the distribution of energy should remain in public hands, several criticize Fluvius' role in district heating because of its stake in gas infrastructure, and because of its privileged relationship with municipalities that might interfere with the right to equal competition of other actors. Moreover, the interviews show contradictory perspectives on Fluvius' locational choices for district heating. Several interviewees, including Fluvius staff, emphasize that district heating is only feasible in contexts with sufficient heat demand (dense urban areas or sites with several large consumers) and a local heat source (residual industrial heat, waste incineration). "*In new residential allotments, unless we're talking about lower temperatures, you should stay away with traditional district heating*." (Fluvius staff 1, interview, 2019) However, another employee claims there is no conflict of interest between gas and district heating: "*Projects where we switch from gas to district heating, are rare. District heating is often developed in greenfields where there is no natural gas network.*" (Fluvius staff 3, interview, 2019) Conversely, the choice for greenfield sites can also be explained as a way to avoid undermining existing gas assets. Ultimately, the decision to develop district heating is presented by Fluvius as a matter of economic feasibility rather than of a societal choice to enable fossil-free heating: "*You have to earn back the investment through the price people pay, that's a purely economic story.*" (Fluvius Board member 2, interview, 2019).

Fluvius' ambiguous role in the transition to fossil-free heating solutions is fundamentally related to its attitude towards long-term spatial energy planning. Unlike the transmission network operator Elia, that prepares strategic 10-year plans in consultation with relevant stakeholders, Fluvius only drafts three-yearly investment plans that need only the approval of the regulator. Several employees express doubts about the feasibility of planning for the distribution system. "*We can respond to questions that exist, but we can't answer questions we don't know will come in the future. […] It has to be plannable.*" (Fluvius staff 1, interview, 2019). Fluvius positions itself as an operational actor that anticipates energy trends and responds to requests from municipalities and developers, rather than planning or directing the energy system in a certain direction. "*We are very neutral, we are an independent, objective partner to think along with municipalities about what is possible, and what is not.*" (Fluvius staff 2, interview, 2019). However, with this claim to 'keep all options open', Fluvius avoids a debate about strategic future choices, which can ultimately lead to suboptimal investments and an expensive energy system.

Many interviewees viewed the lack of a clear (spatial) vision, not only for fossil-free heating but also for electricity distribution, as a crucial shortcoming and major roadblock in achieving a sustainable energy transition (Labour union 2, interview, 2019). While they demand a stronger stance by the Flemish government, some were critical of the limited capacity of the Flemish administration and regulator to develop strategic energy plans (Energy expert SERV; Environmental Association; Labour union 2, interviews, 2019). Moreover, while Fluvius has started to make valuable data available to municipalities, the company could use its substantial technical expertise to support energy planning at the local and regional level (Energy expert SERV; Infrax management, interviews, 2019). Such long-term frameworks can help guide strategic investment strategies that benefit the company in the future.

To conclude, the shift towards decentral electricity production and spatially diverse heating alternatives, requires strategic and spatially selective investment choices. However, Fluvius positions itself as a neutral partner of municipalities, and sticks to an operational role rather than taking the lead in envisioning a sustainable energy system. At the same time, the company has to contend with the legacy of an extensive gas network. Fluvius' ambiguous positioning is therefore not neutral, as it risks to interfere with the company's fossil-free heating ambitions. Formulating a clear sustainability mandate and spatial strategy for Fluvius is hindered by the fragmented government competences on energy distribution matters, and the absence of ambitious energy policy at Flemish level.

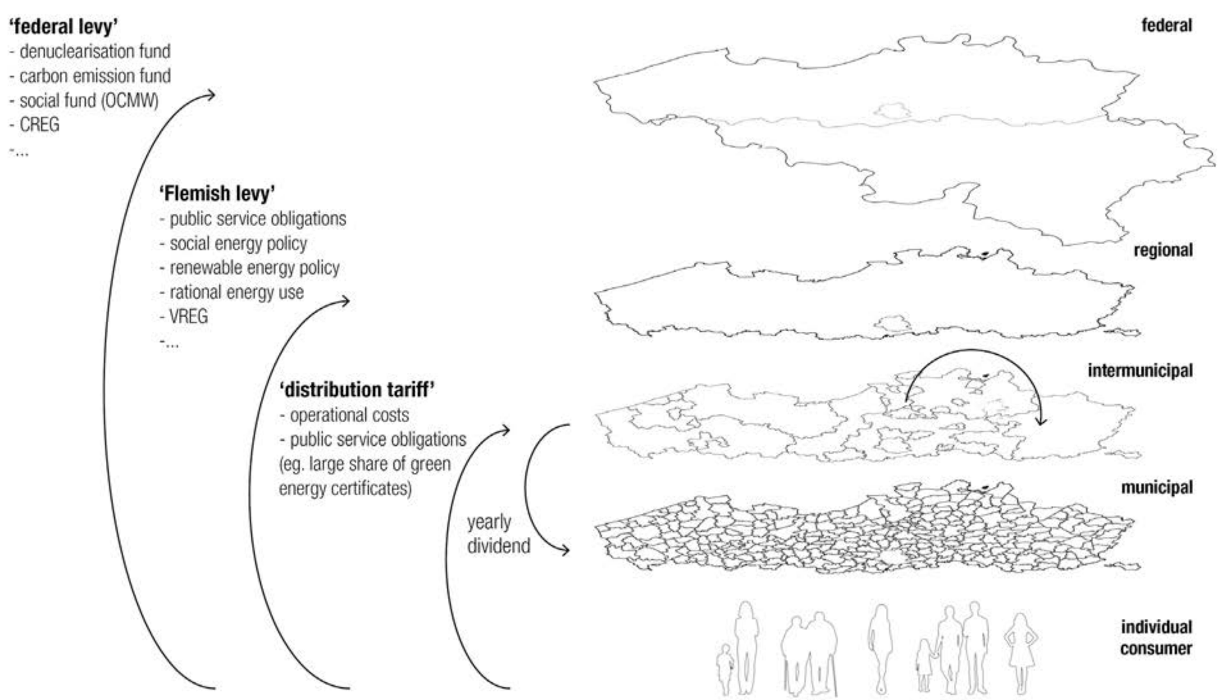
3.4. Socio-spatial redistribution and the cost of a socially just transition

Solidarity mechanisms between energy users have traditionally been part of the governance of the distribution of energy. They were connected with the historical ambition of providing universal access to modern services. Today, formal redistribution mechanisms are inscribed in legislation and organized through 'public service obligations' imposed on the DSOs by the Flemish government. In interviews, Fluvius employees demonstrated a concerted awareness about the company's societal responsibility. This section discusses how the integration of transition costs in energy tariffs challenges the public's sense of solidarity and reveals an unexpected redistribution of societal costs between rural and urban areas. The analysis shows that the current redistributive mechanisms based on universal connections to homogeneous energy grids, need to be structurally rethought as diverse and context-specific energy solutions emerge.

Fluvius is charged with social (e.g. supplying energy to customers dropped by a commercial supplier) and ecological obligations (e.g., awarding subsidies for rational energy use). As illustrated in Figure 4, the costs for these public services are redistributed on different spatial scales. Consumers pay for these costs either directly through the distribution tariff, or through specific levies on the energy tariff. These levies are charged by either the Flemish or the federal government according to their respective competences [Figure 4]. The purpose of the levy by the Flemish government is to fund the regional social energy policy, energy efficiency and renewable energy policy, and the regulator VREG. The purpose of the levy set by the federal government is to finance a federal social fund, social maximum tariff for protected customers, a denuclearization and decarbonization fund, and the federal regulator CREG.

This system has important social objectives. The Socio-Economic Council of Flanders (Sociaal-Economische Raad van Vlaanderen - SERV) calculated that the federal social fund redistributes 183 million euros per year between Flemish customers, by financing a social maximum tariff for

Figure 4.4. The spatial redistribution of social and ecological costs of the energy system through components of the energy tariff.
Source: author based on vreg.be.



specific customer categories (Bollen and Berckvens, 2019). "*Through its size, this is a very meaningful redistributive mechanism*" (Energy expert SERV, interview, 2019). But this redistribution through energy tariffs is also criticized for several fundamental reasons. First, most levies are integrated into the electricity tariff rather than the gas tariff, reducing the competitiveness of sustainable electric solutions. Second, the energy bill is criticized as a form of 'hidden tax' because social and ecological costs are not only funded through different levies but also integrated into the distribution tariff directly. If these public services would be funded through the public tax system, they could be more progressively related to household incomes. Moreover, the system disadvantages customers of the low-voltage grid (households and SME's) because energy-intensive industries are connected directly to the transmission grid and pay no equivalent contribution to the societal transition cost (Labour union 2).

The Socio-Economic Council is particularly critical about the Flemish social obligations imposed on Fluvius. These obligations represent between 11 and 13 million euro per year (Bollen and Berckvens, 2019), but unlike the federal levies they "*actually don't give any financial benefit to social customers*." (Energy expert SERV, interview, 2019). They are used by Fluvius to install budget metres, or follow up lack of payment and disconnection procedures.

Such civil society criticisms about the social impact of tariff structures intensified in two recent debates about proposed transformations in energy distribution: the debated switch to a capacity tariff and the ongoing introduction of digital metres. Fluvius advocates for a capacity-based tariff as a more cost-reflective method that would better ensure revenue with declining energy consumption. Civil society actors are concerned it will disadvantage low-income consumers: "*The more the capacity tariff works as a fixed cost, the better for the high-consuming customers and the worse for the low-consuming customers. And that has a social and economic impact*." (Labour union 2, interview, 2019). Social and environmental organizations argue that Fluvius and the regulator underestimated the social sensitivity of this tariff reform (Environmental Association, interview, 2019). Similar criticisms were voiced in the discussion about the introduction of digital meters in Flanders, where the financing and roll-out strategy didn't sufficiently take into account the impact for different types of customers (Labour union 2, interview, 2019).

Two other issues show how the redistribution of transition costs also has unexpected spatial dimensions. The first debate relates to the socio-spatial distribution of the cost of renewable energy subsidies. DSOs were obliged through the Flemish Energy Decree to buy fixed-price Green Energy Certificates for solar PV installations since 2006. However, the government underestimated the increasing uptake of PV panels, leading to a saturated certificate market and high costs for DSOs that were required to buy these certificates. Moreover, a spatial imbalance emerged as more PV was installed in some regions than in others. "*Eandis had 80% of the energy network and Infrax 20%, but Infrax had 30% of the solar panels and Eandis 70%. Infrax was historically always a pioneer in supporting rational energy use. But it could also be because Infrax had more rural areas and there are more suitable roofs for PV panels*." (Infrax management, interview, 2019). To solve this imbalance between rural and urban regions, the intermunicipal companies agreed to share the certificate costs. But this spatial solidarization was criticized by representatives in urban areas: "*People from Antwerp are paying for the solar panels in Limburg, where people have more financial means and live in a detached villa that needs a very long cable to connect. Urban inhabitants are paying for the solar panels in the countryside, and those urbanites are generally less well off.*" (Fluvius Board member 2, interview, 2019). The solidarity between energy consumers implies not only a social redistribution from customers without PV to those who had the resources to install PV, but also a spatial redistribution between country and city.

The second aspect is related to emerging demands to exchange locally produced renewable energy between consumers. Such local energy communities are also proposed in the EU's 'Clean Energy for all Europeans' package (European Commission, 2019). But Fluvius is reluctant to allow energy exchange between users because it is concerned this would undermine network solidarity (Environmental Association, interview, 2019). "*The network operators are holding back and see the risk of private systems that would desolidarize from the network, which would leave the remaining consumers with ever-increasing costs.*" (Former Eandis Board member, interview, 2019). With the emergence of decentralized electricity production and spatially selective heating systems, such redistribution questions become even more complex, explicitly spatial and socially sensitive. Today, for example, there's no general approach to organize social tariffs for district heating, although this is sometimes organized ad hoc at project level. However, as more context-specific energy solutions emerge, such solidarity issues transcend the operational sphere, and require a more structural answer at the Flemish political level.

In summary, governance arrangements around energy distribution have traditionally included mechanisms of redistribution between consumers. This is organized through components of the distribution tariff for relatively homogeneous energy services. Including the societal cost of the energy transition in regional energy tariffs makes these redistribution questions not only more complex, but also more socially sensitive and explicitly spatial. It leads to unexpected socio-spatial redistributions. The introduction of spatially specific energy solutions, such as local energy communities, collective heating systems or decentral electricity production, further challenges this system of tariff solidarity. However, the current technocratic governance approach depoliticizes the debate. It impedes the process of achieving an equitable shift towards sustainable solutions, even if these differ technologically, spatially or organizationally.

4. DISCUSSION AND CONCLUSION

Transforming energy distribution systems is key in regional transitions, but proves complex due to the embeddedness of these networks in regional territorial and institutional contexts. We have used a spatial perspective to unravel three dimensions of this obduracy in Flemish energy distribution: a possible differentiation of energy tariffs based on spatial density; the spatially selective investment in alternatives to the extensive natural gas infrastructure; and the socio-spatial redistribution of energy transition costs through levies on the distribution tariff. By discussing the implicit spatial logics underlying these lock-ins, this analysis reveals the complexity of transforming energy networks and sustaining solidarity mechanisms in a dispersed territory. However, the technocratic governance of energy distribution treats these societal questions as operational issues, and impedes the development of an integrated transition framework for a spatially sustainable and socially just energy distribution.

First, the interviews revealed that the technocratic study of density-based energy tariffs is connected with a broader and politically sensitive debate about the societal cost of dispersed utility infrastructure. Second, Fluvius' legacy of an extensive gas network and positioning as a neutral partner for municipalities, and the lack of ambitious energy policy at Flemish level, hinder the development of a strategic transition plan for energy distribution. Third, including transition costs in regional energy tariffs leads to undesirable socio-spatial redistribution mechanisms. The emergence of context-specific governance arrangements around sustainable energy solutions challenges the traditional system of tariff solidarity based on territorially homogeneous energy services.

These findings contribute to current debates in transition studies by illustrating the relation between energy distribution and territorial morphology and by unraveling Fluvius' ambiguous governance context.

The case study enriches current understandings of the spatial and material dimensions of regional energy transitions (Bridge et al., 2013) by highlighting not only how energy distribution is spatially embedded in a specific territorial structure, but also how the implicit spatial rationalities of network operators contribute to the (re)production of regional urbanization patterns. On the one hand, Flemish energy distribution is part of a dispersed urban landscape and the legacy of an extensive gas network add to its inertia. On the other, the energy distribution system reproduces unsustainable spatial patterns, through its investment logics and tariff structure. More research is needed to understand and rethink unsustainable spatial rationalities of energy infrastructure operators.

The study also refines existing insights about the role of public incumbent actors in regional transition processes (Mühlemeier, 2018). We show how the position of incumbents is rooted in a historically developed governance context, and that municipal ownership does not guarantee territorial sustainability or transparent energy governance (Becker et al., 2015). Fluvius' ambiguous position is shaped by the fragmentation of authority over energy matters between Flemish government, regulator and municipalities. The unambitious Flemish energy policy, the limited capacity of municipalities and the minimal involvement of civil society voices reduce Fluvius to an operational role rather than developing the company into a strategic transition actor.

Moreover, the case study ties in with calls to recognize and study transitions as political processes (Meadowcroft, 2009). We illustrate how a technocratic governance of energy distribution can depoliticize important societal questions. The neutral positioning of the Flemish regulator and the operational attitude of Fluvius do not acknowledge the socio-political sensitivity of debates around the cost of urban sprawl or socio-spatial (in)equality.

These findings make clear that a regional energy transition requires to rethink and re-politicize the spatial and institutional structure of energy distribution systems. The regional government has a key role to play in formulating an ambitious sustainability mandate for the network operator. Within that regional framework, Fluvius could assume a pro-active role in spatial energy planning efforts and establish partnerships with municipalities to test radical change in pilot projects. Regarding tarification, re-evaluating the complex energy tariff structure is essential to ensure transparent and socially just consumer tariffs. As happens in other countries, the Flemish regulator could consider social and ecological criteria when evaluation investment plans for the energy grid. A more inclusive and transparent decision-making structure could shift Fluvius' focus from a financial-technocratic network governance to the societal importance of a sustainable energy transition. As shareholders of the utility company, municipalities could use their power to advocate for sustainable investment decisions.

Taken together, an ambitious sustainability mandate and spatial strategy, a more inclusive governance structure and just energy tariffs are essential starting points to unlock the transformation of regional energy distribution systems.

Interlude C

Interviewing – unraveling discourses about Flemish energy distribution

Although interviews are commonly used as a qualitative research method, we as planners and designers rarely discuss and reflect about why and how we use interviews, how we engage with our respondents, and how we report interview findings. In a review of recent human geography literature, Hitchings and Latham reveal how geographers report in very limited terms, if at all, about the reason to choose interviews as a research methods, the interview procedures, sample composition and size, the positionality of the interviewer, or even the way they select and use quotations in research publications (Hitchings and Latham, 2020). Other scholars have discussed the interviewing process in more detail, drawing attention to the challenges of gaining access to (elite) interviewees, the influence of the positionality and power relations between interviewer and interviewee, the question of whether to present oneself as an expert or ignoramus and how open to be about the research objectives (Harvey, 2010; McDowell, 1998). Looking back, these questions were also central to my experience of the interview approach I developed with Laura Deruytter as part of the research process for chapter 4 on energy distribution. Both interested in intermunicipal energy companies from a different perspective, Laura and I decided to collaborate for the empirical work about Fluvius. While I would focus on the spatial rationalities at play in Flemish energy distribution, Laura aimed to unravel the financial mechanisms behind intermunicipal energy companies. Who should we interview, and would they agree to speak with us? How did the way we presented ourselves and formulated our questions matter in the kind of responses we received? What quotations would make it into the final papers, and which ones would be left out? How would the respondents react to our critical analysis?

Early-on in the research process, Laura and I realized Fluvius is like a many-headed creature, whereby the particular perspective of each interviewee could only be interpreted as a part of a complex, multi-faceted and ever-evolving puzzle. In that sense, the process was somehow reminiscent of the experience of Joris Luyendijk, an investigative journalist who infiltrated in London's financial sector. He discovered that no single person really understands the system as a whole anymore, and that this might have been a major underlying cause of the 2008 financial crisis (Luyendijk, 2017). But then, who should we be interviewing, and when would we have reached a sufficient and representative sample? Should we select the most critical voices within and outside Fluvius, or focus on more moderate perspectives instead? Finally we let ourselves be guided by the suggestions of our interviewees about relevant actors to interview. We composed a diverse sample of 24 respondents including critical outsiders from civil society actors such as unions, an energy cooperative, the environmental movement and the socio-economic council, but also 'insiders' with relatively moderate or more institutional perspectives such as the regulator, the Flemish energy agency, and different departments within Fluvius. Diverse in terms of professional roles, that is, not in terms of gender or cultural background as we ended up with only two female respondents and no people of colour. Somewhat surprisingly, and in contrast with the barriers described by Harvey and McDowell (Harvey, 2010; McDowell, 1998), it turned out to be very easy to schedule appointments with key figures in- and outside Fluvius, including the former CEO, a crucial political figure in the board of directors, a CFO (chief financial officer) and the director of Flanders' energy agency. An email with a short description of our research and a few possible dates, and at most a friendly reminder, was usually enough to set an appointment. We also provided an information and consent form with an explanation of the research context and a description of what would happen with the respondents' information. The interviewees gladly invited us to their places of work, or sometimes into their home and delved into often very engaged conversations with us, which in many cases revealed a strong awareness of the important societal role of the energy distribution company.

And then, how to frame our research, and how to formulate our questions? "*We are PhD researchers, interested in the financial and spatial logics of energy distribution in Flanders.*" We always started by going through the consent form, asking permission to record the interview and explaining we would anonimize the responses and give interviewees the possibility to review literal quotations before publication. This helped to set the stage for a serious and open conversation, and none of the respondents had any reservations about the recording. We wondered how our appearance as junior, female researchers influenced the way respondents formulated their answers. Often this perception seemed to work in our favour, eliciting quite elaborate reflections about the energy system and its actors, and we regularly used it as an advantage by starting off with relatively open questions first before moving on to more tricky topics. How open should we be about our own, rather critical, perspective? How deeply should we engage in a discussion when we did not agree with our interviewee? "*I think all these citizen energy cooperatives are the biggest bullshit there is, real bullshit!*" How critically should we examine often very understandable statements by Fluvius employees or managers, explaining the complex conditions within which Fluvius has to operate? "*The Flemish government put us in a difficult position by obliging us to extend the gas network up to a connectability rate of more than 90%, until very recently*." How strongly should we go along with the very critical perspectives some interviewees shared? "*The culture of those regional meetings with municipal representatives, was sometimes more focused on the dinner afterwards, then on the meeting itself*." Throughout these interviews, collaborating as a duo was very helpful and improved the flow of the conversation. It allowed to take notes, reflect about previous answers and prepare follow-up questions while the other interviewer was talking.

As we conducted more interviews, our understanding of the energy distribution system, Fluvius' rationalities and the legal, institutional and policy conditions within which the company operates, continuously evolved. We decided to stop interviewing once we felt confident to have identified the key financial processes and mechanisms, and the relevant spatial debates and challenges, and ended up with a list of 24 interviewees. Then started the challenging process of analyzing the incredibly rich material, complementing it with document analysis and theoretical literature. Structuring, discussing and restructuring the material, we co-authored two critical analyses. Laura took the lead in a first article, which focuses on the financialization mechanisms at play in intermunicipal energy companies. I initiated a second article, which unravels the implicit socio-spatial rationalities behind energy distribution in Flanders and became chapter 4 of this dissertation. The format of an academic paper did not offer much space to integrate the rich and varied perspectives about Flemish energy distribution our respondents had to offer. We had to edit out many very telling quotations we would have liked to include, and these are included at the end of this interlude. However, integrating key insights from the interviews allowed to paint a nuanced picture shaped by multiple and often conflicting perspectives on Flemish energy distribution, and to reveal the complexities and the political character of these spatial energy debates. We double-checked with our interviewees about the wording of literal quotations and took into account their alterations and suggestions whenever relevant.

We ended up with very critical conclusions about Fluvius' ambiguous role in the Flemish energy transition, and hesitated about sharing our insights with the respondents. How would they react? We received very enthusiastic reactions from some readers: "*I savored your paper, congratulations. Wonderful to see so clearly articulated in a beautiful summary where things go so wrong with Fluvius. I found myself nodding in agreement most of the time.*" However, most respondents never answered when we emailed our article after publication. Conversations I had later-on about Fluvius often confirmed our analysis, but sometimes also nuanced our diagnosis. During an interview in the context of my later research about regional energy planning, a Fluvius employee conveyed a surprisingly more positive image of the company. He complained that "*I think we are perceived negatively sometimes, as if we are slowing down the transition, but in fact it is the regulator slowing us down*", explained that Fluvius had developed a transition vision for 2030 and 2050 and communicated about that vision more proactively, and added that his department had recently been reorganized to better facilitate the energy transition. When I noted to be positively surprized about Fluvius' shifting attitude in support of the transition towards a more sustainable energy system, he responded that "*this seems evident*." Did we portray Fluvius' position too negatively? Our analysis does not only critically examine Fluvius' approach but also explains its difficult position within a very technocratic regulatory system, and a weak regional policy context. Since our earlier interviews, there are signs that Fluvius is slowly shifting its attitude, communicating more pro-actively about its aim to support the energy transition, taking into account regional spatial energy visions when drafting investment plans, and collaborating with the VVSG on a 'Climate network' to support municipalities.

Overall, the interviews allowed us to sketch a rich and balanced picture, which, despite its inevitable bias and selectivity, aimed to do justice to both critical 'outsider' voices, and to the commitment of Fluvius employees to the societal value of a public energy distribution system in Flanders. From different and often conflicting perspectives, many of these interviewees engage in a struggle to realize sustainable change both from the inside and from the outside.

"Today, tariff differences between different DNO's exist but have developed mainly historically and it has not been proven that these differences are related with spatial density."

Former CFO Infrax

"We have quite big differences in tariffs and one of the extremes is Gaselwest. [...] The big difference is the value of the RAB (regulated asset base). [...] They always told me a mistake was made with printing the Royal decree. [...] Gaselwest, many lines above ground, gave an RAB value that proportionally to the booking value was much higher. [...] That is the reason there are still big tariff differences."

Former CEO Eandis and Fluvius

"Antwerp has a good tariff today, the rest is more expensive, Antwerp thinks they should always be cheaper."

Former CEO Eandis and Fluvius

"My prognosis is that there will be differences, but they will be limited: the disadvantage of being dispersed is compensated by the complexity in urban areas."

Former CFO Infrax

"While distances in the countryside are larger, the cost per meter is higher in urban areas and the one balances the other because breaking open the pavement in the city is more expensive than breaking open a ditch in the country and the risk of damage is higher in the city [...] but the question is: do we have the data to analyse this thoroughly?"

Socio-economic council of Flanders,
energy expert

"You risk to get redistributive shocks that evoke great resistance, but don't have the desired effect."

Socio-economic council of Flanders,
energy expert

C.1. Quotes about density-based energy tariffs and the societal cost of urban sprawl.
Source: interviews in 2019-2020 by author and Laura Deruytter.

"We give an average price to customers... and that is why we are communal. An intermunicipal company is a communal service, of public interest, to the citizens. For such a basic service, I don't think you can really say 'for us another tariff' "

Fluvius, Board of Directors president

"When those networks emerged, the private [sector] was only interested in the cities, and they left the 'sparse' areas for the public sector"

Academic energy expert

"Energy is a basic need and therefore everyone has to have it, and then we [the public sector] have to put a huge amount of money into it. We have to ask whether that is the solution, or whether we have to bring people where the opportunities are. That has to do with densification, strengthening centres and so on."

Fluvius, representative in Board of Directors

"Fluvius could take some initiatives in terms of spatial planning and concentrate investments in urban areas, maybe even strive for spatial differentiation of tariffs between urban and rural areas. Use that to organise the transition to urban living, and those that want to live in the countryside have to pay for it"

Urban planning officer

"What are Regionally Objectifiable Differences: the VREG has concluded that there are none in Flanders."

Former CEO Eandis and Fluvius

"Me personally, and that is a public secret, I think a public utility activity should have the same price for every Flemish person. [...] Tomorrow even more than today, because we'll have production connected to the distribution network that we need to use for all of the region. Perhaps we'll have a lot of production in Antwerp that is needed in Limburg, and vice versa. [...] So it will be a Flemish story, and having different prices for that, I'm radically opposed to that."

Former CEO Eandis and Fluvius

"That's the discussion between the Flemish Parliament and the VREG. How strictly, and that's what they call the 'guidelines', can Flemish Parliament say: 'these are the guidelines within which VREG can operate'? But the VREG strongly holds on to its autonomy, you can't impose too much. And when they go to Constitutional Court, they get one succesfull ruling after the other."

Socio-economic council of Flanders, energy expert

"The crucial factor is that Fluvius has billions in the ground [in natural gas assets]: what will we do? We invested tons in that, and that is what it is all about."

Intermunicipal DSO Board member

"Looking at it from a distance, it's not bad that distribution network operators manage district heating. But in the facts this competes with the gas network, so we need to ensure an open and objective procedure to assess the best solution for each project."

Environmental Association, energy expert

"Phasing out natural gas by 2050, I don't believe that will happen."

Fluvius staff, strategy & district heating

"Should we get rid of natural gas in 20 years, everyone agrees. But I don't want to end up in a German situation, quitting nuclear, big party for renewables and doing everything with browncoal."

Former CEO Eandis and Fluvius

"We strengthen the network for people in neighbourhoods from the 1960s, that are switching massively from fuel oil to gas."

Fluvius staff, strategy & market development

"In the total investment required to realise the energy transition, the residual value of the natural gas network is a marginal element."

Fluvius staff, business & local energy services

"And that is why I get annoyed talking about this, in 2003 the Flemish government obliged us to make 97% of Flemish households connectable to natural gas. [...] We have put over a billion euro in the ground on demand of the Flemish government. And now they ask us: could you open that up again and put a district heating network next to it. And how are you going to produce that heat, wich a gas boiler? What are we doing then! But they think that is a well-sounding story, we are supporting heat. Well then my pants drop off. So I am radically against that."

Former CEO Eandis and Fluvius

"As society, we made the choice for natural gas while we could have invested in district heating, but now it is too late."

Energy expert

"As a company, we were put in a difficult position. The Flemish government obliged us to increase the degree of connectivity to natural gas and this was lifted only recently."

Fluvius, Board of Directors president

C.2. Quotes about spatially selective energy solutions and the cannibalization of the gas network.
Source: interviews in 2019-2020 by author and Laura Deruytter.

"We are very neutral, literally, we are an independent, objective partner to think along with municipalities about what is possible, what is sensible and what is not. We're not here to sell heat pumps or gas boilers. Is it a natural gas net or an electricity net or a district heating system, we'll build it. For us, it doesn't matter what goes in the ground, as long as it's durable. Why? In 20 years we'll still exist, and if it isn't a durable solution we'll have to deal with the cost."

Fluvius staff, strategy & market development

"The future is a mix of everything. [...] District heating in Antwerp, Ghent, Brussels, maybe Liège and some cities that have waste incinerators, and everywhere else will be a mix of all electric, natural gas, some BES, heat pumps,..."

Fluvius staff, strategy & district heating

"We have developed energy concepts that can exist in 2050 and that would be energy neutral. We can guide municipalities to choose energy concepts per neighbourhood based on our data."

Fluvius staff, business & local energy services

"The consulted plans of the DNO's are short term plans, no strategic plans. Also the plans of the Flemish government are very vague on this matter."

Socio-economic council of Flanders,
energy expert

"It's true that we determine where infrastructure is implemented and that the availability of infrastructure has consequences for the decisions people can take in the future. We should try not to block other alternatives, but it's very hard for us to know what will be the best option in 50 years."

Fluvius staff, strategy & market development

"We are not project developers, we don't take the initiative."

Fluvius, Board of Directors president

"City centres where the demand is high, are often located too far from heat sources. New residential areas we develop close to those plants, that would be the biggest opportunity for quick wins."

Fluvius, Board of Directors president

"We need different scenarios to understand what are the consequences of each choice. [...] I think it's the role of the distribution network operator to make such information available to support policy-makers in making an informed decision."

Socio-economic council of Flanders,
energy expert

"If there is one decisive element in the energy transition, it is probably the electricity network. I find it very strange that there is not more vision about it."

Labour union, energy expert

"People consider it's normal that energy is a basic right, you need a fridge in your house to survive. That's organized but someone has to pay for it, it's solidarised."

Fluvius staff, strategy & market development

"The redistribution works through energy suppliers, it is a solidarization between consumers"

Socio-economic council of Flanders,
energy expert

"The highest tariff was the region of Intergem, and the only reason was that Fernand Huts [Belgian billionnaire and entrepreneur] *had put* Katoennatie *full of PV panels. So he received 12 million euro per year in subsidies, leading to the highest tariff for residential Intergem clients. That was per DNO, now it is solidarized so it's redistributed for all of Flanders."*

Former CEO Eandis and Fluvius

"People from Antwerp are paying for the solar panels in Limburg, where people have more financial means and live in a detached villa that needs a very long cable to connect, while Antwerp people live in an apartment or terraced house and the number of connections per cable is much higher. Urban inhabitants are paying for the solar panels in the countryside, and those urbanites are generally less well off."

Fluvius, representative in Board of Directors

C.3. Quotes about socio-spatial redistribution and the cost of a socially just transition.
Source: interviews in 2019-2020 by author and Laura Deruytter.

It involves a lot of redistribution aspects. For low-voltage customers it roughly concerns distribution between poor or low-consumption families, and rich middle-class families and small SMEs. The more the capacity tariff works as a fixed cost, the better for the high-consuming customers and the worse for the low-consuming customers. And that has a social and economic impact."

Labour union, energy expert

"People that can't afford the transition would have to carry all the costs while people that get organized can deconnect from the public network. So the solidarization question needs a proper solution, without blocking the roll out of energy communities."

Environmental Association, energy expert

"I had the impression in the discussion about the capacity tariff, that they didn't realize enough how that was a sensitive and difficult societal debate."

Environmental Association, energy expert

Conclusions

"Als we kans willen maken de opwarming snel te beperken, dan zullen we onverstoorbaar moeten worden. Aan dit gevecht beginnen, weten dat we niet kunnen winnen, en toch volharden. Doorlopen, ook als de moed ons in de schoenen zakt, wetende dat elke stap telt."

"*If we want to have any chance to limit global warming rapidly, we will need to become immutable. Starting this fight, knowing we cannot win, and still persevere. Walking on, even when we get discouraged, knowing that every step counts.*"

Jelmer Mommers, De Correspondent podcast, 27 September 2019.

"Je moet een soort boeddhistische stormram zijn. Je moet willen op vriendelijke wijze blijven beuken, tot ooit die eiken poort vermurwd toegeeft. En dat maakt het ijveren voor klimaat moeilijk."

"*You have to be some sort of buddhist battering ram. You have to continue pounding in a friendly way, until some day that oak gate gives in. And that makes the climate struggle so hard.*"

David Van Reybrouck, Zwijgen is geen Optie, September 2019.

As the social and ecological urgency of a transition towards a more inclusive and sustainable energy system is increasingly clear, what insights does this research have to offer? In this final chapter I synthesize what can be concluded about the socio-spatial consequences of an energy transition in Flanders' dispersed territory, and about a potential contribution of planning and design towards a more spatially qualitative and socially inclusive energy system. Before formulating some general reflections and identifying possible roles and limits for planning and design, I first recapitulate the main insights from each of the chapters composing this dissertation. I will conclude by proposing some pertinent policy recommendations, and formulating avenues for further research. I have added an overview of promising socio-spatial energy strategies for different spatial scales in the first annex.

1. CHAPTER CONCLUSIONS

The first chapter explored how different strands of literature – transition theory, urban metabolism, and urban planning and design – conceptualize the relations between energy and space. I identified key concepts that allow to characterize the connections between spatial morphology, energy infrastructure transformation and energy governance in a context of dispersed urbanization. This conceptual framework was later reworked and condensed in the context of the research about collective heating in Roeselare. The selected concepts draw attention to the territorial characteristics of energy systems (for example how the transition means a shift from an isotropic network to more spatially selective energy solutions), to the spatially transformative potential of energy system change (both through the structuring capacity of energy infrastructure, and through the radical potential of accumulated incremental transformations), to the embeddedness and interdependance of energy metabolisms in multiple spatial scales, and to the socio-politically transformative potential of energy transitions through the notion of energy as a common, and the possible re-organization of energy solutions at collective scales. However, throughout the different case studies, it became clear that the conceptual framework should be expanded to better include socio-political dimensions of energy transitions, as questions around energy democracy and energy justice became more prominent. The concept of energy democracy is rooted in civil society movements that struggle to resist, reclaim, and restructure the political, economic and social configuration of the energy system (Szulecki, 2018; Allen et al., 2019). This became a concrete concern in the case studies through questions about the possible roles of citizens and citizen energy cooperatives, and of local public energy companies in realizing energy projects. Energy justice research addresses inequalities among socio-economic groups and focuses on distributional, procedural and recognition dimensions of justice (Allen et al., 2019; Bickerstaff et al., 2013). In the case studies, financial and practical support and 'unburdening' for underprivileged groups emerged as a key concern to realize inclusive and just transitions. Organising redistribution and solidarity in a spatially selective and diverse energy landscape also came to the fore as a crucial challenge to ensure equal access to sustainable energy solutions.

The second chapter explored the socio-spatial consequences of a transition towards fossil-free heating in Roeselare. It reveals how the introduction of collective heating solutions has a socio-

Transition/metabolism/energy concept	Urban design concept	Empirical/design parameter
Energy as socio-technical system (TS, STS)	Space as palimpsest	Spatial selectivity
Space as context ((S)TS)	Space as agent	Structuring capacity of infrastructure Proximity (density, mixity)
Fundamental transformation, incremental change (TS)	Radical incrementalism Vision and strategic projects	Radical incremental transformation
Obduracy, path dependence, lock-in (TS, STS)	Retro-active urbanism	Obsolescence as opportunity Open flexible system
Energy as metabolic flow, circularity (MS)	Designing with flows	Multi-scalarity Cascading
Energy as 'power' (UPE), energy democracy (ED)	Co-production	Common governance
Energy justice (EJ)	Socio-spatial inequality	Solidarity & redistribution Unburdening vulnerable citizens

Table 5.1. Conceptual framework - reworked.

spatially transformative potential as they introduce logics of proximity, spatial selectivity and collectivity in an urban landscape characterized by low density, ubiquitous energy services and individual energy consumerism. The research revealed socio-spatial opportunities at different scales, from the urban level to the neighbourhood, street and building block. An urban district heating system can act as a spatial carrier for strategic urban renewal and densification projects, and can create meaningful interconnections between urban industrial and residential areas. Collective or public affordable heating solutions can contribute to higher living quality in vulnerable urban areas and be coupled with collective renovation support. Collective heating systems can also be combined with the creation of climate-friendly public spaces. Micro-collective heating solutions around biomass, residual or ambient heat can introduce collective spaces in individualized housing environments, and inspire solidarity and more democratic forms of collaboration between citizens, private sector and local government. However, without some form of planning planning or design such collective opportunities risk to be missed. If fossil-free heating solutions are not developed as part of an integrated spatial plan, they risk to reproduce socio-spatial inequalities or undesirable spatial configurations, for example when district heating only connects the most profitable urban projects while vulnerable areas are left to devise individual heating solutions, or when district heating is extended into the urban periphery to support greenfield developments. Designers can therefore contribute by identifying, co-creating and visualizing socio-spatial opportunities around collective heating solutions at different spatial scales. In Roeselare, such spatial design visualizations inspired policy makers and urban stakeholders to investigate concrete opportunities, for example a shared steam network in the industrial harbour or collective renovation support for the vulnerable Krottegem neighbourhood. However, it remained difficult to identify feasible business cases and funding strategies to convince the harbour industries, and the labour-intensive nature of collective renovation trajectories challenges the capacity of the urban administration. It also proved challenging to align the different municipal services around energy and climate objectives, and to change the course of ongoing urban projects. On the other hand, the value of a more systemic urban framework for energy projects became clear and the city decided to commission a heat zoning and heat transition plan to direct the future investments of different actors.

Although energy transitions are inherently political processes, these politics of transitions are often obscured in planning or transition management practices. The third chapter studied four cases of supra-municipal energy planning in Flanders, in the regions of Denderland, Leiedal, Pajottenland and Waasland. It analyzed how planning and design spatialize generic energy ambitions in a specific regional landscape and institutional setting, what political transition dimensions emerge and how they are addressed. Although these regional energy planning initiatives create valuable arenas to imagine spatially transformative energy strategies that address the characteristic challenges of Flanders' dispersed urbanization, they do not fully recognize the socio-politically transformative potential of regional energy transitions. Throughout these processes, design is a crucial tool to gather local knowledge, visualize the spatial consequences of energy choices, contextualize energy strategies in a regional landscape context, and build capacity among regional stakeholders. Overall, these processes develop in relatively consensual ways. While frictions emerge between municipalities, and between the municipal, regional and Flemish governance level, conflicts between other stakeholders will likely materialize only at the stage of implementation. Defining suitable locations for wind energy production was contested in all cases, but differences in landscape context, governance setting and visioning approach produced different planning outcomes. In Denderland, a radically transformative vision was accepted without much contestation, due to an experienced planning team, visual design support, a regional will to collaborate and some luck. In Leiedal, a lack of political consensus arose as some municipalities wanted to protect the valuable interfluvium landscape from wind energy development, and a regional wind vision was abandoned. In Pajottenland a thorough landscape design and intensive communication approach supported intermunicipal solidarity and acceptance of the wind power strategy. Overall, these regional planning arenas provide a setting where different actors can meaningfully discuss landscape quality, technical factors and societal support. However, regional energy visions have limited regulatory power which risks to undermine their credibility and engagement among economic actors. Implementation remains an ongoing struggle, whereby it is crucial to involve 'social' energy actors to ensure inclusive policy measures and projects.

The fourth chapter unraveled the socio-spatial rationalities behind current debates about energy distribution in Flanders. Firstly, it revealed how important socio-spatial sensitivities around energy tariffs were not recognized in the regulators' technocratic study about the potential spatial diversification of distribution tariffs based on 'regionally objectifiable differences'. Secondly, it showed how the network operator's neutral positioning is unconvincing as its investment choices for collective heating solutions are constrained because of a historical political commitment to natural gas infrastructure. Thirdly, it explains why traditional mechanisms to finance renewable energy and solidarity no longer suffice to organize redistribution in an increasingly spatially diverse energy system. Using a spatial lens was crucial to reveal the inherently political character of these debates regarding the organization, planning, financing and regulation of energy distribution. On the one hand, this chapter pointed out how a spatial perspective and a socio-political reflection are largely lacking, not only in the work of the network operator, but also in the approach of the regulator and the debates and policies of the Flemish government. On the other hand, this case also shows that spatial energy planning efforts should engage more seriously with the rationalities of actors such as Fluvius, and need to be more strongly supported by a spatially explicit and socially careful regulatory and legislative context at the Flemish level. Since the publication of this chapter, a slow shift has taken place in Fluvius' attitude, as the distribution network operator shows more openness to collaborate on regional spatial energy planning, and a more explicit intention to contribute to a sustainable energy transition. Moreover, the need to reform energy tariffs and prevent energy poverty have become more central policy concerns since the recent surge in energy prices.

2. GENERAL REFLECTION AND CONCLUSIONS

"In the end, the rush for solutions obscures the depth of the radical change we need. Although we know that small shifts can bring about radical changes."

Vanesa Castán Broto (2019) *Urban energy landscapes*, p 17.

2.1. Spatial lens into the socio-political dimensions of an energy transition in Flanders

Exploring the transition to a fossil-free energy system through a spatial lens, revealed not only morphological and territorial transition dimensions, but also socio-political questions around energy transitions. Combined, the empirical chapters provide a complementary picture of this inherently socio-political character of transitions and how it relates with Flanders' dispersedly urbanized morphology. First, they illustrate how both explicitly spatial energy strategies (as developed through design research in Roeselare [chapter 2] or observed in spatial energy visions [chapter 3]) and implicit spatial rationalities behind energy distribution, are confronted with or address the social and spatial challenges of Flanders' dispersed urban landscape. Second, they show how these socio-spatial questions around energy system transformation play out differently on different scales. However, it became clear how, even when energy choices were explicitly addressed as spatial challenges, socio-political transition questions often remained hidden, as in the case of supra-local energy planning, and how spatial nor social transition dimensions were fully recognized in energy distribution debates. Here, the spatial and governance parameters selected in the conceptual framework, were useful to identify how, throughout the chapters, key questions, strategies and debates revolve around the key characteristics of Flanders' socio-spatial context: how to introduce spatial selectivity and diverse, context-specific solutions in a landscape characterized by ubiquitous, homogeneous and isotropic energy systems? How to re-create density and revalorize proximity in a low-density environment? How to couple local energy solutions with improving spatial quality? How to introduce collectivity in a system of individual home-owners and energy consumers? How to distribute transition costs and organize solidarity among network users? As energy systems are reorganized from relatively homogeneous networks supplying individual energy consumers, to more diverse and potentially collective energy solutions, risks of fragmentation and exclusion emerge on different scales, but opportunities can also be identified to better adapt energy systems to a specific spatial morphology and to create collective societal benefits.

These socio-spatial risks and opportunities become most tangible at the neighbourhood and city scale, when abstract climate goals are contextualized within a specific urban morphology and stakeholder landscape, and concrete choices are to be made about spatial configuration, stakeholder coalitions, ownership, governance and business models. Within the city, which buildings will be connected to district heating, and which neighbourhoods will not? Who will own the district heating system, do inhabitants have a say about how it is operated, and at what price can heat be purchased? Within the neighbourhood, which street can be redeveloped as a green climate corridor, which buildings are suitable for solar energy production and how can this energy be shared? What kind of support will be provided for those households that have to set up an all-electric heating solution, will that be accessible for the most vulnerable inhabitants, and which households can receive collective renovation support?

At the supralocal level, socio-political dimensions and potential strategies around energy projects appeared to be more abstract. It was difficult to understand and discuss social dimensions of regional energy projects and to identify stakeholders to include in a more inclusive planning process. Important questions were for example: within the region, which locations are most suitable for wind energy production and what open spaces should be protected from energy infrastructure development? Who should own these wind turbines, where will the profits end up and can they be reinvested in the local landscape or community? Which industrial areas can strategically be developed as an energy hub, do these companies want to collaborate as an energy community, and how can different business interests and timelines be reconciled? More difficult to understand was how socio-spatial inequalities between different types of neighbourhoods or energy actors might manifest at a regional scale.

The socio-spatial obduracies I studied at Flemish level appeared to be even less tangible. Important issues include for example how to rethink solidarity, traditionally organized through a relatively universal energy tariff structure, or how to (re-)distribute the societal cost of distributed supply networks and energy transition investments. More concrete questions include where exactly to invest in strategic energy infrastructure (waste-to-heat, hydrogen, (temporary) gas-based electricity production, key high-tension and pipeline infrastructure, district heating), how can the power relations and interests of key stakeholders in such projects be understood, and how can public support or contestation be taken into account in the planning process?

2.2. Insights for current energy transition research

Bringing together a focus on the material and morphological dimensions of energy transitions with a sensitivity for the social and political aspects, involved a continuous attempt throughout this research to bridge different strands of literature and conceptual understandings of energy infrastructure transformation. Unraveling the territorial and societal complexities of the Flemish case, also allows to reflect more broadly about how a spatial planning and design perspective can contribute to a better understanding of the spatial and socio-political dimensions of transitions.

First, this research connects and contributes to geographical approaches to transition studies (Binz et al., 2020; Hansen and Coenen, 2015; Truffer et al., 2015) and critical perspectives on the politics of transforming urban infrastructures (Bulkeley et al., 2014; Meadowcroft, 2009; Shove and Walker, 2007). It draws attention to how spatial morphology informs the types of socio-political questions that emerge when transitions 'land' in a specific socio-spatial context, how it shapes context-specific barriers, obduracies and opportunities for change, and to the geographical variegation of transition trajectories that is linked to their embeddedness in a layered territorial palimpsest. Therefore, the conceptual framework broadens understandings of physical context in transition studies, considering it not only as a geographical condition but understanding spatial morphology also in relation to social and political transition dimensions and as an object of change itself. In contexts that share with Flanders a history of dispersed urbanization, socio-spatial challenges may be similar and relate with the societal cost of distributed supply networks, the complexity of organizing solidarity and redistribution between network users as energy solutions are becoming more fragmented and spatially specific, or the need to introduce more energy-efficient typologies or collectivity to enable sustainable energy solutions. In situations where energy networks are less ubiquitous and isotropic or urban development is more concentrated, different questions may arise such as the challenge to ensure equal access to sustainable systems in disconnected areas or to provide fossil-free energy production in dense and compact urban regions. Therefore, the parameters proposed in the conceptual framework to identify and describe key spatial and governance characteristics of energy systems, might differ for other contexts.

Secondly, this research answers calls from geographical transition scholars, such as Binz et al. (2020) for a better multi-scalar understanding of transition processes. The multi-scalar analysis of the Flemish case, shows how such an approach provides rich and complementary perspectives not only on how spatial and political questions around transitions manifest differently on different scales, but also on the role of public and regime actors in transitions. For example, inspired by work of Muhlemeier (2018) on public network operators in the federal states of Switzerland and Germany, it explored the role of Fluvius as a public network operator and regime player not only in 'horizontal' relation to the Flemish government, energy regulator, or civil society and energy sector associations, but also in 'vertical relation' to the municipalities as its shareholders, and provinces or supra-local regions as energy visioning actors. Moreover, this research looked at municipalities 'from below' as initiators of energy and climate policy and coordinators of local climate initiatives, but also 'from above' as partners and shareholders in intermunicipal energy or spatial development companies, or as the most local tier of government below the provincial and Flemish level. While governance context and energy infrastructure ownership might differ in other countries, this multi-scalar perspective draws attention to how different types of interscalar relations between energy transition actors play a role in transition trajectories, such as financial dependencies (e.g. between municipalities and other tiers of government or intermunicipal companies, as emphasized in (Deruytter, 2022)), the division of competences between different government levels, or the (lack of) interaction between different policy and transition domains at different scales (e.g. energy and spatial planning, but also mobility, housing, or economic policy and transition initiatives and policies focused on food, water or circular economy).

Third, recognizing the inherently political character of energy transitions and exploring the specific socio-spatial questions at stake in the Flemish energy transition at different spatial scales, was strongly inspired by urban political ecology's critical attention to power and inequality around urban metabolic flows and infrastructures (Castàn Broto et al., 2012; Kaika, 2004; Kaika and Swyngedouw, 2000). Being reflexive of planning and design's recent adoption of the 'urban metabolism' concept and emerging practices of 'designing with flows', this research started to explore how designers could better engage not only with the technicality and materiality of urban flows but also bring in these social and political considerations. The concepts of energy justice and energy democracy allowed to identify different types of inequalities and struggles related to energy transitions. Energy justice as a rather theoretical concept draws attention to the distributional, procedural and recognition dimensions of justice. Energy democracy originates in civil society movements that advocate for a stronger role for citizens in energy transitions, and attempt to resist, reclaim and restructure energy systems (Allen et al., 2019; Bickerstaff et al., 2013; Szulecki, 2018). Adopting a spatial planning and design perspective, this research shows how both energy justice and democracy can be strongly linked to the spatial configuration of society and to how space or spatial energy strategies are produced. It illustrates how inequalities or benefits and burdens around energy are distributed in relation to spatial density and societal cost of infrastructure, housing quality or in relation to locational choices for energy production, but also shows that both qualitative and quantitative research is needed to better understand these relations. Critically analyzing planning and design processes also revealed how these can play a role in enabling or inhibiting more recognition and procedural justice by deciding who is invited to participate, in what way(s) and settings, and how questions around energy transition are framed. However, what became increasingly clear throughout the different case studies is that knowledge about and experience with more inclusive, just and democratic alternatives in terms of spatial energy strategies, governance models or co-creative energy visioning are still rare both in academic literature and among spatial and social practitioners.

Lastly, bringing together transition management and spatial planning literature revealed similarities and complementarities between both approaches to imagining alternative futures and enacting sustainable change. Transition management and strategic planning share a combination of future visioning with short-term actions and co-creation. In this process, the often more visual approach of planning and design can be a valuable contribution throughout the co-creative process, as became clear during the creation of Roeselare's climate plan. However, both approaches also struggle to account for contestation and for the politics of transitions (Albrechts, 2013, 2015; Kenis et al., 2016; Shove and Walker, 2007). A critical reflection about transition management practices could draw from the broader experiences of spatial planning, for example reflecting about power relations, values and politics through concepts such as 'collaborative planning' (Healey, 2003). Albrechts states that planning does not aim to, or is not able to eliminate conflicts, but "it is in its power to create the practices, discourses and institutions that would allow those conflicts to take an agonistic form" (Albrechts, 2015: 107). However, it remains difficult to imagine what those practices, discourses and institutions could then look like, and I will further reflect about this in section 2.3.

2.3. Meaningful roles for planning and design in a dispersed reality

> *"Hence we are with Rip (2006) in recognizing the value, productivity and everyday necessity of an 'illusion of agency', and of the working expectation that a difference can be made even in the face of so much evidence to the contrary."*
>
> Elizabeth Shove and Gordon Walker (2007)
> 'Caution: transitions ahead', *Environment and planning A*, 39(4), p. 768.

In the introduction to this manuscript, I referred to Dehaene's reading of the Flemish landscape, not only as an energy-intensive territory in deep social and ecological crisis, but also as a resilient landscape of accumulation and potential recombination. In his essay 'Gardening in the urban field', he describes the Belgian territory as "*a tapestry metropolis waiting for its ecological re-edition. A project initiated by engineers but brought to fruition by gardeners who continue to cultivate with great care and attention the possibilities that have been injected into the territory, without however consuming them"* (Dehaene, 2013: 101). Building on the work of Jean Remy, he understands urbanity as a collectively produced value, and urges planners and designers not to reject the horizontal metropolis altogether, but to cultivate diverse opportunities to accumulate and share collective value within this diverse spatial ecology (p. 92). Pioneers of the urban project also emphasized the importance of positive externalities – De Solà-Morales focused on the 'intermediate scale' and defined a designs' impact 'outside the contour of the project' as a key characteristic of the urban project. However, Dehaene puts a stronger emphasis on the governance arrangements built up around urban questions in different domains. The examples he cites – Baugruppen and Community Land Trust as collective housing models, car- and bikesharing as collective forms of mobility, community-supported forms of urban agriculture, or even the collective lands ('kouters' and 'dries') developed in the Middle Ages – are all collective arrangements that replace ownership rights with use value. This is clearly not a plea to continue Flanders' dispersed urbanization, based on generalized mobility and home ownership, but rather an invitation to explore the qualities of Belgium's horizontal substrate, and to reflect about "*those instances in which the production of added value calls for localized and place-based strategies, or when alternatively it can be part of a distributed logic*" (Dehaene, 2013: 95). Building on Dehaene's reading, in the following paragraphs I reflect about what it could mean to 'cultivate the possibilities of the territory' from an energy perspective, and argue that spatial design disciplines have valuable contributions to make by focusing on different scales of collectivity. I explore how planning and design can contribute to a qualitative and inclusive energy transition in Flanders' dispersed territory, while remaining critically aware of the limited impact planning and design have traditionally had in the Flemish context.

Collective energy strategies to realize societal and spatial value

Before outlining the possible impact of spatial design, it is important to first clarify the dominant characteristics of current energy policy in Flanders. Most relevant in relation to this discussion, is the traditional focus of energy policy on incentives for individual households or companies. Typical policy measures are incentives to stimulate individual renewable energy production (e.g. green energy certificates and later the 'reversed counter' ('*terugdraaiende teller*') to support the uptake of solar PV systems) and energy efficiency renovations of individual homes (subsidies or fiscal incentives for renovation). Problematic about these policy measures is not only that they tend to be changed continuously, leading to uncertainty and undermining public support. Even more fundamentally these individual measures are not spatially specific, not socially inclusive, and don't have the necessary impact to reach climate targets (Bollen and Berckvens, 2019). First, because these incentives are not spatially selective, they support the reproduction of dispersed housing patterns, for example by granting subsidies and fiscal incentives to renovations in locations with low levels of utilities and mobility services. Second, such measures usually benefit middle class households while the most underprivileged population is not reached, creating a Mattheus effect. Third, both the uptake of fossil-free energy solutions and the rate of renovation in Flanders are too low to reach European renewable energy and energy efficiency targets (Bollen and Matheys, 2021). A second crucial tendency of energy and spatial planning policy in Flanders is to devolve many responsibilities to the municipalities, without providing the necessary financial means at municipal level. With the shift from structure- to policy planning, the Flemish government lets go of its directing role and creates more scope for initiative from lower government levels and other stakeholders (Voets and Schraepen, 2019). Another telling example is the intention of the Flemish government to devolve the competence to evaluate wind energy permit applications to local governments (Corens, 2021: 215). In that context, spatial planning and design for an energy transition in Flanders can make a difference by focusing on collective strategies for different scales. The scale of the neighbourhood and of the supra-local region appear as the scales where strategic impact can be realized. The level of the neighbourhood allows to co-create collective energy solutions for a group of households or companies, but today usually lacks the capacity or an actor to facilitate this process. The scale of the supra-local region allows to pool and support municipal resources and to develop energy strategies that transcend municipal interests, but lacks a dedicated governance level.

An important contribution of spatial planning and design approaches to energy transition, is to identify opportunities to create collective value around energy solutions by connecting energy infrastructure with other societal and territorial challenges. The design strategies we co-created in Roeselare, and the regional visions in Denderland, Leiedal and Pajottenland, showed how energy strategies at different scales, can be integrated with other spatial questions around mobility, climate adaptation, urban densification and development, or landscape quality. Examples of how energy strategies can be combined with other spatial challenges, can be found in the overview in annex. It presents strategies at different collective scales, from the building block or the street, to the neighbourhood, city and urban region, sourced from the case studies included in this research and other research-by-design studies and projects. Broadening debates about energy transitions beyond quantitative goals and technological solutions, to include other spatial and societal dimensions, is a valuable contribution in itself. Moreover, all the cases in this research show that, in the Flemish context, the sustainable transformation of energy systems can only be understood in relation to the dispersed morphology of its urbanized territory. Integrating renewable energy production and energy transport infrastructure is complex in this fragmented landscape that already has to reconcile many spatial claims. Moreover, energy demand for transport and heating are related to a large extent with urban morphology and mobility through characteristics such as density, function mix and compactness. No wonder that spatial energy strategies for the Flemish context often engage with characteristic challenges of this dispersed urban landscape, such as the fragmentation and decline of open spaces, the large amount of hardened surfaces and increasing pressure on the water system, the energy-intensive dwelling environments or the dominance of car mobility. For example, the concept of wind winning areas developed by the province of East-Flanders proposes to combine renewable energy production with the need to reverse dispersed urbanization patterns and to protect and redevelop degraded open landscapes. Clustering wind turbines in dedicated open spaces, not only avoids further 'cluttering' of the landscape, but a landscape fund also allows to reinvest profits in small-scale landscape elements. On the long term, phasing out housing in undesirable locations could open opportunities for more wind energy production. Also fossil-free heating concepts are directly connected with spatial morphology, whereby denser urban environments offer opportunities for collective heating systems, and vice versa. The design strategies developed by Leiedal show how the development of district heating systems can be connected not only with the refurbishment of public building patrimony (municipal buildings, schools, care facilities, social housing, etc.) and urban renewal or densification projects, but also with the redevelopment of public spaces to include sustainable utility networks, soft mobility lanes, permeable surfaces and blue-green elements. These proposals illustrate how context-specific designs can use strategies of concentration, recombination and densification to inject collective spatial and societal value into Flanders' horizontally urbanized territory.

No fundamental transition without spatial and socio-political transformation

However, coupling energy transition with broader spatial transformation may seem too ambitious, and indeed, implementing these concepts remains difficult. One might say that energy visions should focus on energy infrastructure instead of addressing challenges of dispersed urbanization. However, I would argue that, on the contrary, these spatial strategies are not even ambitious enough. First, because if the transformation of the energy system is to be a real transition – a fundamental societal change – it cannot be meaningful without questioning the energy-intensive urbanization patterns that characterize Flanders, or without connecting energy strategies with systemic solutions to other ecological crises this landscape faces, as described above. Without spatial planning and design, alternative energy systems risk not only to reproduce undesirable spatial patterns and extremely individualized models of housing and energy consumption, but also to become overdimensioned, incompatible and ultimately societally unaffordable. Second, and this is where I return to Dehaene's reference to collective governance arrangements, a fundamental transition involves not only a spatial transformation, but also has a socio-politically transformative potential. This means planners and designers should not only formulate spatial strategies, but also address questions of process design and co-creation, stakeholder coalitions and inclusion, ownership of energy systems, governance models and business cases, financing and affordability. In Flanders' individualized housing and energy system, imagining collective modes of energy governance around values of solidarity and democracy could mean a radical shift in the type of actors and governance models that dominate the energy market.

Aiming for both spatial and socio-political transformation instead of focusing on technological innovation, may cost more effort at first, or seem like a waste of time in view of the urgency of the climate crisis. However, including these dimensions is not only essential to realize the transition as a fundamental transformation, but also the only way to realize a transition at all. Climate justice movements have made clear that considering aspects of energy justice and energy democracy is necessary to build public support, in particular to implement energy strategies at a collective scale. Therefore, planners and designers can have a crucial impact by re-politicizing energy debates, addressing both spatial and social aspects of energy infrastructure, and by introducing concepts for inclusive, collective and fair energy models alongside integrative spatial strategies. Without regional spatial energy vision, no clusters of wind energy production strategically integrated into the regional landscape, and no collective landscape fund, but a few ad hoc wind turbines here and there owned by energy multinationals. Without careful urban densification and redevelopment projects, less opportunities for district heating systems that can be managed by public or common operators. Without coordination and facilitation, no energy communities in industrial parks or residential neighbourhoods, no collective renovation of urban blocks, no micro-collective heating systems in residential allotments.

Imagining politically transformative planning and design processes and tools

However, my research also shows that addressing the socio-politically transformative potential of energy transitions is a challenge for planning and design. Planning and design processes and instruments struggle to acknowledge and address the politics of transitions, and the tools and experience of spatial professionals seem to be more attuned to spatial than social transition dimensions. Being inherently political processes, transitions involve societal struggle and conflict. Planning or design trajectories can not accommodate all forms of political contestation and are developed alongside other and broader societal discussions (e.g. the campaign of the former Flemish Bouwmeester about more efficient land use), manifestations and activism (e.g. the youth for climate strikes (2018-2019) or the gilets jaunes protests (yellow vests, fall 2018)), citizen initiatives (e.g. cooperative energy projects) or policy debates (e.g. taking place in parliament). However, spatial professionals can aim to shape conditions where contestation around concrete energy solutions can play out, by designing processes and using or developing tools that allow for different voices, knowledges, values and transition objectives to be expressed, recognized, negotiated and contested. From that perspective, co-creative energy planning does not need to be, or should not aim to be consensual. In line with Mouffe's statement that every consensus is a temporary stabilization of power that always entails some form of exclusion (quoted in Kenis, Bono and Mathijs, 2016), a co-created energy vision, strategy or project can be interpreted as one possible materialization of a temporary balance between different actors' interests, ideals and aspirations. Any vision or implemented project then becomes an imperfect basis for further contestation. This calls (spatial) practitioners to adopt a reflexive and vulnerable position as they translate abstract ideas into concrete processes and solutions, which is the only way to move beyond societal discussion and enact sustainable change.

Accounting for the politics of transitions then requires to critically apply and rethink planning and design processes and tools. A short essay by Bronsvoort et al. offers insights along three main dimensions about 'shaping inclusive encounters in the energy transition' (Bronsvoort et al., 2020): 'what: how is the problem framed?', 'how: staging and setting the interaction', and 'who: who initiates the interaction, who is invited and who participates?'. Regarding this last dimension, the planning and design processes I studied (regional energy planning) or supported (Roeselare scenario workshops) created valuable arenas where different stakeholders were brought together, from municipal spatial planners to technical energy experts and energy project developers, from citizens to industries and social housing companies. At the same time, some perspectives were underrepresented, in particular expertise about social energy dimensions is often lacking and social actors did not always feel entitled to participate. Moreover, different types of power imbalances and inequalities exist between possible participants (e.g. related with technical expertise, political or policy-making power, education, gender or socio-economic background) that need to be acknowledged and that can be mediated through the design of the setting and methodology of co-creation moments ('how'). An interesting practice used in the Waasland case, which could help overcome power imbalances created by differences in technical expertise and policy-making experience, was to offer a masterclass in spatial energy planning to selected citizens participating in the citizen panel, and to municipal politicians and civil servants, as a way to create a shared language and understanding about spatial energy dimensions. A key issue is how the challenge of energy transition is framed, and whether the process explicitly acknowledges that this is not a neutral term but an inherently political question that different actors can interpret and envision differently depending on ideologies, values or interests. The development of an ambition framework with regional stakeholders in the cases of Pajottenland and Waasland, was a valuable way to reveal and discuss different ambitions connected with regional energy transitions [chapter 3]. Using future scenarios based on possible worlds or diverging values can also allow to explicitly question and discuss different social and political transition outcomes or aspirations (Cavalieri, 2019; Juwet, 2019) [chapter 2].

Planning's eternal weakness: implementation

So far I've mainly argued what spatial planning and design can contribute in terms of envisioning fundamentally transformative energy strategies. Spatial professionals can play key roles by identifying, conceptualizing, visualizing and facilitating energy solutions that couple infrastructure transformation with spatial quality and collective governance. However, this research gives less cause for optimism regarding the impact of planning and design on the realization of strategic energy projects and on ongoing energy system transformations. First, a crucial barrier to implement spatial energy strategies is the lack of supportive policy ambitions, regulatory frameworks and resources at Flemish level. Second, bringing collective energy strategies from concept to realization requires intensive coordination and guidance, which often exceeds the capacity of individual municipalities. Third, energy projects are rarely initiated as spatial planning projects or driven by concerns for spatial quality or social innovation, but rather driven by economic actors and technocratic rationalities or 'engineering logics'. When developing or evaluating the feasibility of different scenarios, or in the phase of formulating concrete energy projects, it is therefore crucial to engage more structurally with economic actors and perspectives, such as energy network operators, energy project developers, key industries, and financial and technical experts.

Moreover, when these economic logics run into the limits of Flanders' dispersed urbanization, spatial planning can potentially make a difference. This is for example the case with wind energy, where local resistance and lengthy permit procedures limited the number of realized projects, and a shared framework could help to build public support and provide a basis to evaluate permit applications. Vice versa, 'energy transition' might not in itself be a convincing starting point for an urban development project, but can be meaningfully integrated as part of a holistic masterplan.

From this critical reflection I don't mean to conclude that planning and designing for energy transitions is not possible or valuable. Both strategic and more comprehensive approaches to planning are useful, even if policy conditions at Flemish level are not yet favourable for effective implementation.

In the previous paragraphs I've described the value of strategic and context-specific energy concepts for neighbourhoods, cities and regions. A crucial challenge is to implement these strategies, which requires better policy frameworks at Flemish level, stronger regulatory power and more resources for implementation. In the next section, I list policy recommendations in that direction.

At the same time, comprehensive or 'zoning' approaches can be useful as frameworks for spatially specific policy measures and investments initiated in other policy domains or by other actors. This is where planning and design can guide, as suggested by Dehaene, 'distributed logics' of energy systems at different scales. At the scale of a municipality, city or region, heat zoning plans are strategic planning instruments to provide a long-term perspective and timeline for each neighbourhood in terms of the desired fossil-free heating solution to be developed. These can guide investments in collective (e.g. district heating), micro-collective (e.g. shared heat storage or biomass installations) and individual heating solutions (e.g. solar boilers or heat pumps) by households or commercial, cooperative and public heat infrastructure developers. Such plans should also be used as a basis for spatially specific local renovation funding and support. Regional energy plans can provide a framework for investments in regional energy infrastructure. They can dedicate or exclude certain zones for wind energy production, develop location policies for industries based on their energy profiles, indicate areas to locate large-scale heat sources (waste incineration, energy-intensive industries), energy buffer and storage infrastructures, provide a basis for investment plans in electricity distribution networks or phasing-out strategies for natural gas networks. At Flemish level, a spatial foundation can be investigated and established to diversify energy and renovation subsidies depending on location, for example taking into account housing morphology, accessibility and service level. Moreover, a comprehensive monitoring and coördination of regional energy ambitions should ensure overall climate objectives are achieved and cross-border conflicts or exchanges can be resolved. However, delivering on this potential requires important changes in energy and planning policy, as becomes clear in the following section.

3. POLICY RECOMMENDATIONS

"We have not come here to beg world leaders to care. You have ignored us in the past and you will ignore us again. You've run out of excuses and we're running out of time. We've come here to let you know that change is coming whether you like it or not. The real power belongs to the people."

Greta Thunberg, UN Climate Change Conference,
Katowice Poland, 15 December 2018.

"The jury has reached a verdict, and it is damning. This report of the IPCC is a litany of broken climate promises. It is a file of shame, cataloguing the empty pledges that put us firmly on track towards an unlivable world. We are on a fast track to climate disaster."

António Guterres, Secretary-General of the United Nations,
introduction to the release of IPCC report 'Mitigation of climate change', 4 April 2022.

Governments have an overwhelming responsibility to address the climate crisis by formulating ambitious energy and spatial planning policy. This research showed that in Flanders, cities and regions are taking the lead while the policy framework provided at the Flemish level lacks vision and ambition. Based on the cases I studied, I formulate a series of recommendations in the following sections, directed at different scales and actors of government. I start by suggesting avenues for further socio-spatial research through mapping that can serve as a basis for spatial and energy policy at different scales. At the end I refer to other relevant resources for additional policy suggestions and best practices.

3.0. Integrate and visualize social and spatial data through mapping as a basis for spatial energy policy on different scales

Energy and spatial planning policy needs to be founded on a better understanding of social and spatial energy transition dimensions. A combination of technical, spatial and social energy data would provide a valuable basis for local, supra-local and regional spatial energy policy. Mapping such information allows to integrate and visualize different aspects of current and potential energy systems within their spatial context and make them available and accessible for different types of actors. Some existing studies already provide relevant insights about spatial energy potentials, such as the first design exploration Vlaanderen Energielandschap (Revier et al., 2015) or the Energie Atlas and Warmtekaarten developed by VITO (Renders et al., 2015; Van Esch et al., 2016; Warmtekaart 2019). However, often such studies only provide data at an aggregated resolution and are not detailed enough as a basis for energy strategies at smaller spatial scales. Studies usually focus on only one aspect instead of bringing together both spatial and social or governance dimensions of energy systems. Moreover, while many data exist but need to be made available, integrated and visualized, other information – especially regarding social energy dimensions – requires further research and data collection. Comprehensive mappings can be made publicly available in an easily accessible format and appropriate resolution, for example through the Flemish Geopunt platform. These can be complemented by co-creative mapping exercises with local stakeholders to collect and visualize locally specific information. Social and spatial energy maps can be used as a basis to co-produce local heat zoning and heating transition plans, urban and regional energy landscape visions, or neighbourhood energy strategies. In the following paragraphs I describe what types of information would be relevant to collect and combine through mapping.

First, information is needed about the current energy system: existing energy infrastructure for production and distribution, and information about the potential for sustainable energy production or networks in different locations. Fluvius already makes important data available as open data on its website, but it is not always easily accessible or represented spatially. First, it provides information about current gas and electricity use. In particular current linear gas use (if corrected in proportion to the percentage and location of natural gas consumers) can be interpreted as a proxy for linear heat demand and therefore give an indication for the potential of collective heating systems in a certain street. The network operator also provides information about the network assets and their financial value, which is relevant to develop implementation strategies for alternative systems or infrastructure replacement. Information about the development and maintenance cost of energy networks in specific areas (for example in relation to the number of connections along a certain distance) would be relevant to substantiate debates about the societal cost of dispersed networks and to better understand a possible differentiation of connection or distribution tariffs. Fluvius also offers data about local energy production. Other studies have also mapped information about energy demand, networks and production, for example in the Warmtekaart developed by Vito in 2019 (heat demand, existing district heating systems, potential residual heat sources) or in the Hernieuwbare Energie Atlas (current and potential renewable energy production). The 'Zonnekaart' provides more detailed insight into the potential of individual roofs for solar PV. For wind energy, planned or permitted wind projects could be visualized, and even existing land right contracts could be mapped as a basis to collectivize and redistribute wind profits among neighbouring land owners.

Such information about current and potential energy systems should be mapped in relation to information about existing spatial morphology and desired future spatial development, and in relation with social and governance information. Crucial information to be mapped about the built environment is the building quality or current heat demand, for example through data about building energy performance or thermographic aerial scans. To evaluate the desirability of future spatial development in a particular location, existing mappings about for example node value (service level and connectivity of a certain place) (Verachtert et al., 2016), 'mobiscore' (accessibility through soft and public transport modes) (Van Den Bergh et al., 2018), but also information about water systems (flood risk) or demographic evolution would be relevant to consider. To understand social energy dimensions, general information about socio-economic characteristics (for example on the scale of statistical sectors) can be a useful start. Fluvius provides data about budget meters and social energy supplier connections, but only on the scale of municipalities. More spatial data about home ownership (social housing, private ownership, private renter) and energy poverty would be relevant to collect and visualize. Such social and spatial energy mapping exercises can be synthesized into 'energy neighbourhood typologies'. For different types of neighbourhoods, it can indicate suitable renovation and energy system strategies in relation to each neighbourhood's spatial morphology, energy potential and social characteristics, that can form a starting point for co-created urban and neighbourhood energy strategies.

On the scale of supra-local regions, it is important to understand landscape structures, processes and qualities. An ongoing study is exploring spatial energy concepts for different typical traditional landscapes in Flanders (Custers, Landschappelijke inpassing van energie in het Vlaamse landschap, forthcoming) and can serve as a useful basis for more specific regional energy landscape visions.

To refine and complement the mapping of such region-wide data, more specific information can be harvested through a co-creative mapping approach involving local or supra-local stakeholders. At the scale of a municipality or supra-local region, mapping can be used to collect and visualize information about for example existing energy installations and potential energy sources, ongoing and planned development or energy projects, relevant actors and opportunities, (public) land ownership, or local and regional landscape identity and appreciation.

3.1. Provide an ambitious social and spatial energy transition framework at the Flemish level that sets favourable conditions for transformative action on the regional, municipal and neighbourhood scale

The Flemish government should formulate ambitious climate and energy targets that are in line with the European ambitions to reduce 55% carbon emissions by 2030. The recommendations of the 'Panel for Climate and Sustainability', set up in the context of the Youth Climate Protests under the lead of the former Flemish Bouwmeester Leo Van Broeck and climate expert Jean-Pascal van Ypersele, can serve as a basis to develop meaningful policy measures (Van Broeck and van Ypersele, 2019). In fall 2021, the Flemish government proposed additional measures to step up the ambitions of the Flemish Energy and Climate Plan (*Visienota aan de Vlaamse regering. Bijkomende maatregelen klimaat*, 2021). These include promising actions such as the roll-out of electric charging infrastructure and an obligation to renovate residential buildings upon notarial transfer ('*notariële overdracht*'), although the expected renovation level (D-label) should be increased to avoid lock-in. Moreover, further calculation, additional funding and supportive measures are crucial (Bollen and Matheys, 2021: 55).

The strategic vision of the Flemish Spatial Policy Plan should be translated into a policy framework on energy ('*Beleidskader energie*') that concretizes the relation between energy and spatial development as a guiding reference for spatial energy planning initiatives at the provincial, regional and municipal level.

At the Flemish level, a clear timeline should be formulated for phasing out fossil fuels in residential heating, industry, mobility and electricity production. This can provide perspective for individual investments by households and companies, and incentivize the development of fossil-free alternatives. The Dutch example is inspiring: not only did the government set a clear date to end natural gas extraction in Groningen, it also set up an ambitious policy and funding scheme to support fossil-free regions and neighbourhoods (see also below) (*Klimaatakkoord*, 2019). Currently, additional gas-based power plants are being commissioned by Belgium's Federal government, as a last resort solution to compensate for the nuclear phase-out (established by law in 2003 and currently planned for 2025). Although this is far from an ideal scenario, Flanders can strategically plan these gas installations in terms of scale and location to boost its energy transition. Combined heat-and-power plants near town centres, rather than large-scale gas plants in remote locations, can catalyze investments in district heating that remain useful in a carbon-free future. Obviously the proposed projects should include far-going measures to offset additional carbon emissions and a socially sensitive phasing-out strategy.

Also the location of other large-scale energy infrastructures and energy-intensive industries should be planned and coordinated at the Flemish scale. Waste incinerators, industries with large amounts of residuel heat or steam, hydrogen-based activities, main pipeline infrastructures should be strategically located. More funding should be allocated to strategic infrastructure investments, for example to adapt the electricity network to accommodate electrification of transport and heating, or to accelerate the roll-out of district heating in urban centres (Bollen and Matheys, 2021).

Because of the levies on electricity distribution that finance social and ecological energy policy, electric heating solutions are not competitive in comparison with fossil fuel-based heating solutions (see chapter 4), although this imbalance has recently shifted due to the rise in fossil fuel prices. Resolving this economic disadvantage requires to rethink these levies, and possibly shift them to fossil-fuel-based energy carriers or uses. Social energy policy and renewable energy investment should be financed more through the regular tax system or via the Climate Fund rather than through energy tariffs. The introduction of the 'capacity tariff' was recently questioned by the energy minister, because the tariff structure as proposed by the Flemish regulator VREG, would disproportionately affect vulnerable households (De Standaard, February 2022). Indeed, this tariff proposal should be thoroughly evaluated and reformed from a social justice perspective. Energy-intensive industries should contribute more to the financing of the energy distribution system. Taxing heat loss through cooling water discharge, can be an incentive for collective heating solutions based on cascading residual heat (Declerck et al., 2019).

The Flemish regulator VREG and network operator Fluvius have a key role to play in the energy transition. The Flemish government should give them an ambitious 'energy transition mandate': clear objectives for the integration of renewable energy, adaptation of the electricity grid, and replacement of natural gas with fossil-free heating alternatives. It should incentivize Fluvius to investigate the financial feasibility of an accelerated phase-out or repurposing of natural gas infrastructure. The regulator should get an explicit responsibility to monitor, regulate and support these transition objectives. When evaluating grid investment plans, not only 'network costs' but also transition objectives should be considered. The management of Fluvius should be opened up to include not only political representatives, but also (social) energy experts and voices from civil society. In discussions around tariff reforms, energy poverty and a fair financing of the energy transition, the expertise of social and ecological organizations like SERV (Socio-Economic Council of Flanders), Samenlevingsopbouw, Reset.Vlaanderen, the energy working group of Transitienetwerk Middenveld, Koning Boudewijnstichting, Fairfin, labour unions, Bond Beter Leefmilieu and Greenpeace can provide crucial input about social justice. The team working on strategic network development within Fluvius, should be expanded and given a central role to further strengthen Fluvius' transition vision (*Visie 2050: de Vlaamse energienetten van de toekomst*, 2020), actively promote it towards its municipal shareholders and other stakeholders, and experiment with innovative pilot projects.

Current subsidies and fiscal incentives for energy renovation and renewable energy production mostly focus on individual households and companies. They are not spatially selective, and often inaccessible for underprivileged households. An appropriate basis for spatially diversified renovation subsidies (e.g. the analysis of node value and proximity of amenities developed by VITO (Verachtert et al., 2016)), and the social consequences of such a policy measure, should be investigated. The fee for connection to energy distribution networks could also be diversified accordingly. Moreover, Green Energy Certicificates (Groene Stroom Certificaten) could be spatially diversified or applied as part of an area-specific approach, for example to support the implementation of regional energy visions (L'Ecluse et al., 2020). Financial stimulation should be deployed where it can make a real difference; therefore substantial financial support should be directed primarily to underprivileged groups (Bollen and Matheys, 2021). Generally, subsidies should be aimed more towards the facilitation of and investment in collective renovation and energy infrastructure (see infra). Any barriers for collective energy installations in the current EPB-legislation (energy performance regulations) or in the Flemish Housing Code ('Vlaamse Wooncode') should be lifted. Social housing companies should be provided with adequate resources and incentives to integrate sustainable energy installations in renovation and development projects. Overall, realizing more social housing is necessary to ensure better access to qualitative housing. To enable a real 'renovation wave', it is furthermore necessary to invest in a stronger sustainable building sector.

3.2. Install a sound juridical and operational foundation for spatial energy planning initiatives at regional and municipal level

Following the Dutch example, the development of Regional Energy Visions at supra-municipal level should be made compulsory. A strong coordination, monitoring and support programme should be set up at the Flemish level. Potentially, criteria and conditions for regional energy visions could be established by adapting the Energy Decree (*Energiedecreet*) or developing a Framework Decree on Regional Energy Landscapes (*Kaderdecreet Energielandschappen*) (L'Ecluse et al., 2020). The development of a regional approach to energy planning is in line with the Flemish governments' ambition to set up 'Referentieregio's, in order to streamline the variety of existing structures for supralocal collaboration. Similar regional approaches are already applied for transport ('*vervoerregio's*'), housing (the regional reorganization of housing associations ('*woonmaatschappijen*')) and care ('*zorgregio*'s). In due course, alignment of the energy regions with the proposed 'referentieregio's' could be investigated. However, regarding energy transition, the roles and institutional setup of provinces, intermunicipal development companies and other regional stakeholders differ in each region, and the choice of a suitable initiator for a regional energy vision will depend on the regional context (Custers et al., 2021). Moreover, this process of governance rescaling should be critically assessed to avoid further depoliticization of spatial energy decisions and instead facilitate more transparent and democratic governance. Flemish grid operator Fluvius should be obliged to participate in these regional energy planning processes and to evaluate the feasibility of different regional energy scenarios. The Flemish level is responsible to coordinate between regional energy ambitions to reconcile different energy balances (between energy-producing and energy-importing regions) and to resolve cross-border challenges.

After approval, regional spatial energy visions should be anchored in both guiding and regulatory policy and spatial planning instruments and form the basis of concrete action programmes and projects. Suitable instruments were researched in the '*BRV Proeftuin Dendervallei*', which included an expert workshop organized by VRP (Association of Flemish Spatial Planners), Departement Omgeving and the province of East-Flanders (Tindemans et al., 2019). Rather than developing new spatial planning instruments, experts and practitioners agreed the existing policy instruments should be applied strategically, simplified and adapted to remove inconsistencies. Translating a regional vision into a regional policy framework for energy, in combination with an action programme, seems a promising approach to establish the vision as a regional spatial policy. Key elements from a vision, such as wind winning areas or zones excluding wind energy production, could be juridically established in a Spatial Implementation Plan ('*Ruimtelijk Uitvoeringsplan*'). This is the most robust approach to give a regional energy plan regulatory power, provide a basis for permit evaluations and for potential acquisition of lands for implementation (L'Ecluse et al., 2020; Tindemans et al., 2019). An alternative could be to broaden the decree on land development ('*landinrichting*') and integrate energy in land development projects (L'Ecluse et al., 2020).

The legislative basis for wind energy planning, based today on a circular ('*omzendbrief*'), a book of guidelines and a manual on wind turbines, needs to be reformed. Rather than using the generic rule that wind energy projects should be located near linear infrastructures or on industrial terrains, regional energy visions should form the basis for the evaluation of wind energy permit applications. The competence to evaluate permit applications for wind energy should not be devolved to the municipal level but can remain at the level of the province, so that local interests and conflicts can be assessed from a broader perspective. To allow for regionally specific wind energy strategies, adapted to each region's unique landscape context, the evaluation of MER-analyses (environmental impact assessment studies in the context of a permit application) should be based on region-specific spatial criteria (Custers, Landschappelijke inpassing van energie in het Vlaamse landschap, forthcoming).

The benefits and burdens of wind energy should be shared more fairly, in essence wind should be treated as a common. Ideally, land development rights ('*opstalrechten*') should be organized and distributed collectively between land owners, to avoid that one owner has a 'win-for-life' while direct neighbours are confronted with the environmental impact but receive none of the added value. This requires a central database of existing land development rights and option contracts (L'Ecluse et al., 2020). Moreover, to implement regional wind strategies, governments can offer suitable properties for development by private actors through a tendering procedure. This would allow to couple specific criteria, such as direct (financial) citizen participation, realizing societal value, or the creation of a landscape fund ('*omgevingsfonds*'), to the selection of project developers. The positive experience of the province of East-Flanders with this approach in Eeklo can serve as a good example (Causyn et al., 2017; Sansen, 2015). A broader application of the urbanistic charge ('*stedenbouwkundige last*') could be used to impose wind developers to contribute to a landscape fund to invest in open space development. Depending on the specific project characteristics, financial profits of wind energy projects can even be used to finance the phasing out of undesirable dispersed buildings (L'Ecluse et al., 2020). Today, municipalities and provinces regularly specify conditions for citizen participation through energy cooperatives or energy communities, but these can be undermined during permit application procedures. A stronger legislative basis (decree at Flemish level) is necessary to enforce financial participation by citizens, companies and local communities.

At the municipal level, heat zoning plans are a promising approach to specify suitable heating solutions for each type of neighbourhood, and provide a long-term perspective for future investments. Such plans should take into account not only current spatial density and energy demand, but also desired or planned future spatial development and energy demand. Intermunicipal companies, provinces and the Flemish government can support municipalities with a limited planning capacity, to develop such plans. Specific elements, such as the need for a collective technical space in apartment buildings, can be integrated in the municipal spatial regulations. Heat zoning plans can be an interesting basis to spatially diversify municipal/regional subsidies or policy instruments, depending on the most desirable renovation and heating approach for each neighbourhood.

3.3. Improve municipalities' capacity to plan, facilitate and implement strategic energy projects

In terms of climate and energy policy and actions, a wide gap exists today between the capacity and practice of the larger cities like Ghent, Antwerp or Leuven, and even the other central cities like Roeselare or Mechelen on the one hand, and most small municipalities on the other hand. Overall, there is a strong mismatch between the (climate, energy and spatial planning) competences devolved to the municipal level, and the resources provided by the Flemish government. On the other hand, municipalities have the potential to play a key role in climate action, on the condition that adequate resources are provided. The efforts proposed in the Local Energy and Climate Pact ('*Lokaal Energie- en Klimaatpact*') between the Flemish government and the municipalities, should be increased and expanded (*Lokaal energie- en klimaatpact*, 2021). Today, small municipalities usually lack the capacity to develop dedicated energy planning initiatives or ambitious climate projects. Supralocal collaboration is therefore crucial to support and develop municipal capacity, for example in the domains of spatial (energy) planning (intermunicipal development company, energy region), climate planning (support by provinces or intermunicipal companies), housing (*Bovenlokaal woonoverleg*, *woonregio*) or mobility (*vervoersregio*). Both within the municipal administrations and at the level of these platforms for supralocal collaboration, a stronger interaction and alignment between different domains is important. The example of Interwaas in the Waasland region is interesting: this intermunicipal company centralizes not only climate action in the region under the umbrella of *Waasland Klimaatland*, but also organizes intermunicipal collaboration in the domain of housing, and provides the '*Woon- en energieloket'* as a one-stop-shop for inhabitants with questions about housing or energy. Policy measures and projects for energy transition can not be implemented in isolation or by a separate department but should become integrated into all municipal policy domains and projects as a transversal concern. Moreover, more capacity should be dedicated to climate and energy topics across all organizations as a key domain for local governance, from small municipalities to larger cities, intermunicipal companies and provinces.

Provinces and intermunicipal companies can play key roles to support municipal energy planning capacity, and to assist in the implementation of concrete projects. Actors like Leiedal or the provinces of East-Flanders and Vlaams-Brabant already generate impact by attracting funding from Europe (Interreg, Urban Innovative Action) or Flanders (Strategic Projects). This often allows to explore new energy concepts (HeatNet: low-temperature heating systems, Rhedcoop: cooperative ESCO for collective renovation, Lecsea: local energy communities) and fund the uncertain phase of feasibility analyses and experimentation. Indeed, bridging the first phase of project implementation, to form a coalition and secure commitment from key actors, to study feasibility and develop a business case is a key challenge in moving from vision to implementation. Initiatives such as the '*Netwerk Klimaat*', founded in 2020 and led by the VVSG (Association of Flemish Municipalities) are promising but could be more ambitious. This network can provide support by sharing best practices, providing energy and climate data and monitoring expertise, or exchanging examples and templates for policy measures and spatial planning regulations. Municipalities can also make better use of the support offered by VEB, the Flemish Energy Company, in terms of energy-efficiency and energy production for their public patrimony.

3.4. Create opportunities for citizen-based energy initiatives

The German *Energiewende* has shown that providing opportunities for citizens in the energy market can have a big impact (Morris and Jungjohann, 2016). In Flanders, this potential for citizen energy projects can be harnessed much better. First, the transposition of the European legislation for Energy Communities (*Clean energy for all Europeans*, 2019) tends to be rather conservative and needs to be re-evaluated to ensure real business opportunities for citizen initiatives. Potentially, Citizen and Renewable Energy Communities could mean a shift not only in the type of actors and governance models active in the energy market, but also in the type and amount of spaces used for local energy production and exchange. The current Flemish legislative proposal insists on the need for Energy Communities to pay a distribution grid fee even when such communities actually help to balance and decongest the network. This decision is based on the concern that network financing would be eroded if energy communities 'disconnect' from the grid, but ultimately impedes the elaboration of feasible business cases for these communities. Instead, the distribution grid tariff should be reformed in light of the expected and desired diversification and decentralization of energy systems. Local energy exchange, storage and buffering should be stimulated to optimize grid balance while ensuring solidarity within and between energy communities. More support should also be provided to facilitate the creation of such communities, whereby actors such as urban planners, co-creation experts, transition practitioners or energy cooperatives can play a key role.

Moreover, public governments should commit to public-civil partnerships for energy projects. The possibility to specify criteria for citizen participation in tendering procedures for wind energy projects, as practiced in Eeklo, was already explained above. Another interesting initiative is the framework contract (*raamcontract*) set up by the Flemish Energy Company VEB, so that municipalities can easily enter in a power purchase agreement with energy cooperatives to realize cooperative solar energy projects on municipal buildings. However, although this initiative largely unburdens municipalities, the take-up is relatively low. VEB also offers similar support for a sustainable transition of the patrimony of municipalities (SURE 2050 project) and other public actors and sectors, such as care and education. As the practice of cooperatives such as Beauvent and Energent shows, setting up collaborations between diverse public actors (school, cultural centres, care facilities) and citizen energy cooperatives is very promising. At the same time, more investment in the professionalization of citizen energy cooperatives is necessary. While experienced cooperatives (Ecopower, Beauvent, Energent) manage to implement ambitious energy projects, others regularly struggle to develop feasible business cases.

3.5. Support collective and inclusive trajectories towards sustainable energy projects

A transition in the Flemish energy system requires scaling-up from individual to collective energy projects: collectively renovating, and exchanging, storing, buffering and distributing heat and electricity via shared energy infrastructures at the scale of a building block, street or neighbourhood. Developing and realizing such projects requires intensive support and facilitation. Collective renovation is extremely difficult in Flanders because of the fragmented ownership and architectural diversity of its housing patrimony (Heylen and Vanderstraeten, 2019). Pilot projects such as *Wijkwerf* (*Energent*) or *Dampoort KnapT Op* can provide crucial lessons about upscaling the renovation rate and supporting underprivileged groups. In the Dampoort KnapT Op project, a coalition of public and social organizations provided a long-term renovation loan (30.000 euro) and intensive support to emergency buyers. This loan only needs to be repaid upon sale of the house, based on the added value created by the renovation (*Dampoort KnapT OP, Wijkrenovatie met noodkopers*, 2016). Meanwhile, based on this experience, the Flemish level set up the '*Noodkoopfonds*', to financially support renovation by emergency buyers. This initiative should be expanded and combined with facilitation to improve housing quality at the bottom of the ownership market.

Although ESCO models (energy service company) are promising for large-scale investments in energy efficiency (as practiced for example by energy service company Wattson for care facilities, industries or residential care centres), they remain difficult to implement for housing patrimony because home renovations are challenging to upscale. Promising experience has been built up internationally, for example with the Labeef model in Latvia, where a combination of European funding, clever financing schemes, and thoughtful process facilitation allows to develop esco-based renovation trajectories for post-Soviet collective housing buildings (Skudra, 2021). The Rhedcoop project explored cooperative esco models in the Flemish and Dutch context and built a 'coop-kit' to support energy cooperatives and public governments in setting up collective energy services and renovation trajectories for private and public patrimony (BE_REEL!, 2021).

In the development of fossil-free heating systems, an important hurdle is to connect existing housing to district heating networks. Today, this proves nearly impossible because of the individual connection cost in comparison with a connection to the natural gas grid, and the need for intensive coordination and collective decision-making at the level of a street or building block. The experience of Mirom in Roeselare with the connection of apartment buildings shows how important intermediate figures, such as the '*syndicus*' (property manager) are to gain co-owners' trust and build support for a shared heating system (Schoonjans, 2020).

Initiatives such as the Pilootprojecten Klimaatwijken, set up by '*Labo Ruimte*' (Department of Environment and the Flemish State Architect), are crucial to explore holistic approaches to sustainable neighbourhood reconversion and should be expanded. Governance models such as the '*Wijkbedrijf*' in the Netherlands or the 'Community Trusts and Enterprises' in the UK can also inspire innovative approaches to collective governance and financing (Boeije and Ligtenberg, 2018; Von

Meding, 2019). The '*Kempenlab Wijkrenovatie'* explored how this approach could contribute to the renovation of social housing estates in Flanders (Pieters and Wouters (eds.), 2019). Projects such as '*Buurzame Stroom'* (Baets et al., 2020) or '*La Pile'* (City Mine(d), 2020) have explored how innovative energy solutions can be implemented in complex urban neighbourhoods.

Industrial areas can become important hubs in a sustainable transformation of the Flemish energy system. They can be developed as spaces where energy is not only produced and consumed, but also collected from a broader region, converted into a different form (power-to-hydrogen, power-to-gas) or stored. Provinces and provincial development companies (POMs) are already facilitating projects to exchange energy flows by creating the position of an 'energy broker' ('*energiemakelaar'* – e.g. in the Interreg project DOEN) and to set up energy communities (Interreg project Smart Energy Link). As developers and managers of industrial terrains, intermunicipal companies and POMs can take energy flows into account early-on. Granting concessions or selling terrains can be based on a strategic location policy whereby companies with a complementary energy profile are located together.

Further policy suggestions on spatial energy policy in Flanders can be found in '*Ruimte voor de energietransitie*' (Declerck et al., 2019), and in the Minaraad report '*Gebiedsgerichte afstemming van hernieuwbare energie*' (Corens, 2021). Effective energy policy measures are listed in the SERV report '*Met 'Fit for 55' naar een fit Vlaanderen. Krachttoeren om de CO2 trends snel om te keren* (Bollen and Matheys, 2021). Guidelines on regional energy planning were formulated in '*RRES: Draaiboek ruimtelijke regionale energie strategie*' and its annex with policy recommendations (Custers et al., 2021). Inspiration for concrete actions and policy measures for energy regions can be found in the Roadmaps presented in the Pajottenland regional energy vision (Devos et al., 2021), and advice on useful planning instruments was collected in the report '*BRV Proeftuin: werk maken van ruimtelijke transformaties in de Dendervallei*' (Tindemans et al., 2019), and the report on '*gebiedswerking in de Dender vallei*' (L'Ecluse et al., 2020). A visual overview of energy building blocks and their spatial dimensions was developed in the context of Waasland Energielandschap (*Energielandschap 2050 Waasland. Bouwstenen*, 2021). Valuable information on municipal heat planning is bundled in the '*Leidraad warmtenetten voor lokale besturen*' (Neyens et al., 2018). Planning and design advice for climate transitions at a neighbourhood scale can be found in the report '*Verkennend onderzoek energie- en klimaatwijken*' (Van Den Driessche et al., 2018).

4. AVENUES FOR FURTHER RESEARCH

Although this research has already identified a number of avenues towards a spatially and socially meaningful energy future, many questions remain to be explored.

In terms of bridging different theoretical perspectives, I've attempted to combine the systemic approach of transition thinking with the attention to materiality and morphology of planning and design, and the sensitivity to social and political transition dimensions from social infrastructure studies, energy justice debates and urban metabolism studies. Meanwhile, the question of how to connect ecological transitions with social justice is increasingly taken up in public and academic debate. Important lessons are to be drawn from ecofeminist, intersectional and decolonial approaches to climate and transition challenges. Moreover, this research did not yet engage with fundamental ethical questions, for example about the environmental impact of resource extraction for renewable energy technologies, or about what energy use is 'sufficient' or 'necessary' and how degrowth might inspire energy transition strategies.

In practice, a large gap remains to be bridged between the multitude of inspiring transition initiatives on the one hand, and the urgent and major systemic transformations that are necessary to cope with the global climate and biodiversity crisis on the other hand. Applied research is necessary to develop spatial and economic strategies to phase out outdated energy infrastructure and support the associated retraining of the workforce in the energy sector. Strategic location factors for energy-intensive industries, waste treatment and large-scale energy production and conversion hubs need to be identified. The potential socio-spatial consequences of spatially diverse energy and renovation subsidies, taxes, fiscal incentives and distribution grid connection fees should be analyzed. A potential reform of distribution tariffs should be investigated that accommodates the emergence of citizen and renewable energy communities while ensuring solidarity between different energy users and maintaining the societal affordability of the distribution grid.

Regarding energy planning, further research could explore how planners, designers and transition practitioners can better address questions around power and inequality, democratic energy governance, inclusion and solidarity in practice. How can we visualize not only opportunities for spatial transformation but also for socio-political change, and how can social concerns and actors be involved meaningfully in designing future energy scenarios and visions? At the neighbourhood scale, spatial professionals can explore how research-by-design can support citizen transition initiatives to increase their ecological, social and spatial impact and connect different transition domains. Interconnections between energy and other metabolic flows, such as water, food, organic waste or material flows can be investigated. Designers can collaborate with social and economic actors and researchers to imagine how spatial energy strategies can be coupled with inclusive governance models, financing mechanisms and feasible business cases, and how energy communities can be set up that are inclusive and fair. Action research can be used to test how inspiring governance models such as the cooperative esco, or (cooperative) neighbourhood companies ('*wijkbedrijf*') can be implemented in the context of Flemish neighbourhoods.

Conditions and strategies for upscaling local transition practices also need to be further investigated. What aspects of an energy strategy are context-specific and which elements can be replicated in other neighbourhoods or regions? Research can explore what financial mechanisms (e.g. rolling fund, social impact bonds) can be used to scale up investments in sustainable energy solutions, or focus on strategic policy choices that could catalyze a shift in mobility patterns, heating choices or renovation practices.

Annex - spatial energy strategies

Legend

SCALE LEVEL OF ENERGY STRATEGY

DESIGN PARAMETERS (BASED ON CONCEPTUAL FRAMEWORK)

SPATIAL ENERGY STRATEGY TITLE

Spatial

Description of the spatial energy strategy, as proposed in the cited references.

Governance

Possible governance approaches, based on cited examples or proposed by author.

- Reference project / spatial design proposal that applies this strategy
- Other spatial design proposal that applies this strategy

CLIMATE AXIS

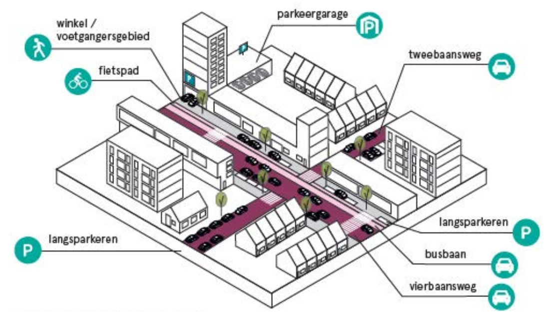
Spatial

Integrating strategic energy infrastructure (electricity, heating, storage and buffering) in the redevelopment of a principal mobility infrastructure (e.g. ring road). Potentially combining the redevelopment of public space (integrating blue-green spaces, energy infrastructure, separate public transport, cycling or pedestrian lanes) with the location of urban redevelopment and densification projects along this energy backbone.

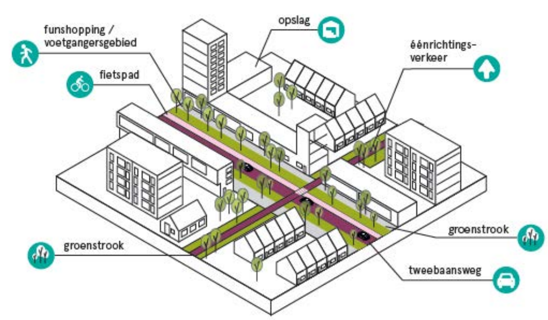
Governance

Public actors (municipality, Flemish road authority, utility network operators, ...) in collaboration with urban developers. Urban energy coordinator/ambassador.

- Leiedal Regional Energy Strategy
- Groningen Slimme Energiestad



Toegangswegen en woonstraten 2035



Refurbishment of street profile along 'heat ring'. Source: Groningen slimme energiestad, 2016.

BLOCK/STREET RENOVATION

Spatial

Coordinated retrofitting at the scale of a collective building, building block or street. Collective renovation support, pooling expertise, contractor, building materials.

Potentially integrating collective heating systems (district heating substation, heat pump, geothermal installation, ...) or storage facilities (batteries) and/or other collective spaces.

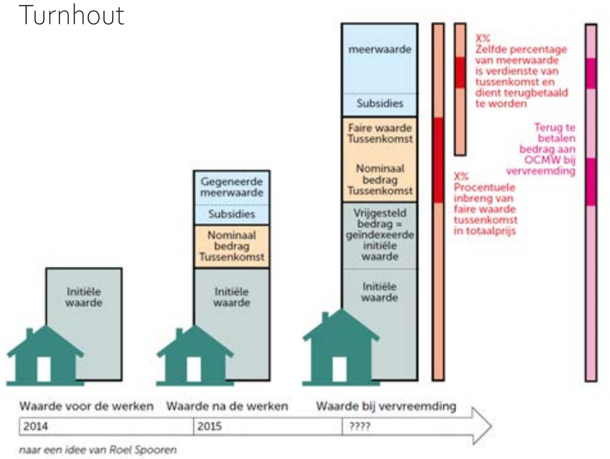
Governance

Building trust: apartment manager (syndic).

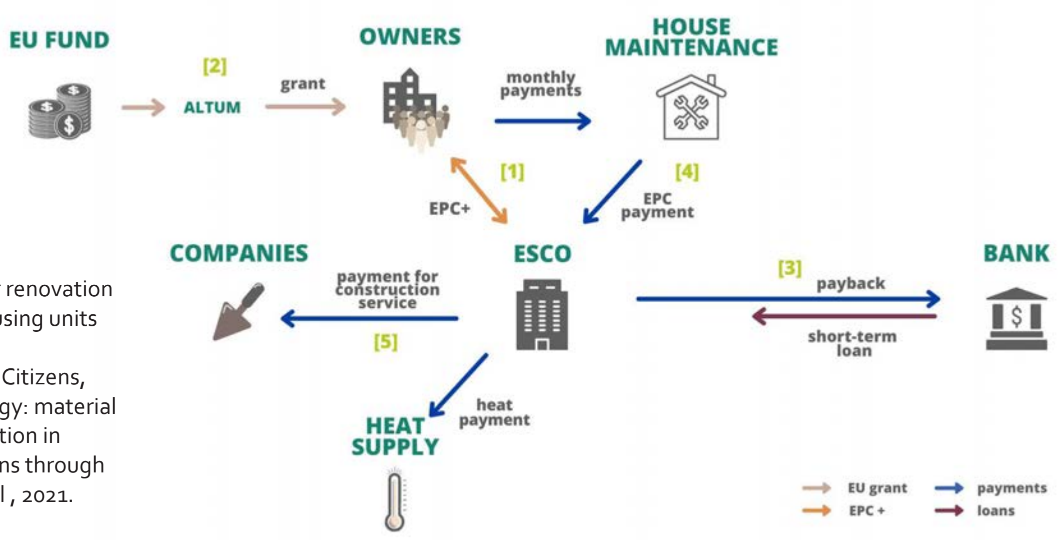
Facilitation & renovation support: energy cooperative, neighbourhood energy ambassador.

Financing: (cooperative) ESCO formula, rolling renovation fund (CLT-principle).

- Latvia ESCO-system Labeef
- Interreg RHEDCOOP cooperatieve Esco
- Wijkwerf, Energent
- Dampoort KnapT OP - Gent KnapT OP
- Wijkbedrijf, Selwerd, Nederland
- Wijkmotor, Egelsvennen, Mol & Parkwijk, Turnhout



Financing scheme
Source: Dampoort KnapT OP, 2016.



ESCO model for renovation of collective housing units in Latvia.
Source: Skudra, Citizens, housing & enerrgy: material citizen participation in energy transitions through the ESCO model , 2021.

NEIGHBOURHOOD ENERGY HUB

Spatial

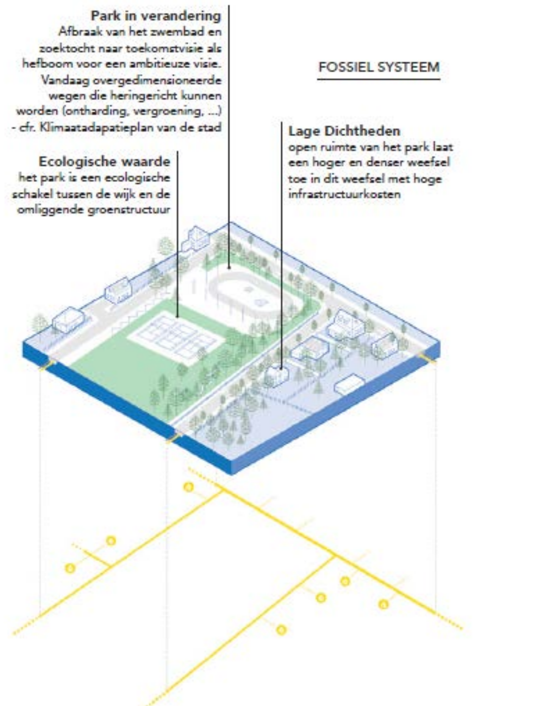
Energy square / park / building. Integrating collective energy infrastructure (heat storage, collective battery, collective heat pump, district heating substation, PV installation, geothermal installation) under public spaces or in/on public and collective buildings. Combining collective energy infrastructure with other collective block/neighbourhood functions (bicycle storage, shared work spaces and ateliers, collective gardens, ...) or with densification (additional housing units).

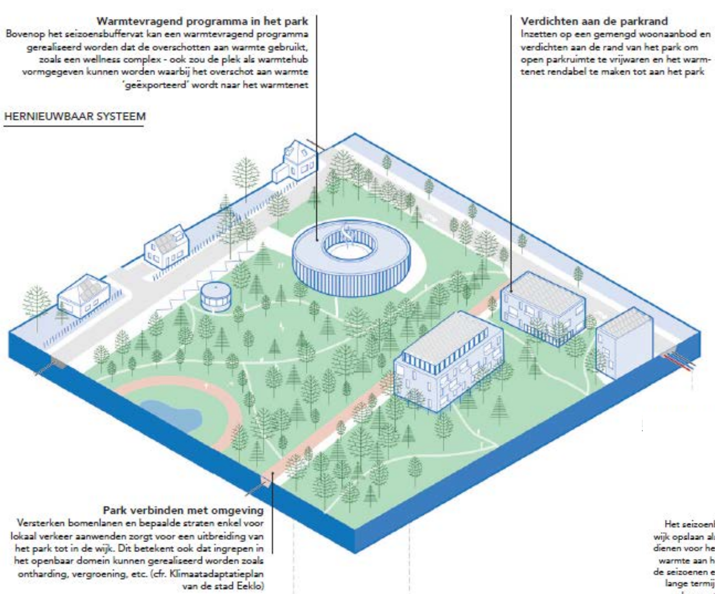
Governance

Coordination & facilitation: municipality / neighbourhood energy ambassador.

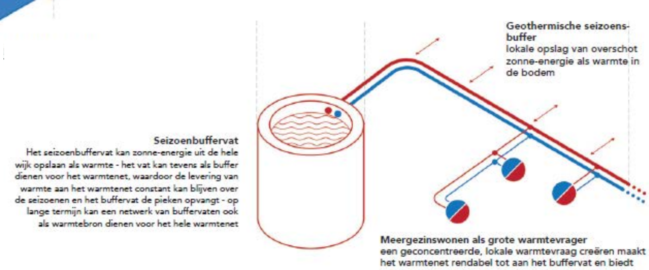
Governance & financing: neighbourhood cooperative, energy cooperative, neighbourhood energy community.

- Roeselare energy scenario workshops
- Energiewijk Oostveld Eeklo





Heat/housing concept 'wonen aan het park'. Source: Energiewijk Oostveld, no date.



URBAN PROJECT AS TRANSITION CATALYST

Spatial

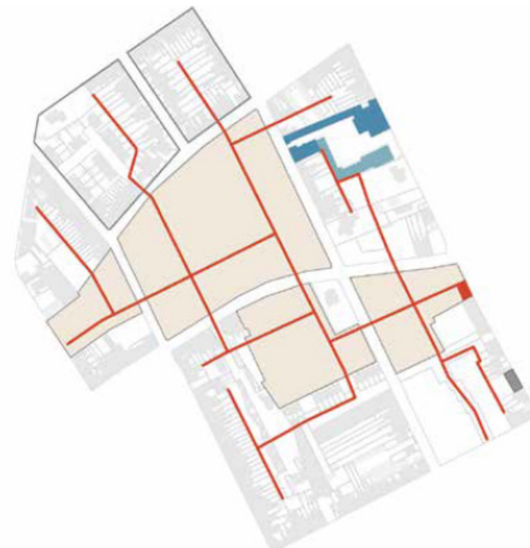
Urban renewal project as catalyst to initiate or extend collective heating systems. Extending energy networks in redevelopment projects into the surrounding neighbourhood, sharing collectively produced electricity with surrounding activities, integrating collective energy production, storage and buffering installations in new buildings. Extending district heating networks into new areas by connecting urban renewal and densification projects.

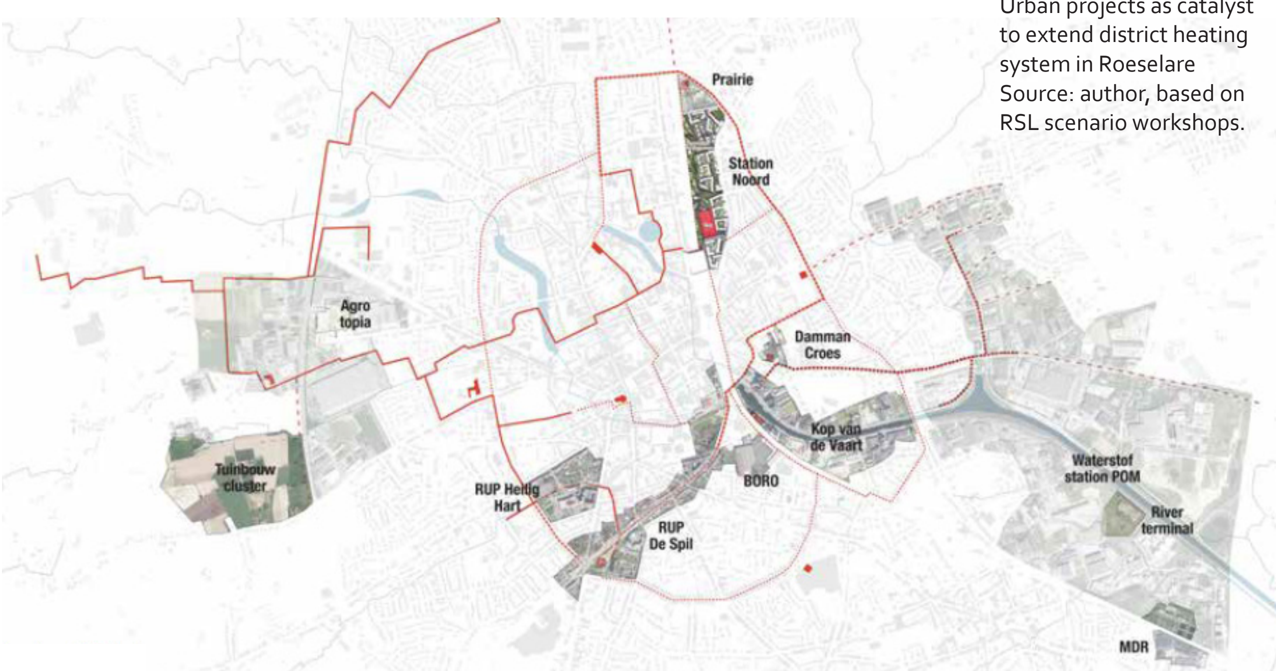
Governance

Coordination & facilitation: urban/neighbourhood energy matchmaker.

Development & governance: innovative project developers and development models, neighbourhood energy community, resident cooperative.

- Roeselare energy scenario workshops
- Leiedal Regionale Energiestrategie





Urban projects as catalyst to extend district heating system in Roeselare
Source: author, based on RSL scenario workshops.

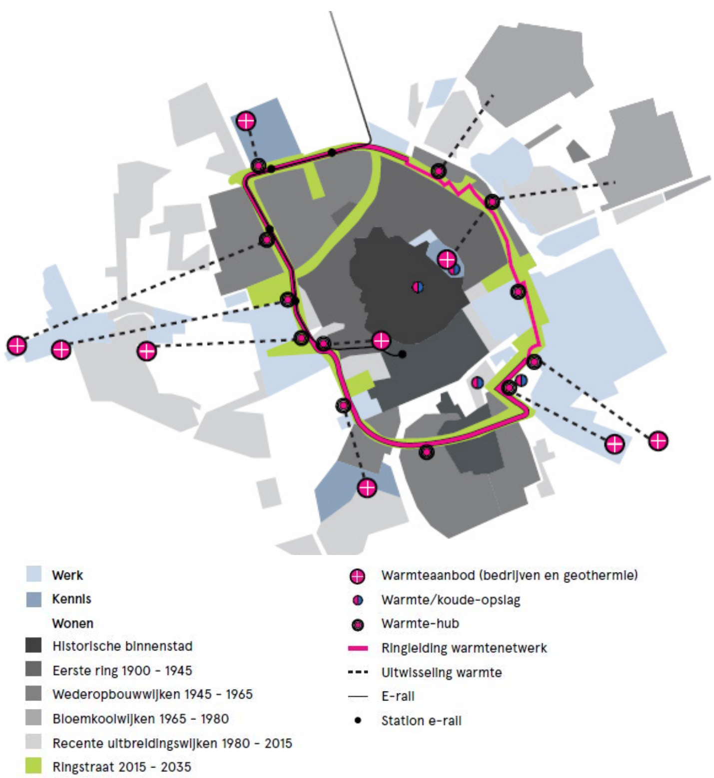
ENERGY BACKBONE

Spatial

Integrating strategic energy infrastructure (electricity, heating, storage and buffering) in the redevelopment of a principal mobility infrastructure (e.g. ring road). Potentially combining the redevelopment of public space (integrating blue-green spaces, energy infrastructure, separate public transport, cycling or pedestrian lanes) with the location of urban redevelopment and densification projects along this energy backbone.

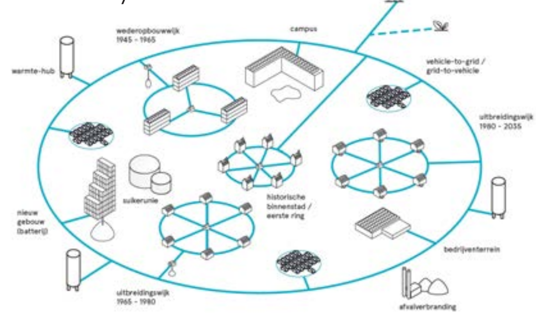
Governance

Public actors (municipality, Flemish road authority, utility network operators, ...) in collaboration with urban developers. Urban energy matchmaker.

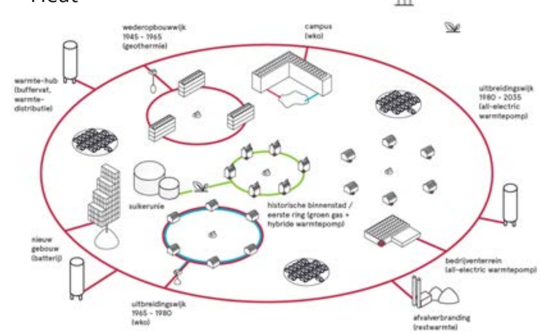


- Groningen Slimme Energiestad

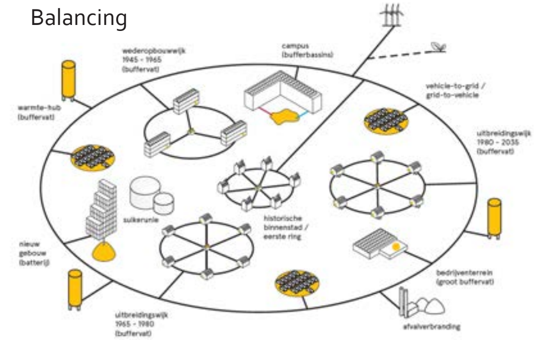
Elektricity



Heat



Balancing



Urban 'heat ring' as carrier of boulevard redevelopment.
Source: Groningen slimme energiestad, 2016.

HEAT STEPPING STONES

Spatial

Connecting different sites with collective heating systems, combining public buildings, energy-intensive activities and urban (re-)development projects. Developing district heating networks as carriers of urban redevelopment and densification projects, while potentially creating more open spaces along blue-green systems.

Governance

Local government and public actors (public buildings as critical mass), urban developers, urban energy matchmaker.

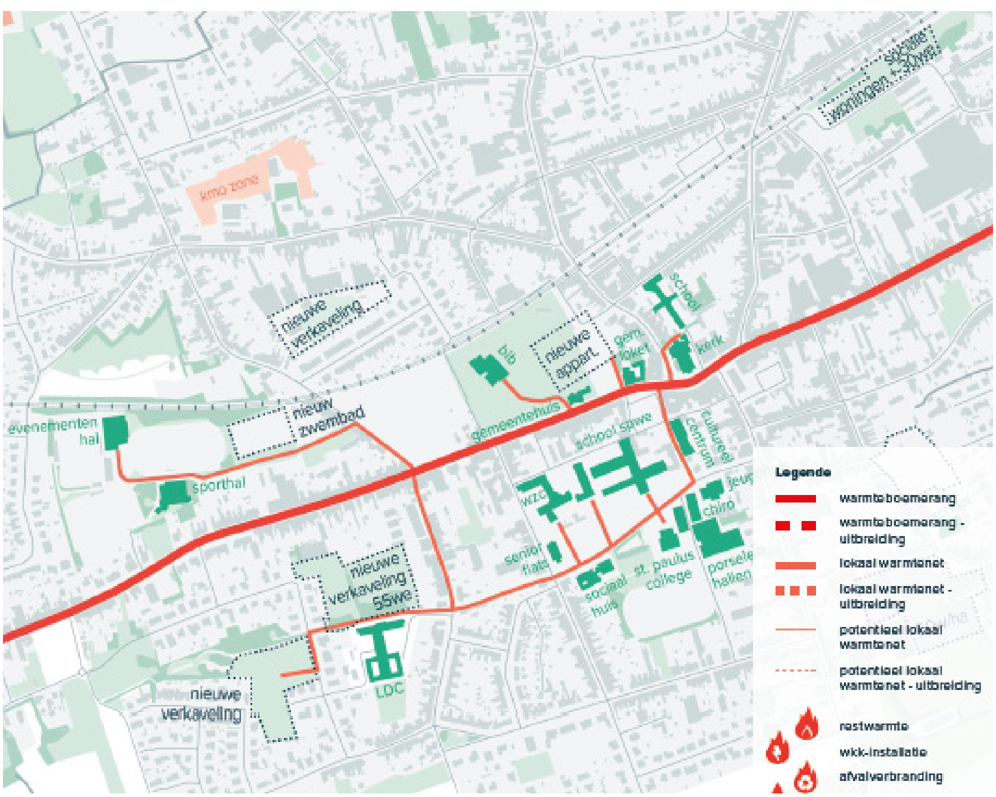
PROXIMITY (DENSITY, MIXITY)

STRUCTURING CAPACITY INFRASTRUCTURE

OPEN FLEXIBLE SYSTEM

CASCADING

- Roeselare energy scenario workshops
- Groningen Slimme Energiestad
- Leiedal Regionale Energiestrategie
- Atelier Diepe Geothermie



Potential district heating in Wevelgem.
Source: Leiedal Regionale Energiestrategie, 2020.

SPATIAL SELECTIVITY

RADICAL INCREMENTAL TRANSFORMATION

HEAT ZONING

Spatial

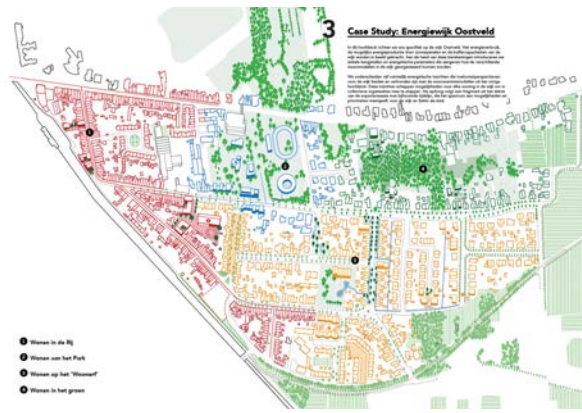
Categorization of neighbourhoods based on energy characteristics (building morphology and type, age, renovation status, activities, energy production potential) and governance characteristics (ownership, socio-economic profile), specifying energy concepts for each type of neighbourhood. Ranging from large-scale public energy networks, to collective and micro-collective energy solutions or individual installations. Zoning plan should be refined through co-produced neighbourhood energy strategies.

Governance

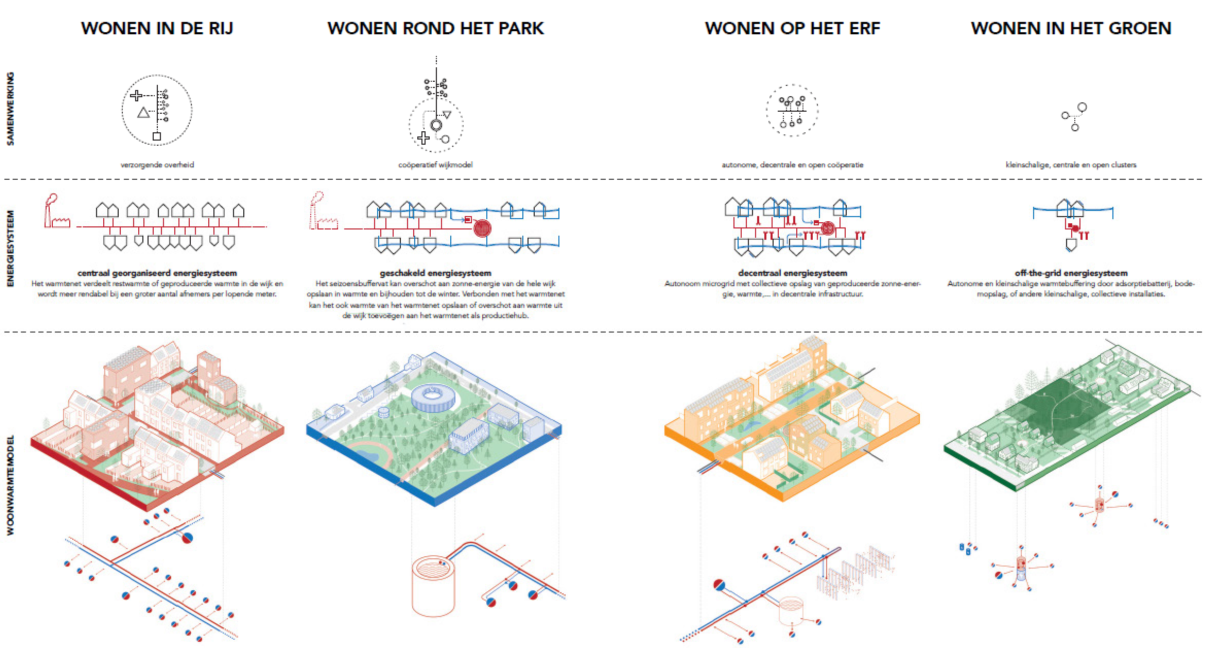
Specific governance model depending on the neighbourhood energy concept. Public system: municipality, energy network operator, urban energy ambassador.

Collective system: neighbourhood energy community, energy cooperative, neighbourhood energy ambassador. Individual: one-stop shop renovation and energy support.

- Roeselare energy scenario workshops
- Groningen Slimme Energiestad
- Energiewijk Oostveld Eeklo
- Energiestrategie Bospolder-Tussendijken Rotterdam



Four heat-housing typologies for Oostveld.
Source: Energiewijk Oostveld, Eeklo, no date.



WIND LANDSCAPE CLUSTER

Spatial

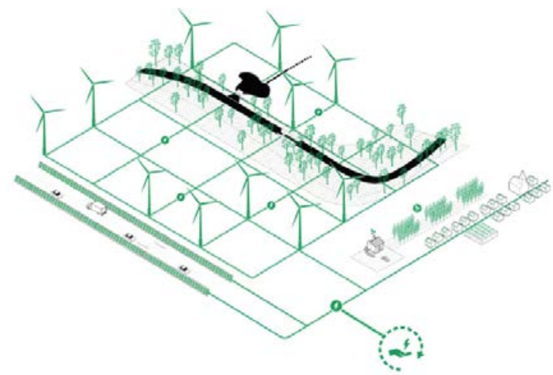
Cluster wind turbines in suitable open spaces, while keeping other landscapes free from wind energy production infrastructure. Maximize wind turbine potential by phasing out dispersed urbanization on the long term. (Re-)develop open spaces as productive landscapes and/or re-introduce and strengthen small landscape elements.

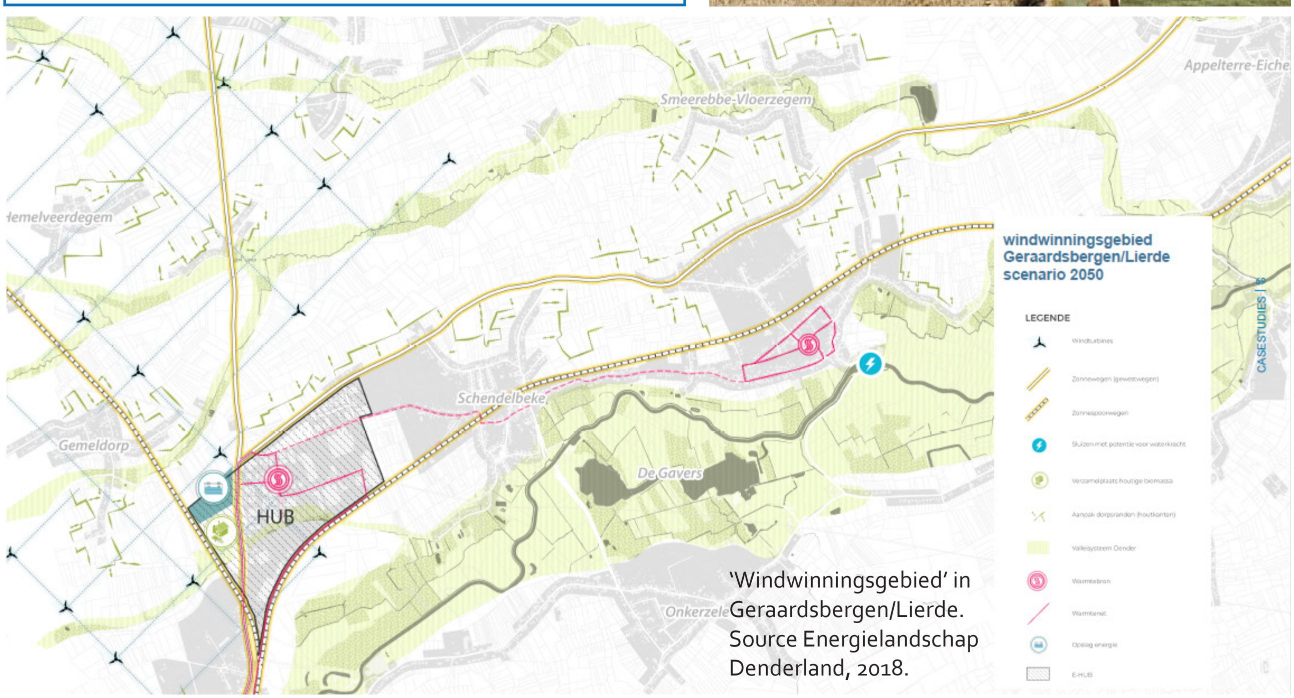
Governance

Landscape fund (re-invest profits in fund for landscape development and/or collective projects). Organize and pool land rights (*opstalrechten*) collectively.

Public-civil partnership: couple wind project to conditions about (financial) citizen participation to create investment opportunities for energy cooperatives.

- Energielandschap Denderland





'Windwinningsgebied' in Geraardsbergen/Lierde. Source Energielandschap Denderland, 2018.

DYNAMIC ENERGY STRIP

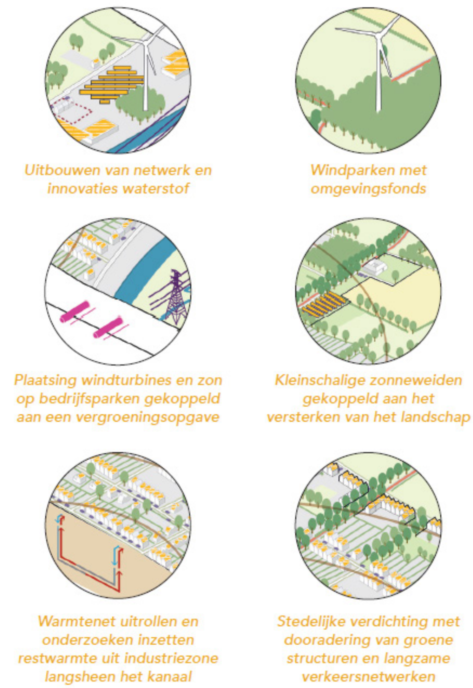
Spatial

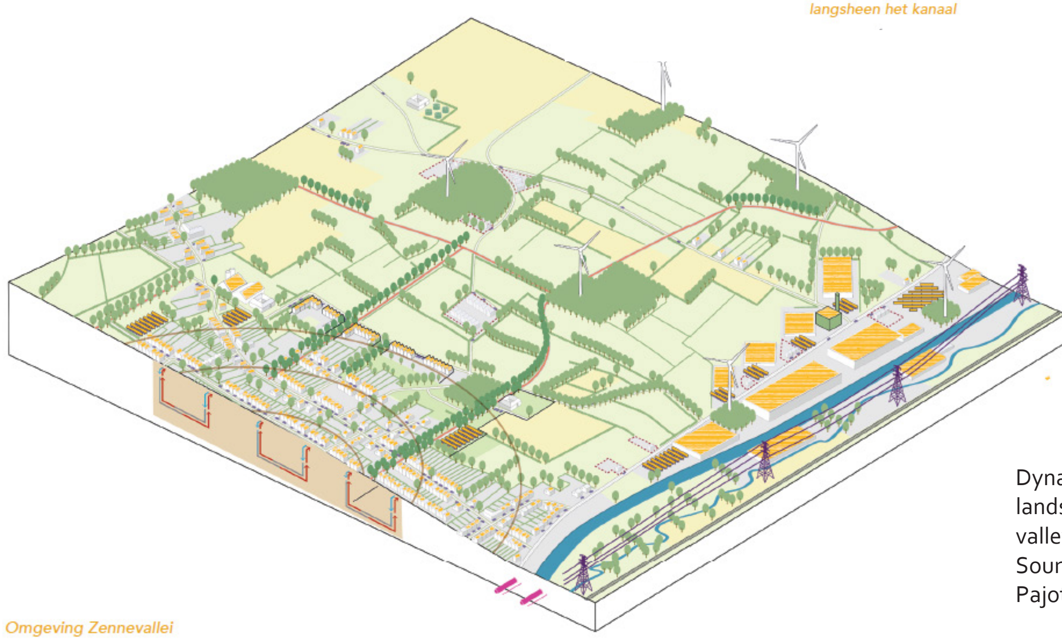
Integrate energy production in urbanized/industrialized zones to reinforce and power diverse activities. Cluster wind turbines along important infrastructures (canal, rail, road) and nearby industrial areas.

Governance

Provincial development company, intermunicipal development company, industrial area associations, energy community with industries and inhabitants.

- Pajottenland landschapsvisie





Dynamic and plural energy landscape along the Zenne valley.
Source: Landschapsstudie Pajottenland, 2021.

SPATIAL SELECTIVITY
PROXIMITY (DENSITY, MIXITY)
COMMON GOVERNANCE

INDUSTRIAL PARK AS ENERGY HUB

Spatial

Select and develop strategic industrial areas as hubs where diverse energy flows can be collected, produced, transformed, used, stored and redistributed towards other sites.

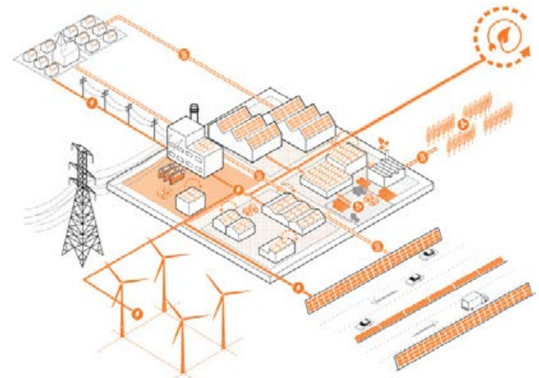
Governance

Building trust: industrial park association.

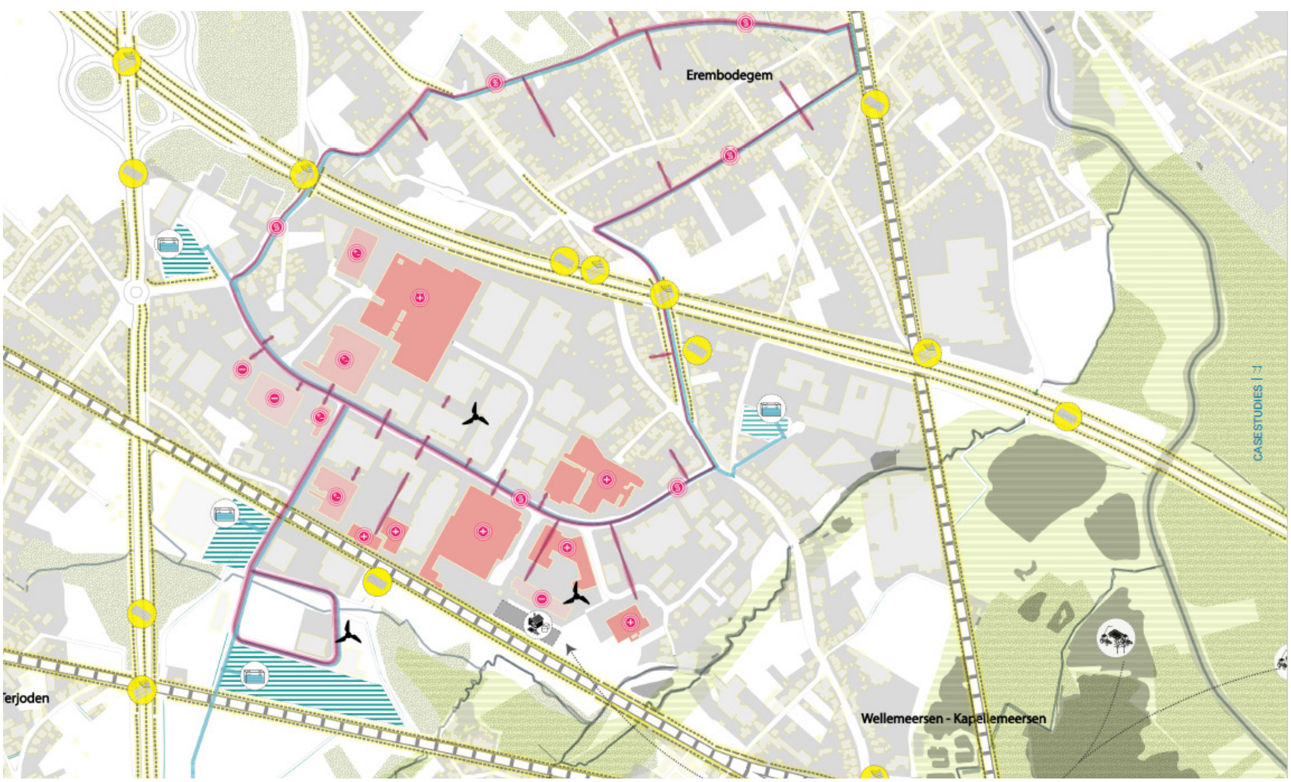
Coordination & facilitation: energy matchmaker (*Energiemakelaar*), province, provincial development company, intermunicipal company.

Governance: energy community of local businesses.

- Energielandschap Denderland
- Leiedal Regionale Energiestrategie
- Oost-Vlaanderen energiemakelaar (DOEN)
- Smart Energy Link



EHUB Erembodegem, scenario 2050.
Source: Energielandschap Denderland 2018.



REGIONAL HEATING BACKBONE

Spatial

Incrementally connect local collective heating projects to a regional district heating infrastructure.

Governance

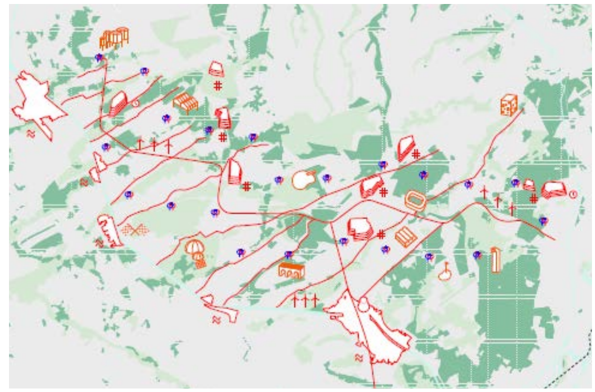
Intermunicipal company, regional public energy / waste company, energy cooperative.

STRUCTURING CAPACITY INFRASTRUCTURE

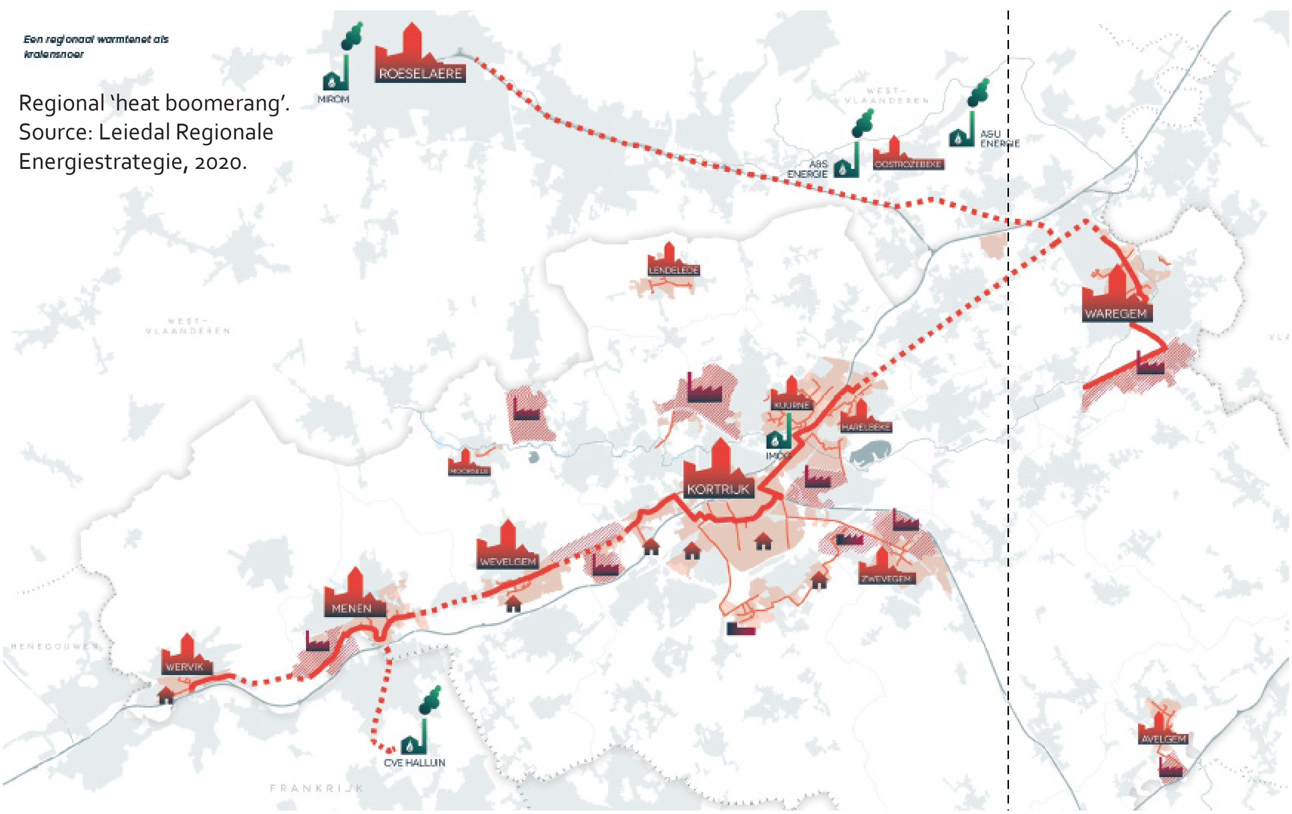
OPEN FLEXIBLE SYSTEM

CASCADING

- Leiedal Regionale Energiestrategie
- Atelier Diepe Geothermie



Collective heating system along former regional coal railway track.
Source: Atelier Diepe Geothermie, 2015.



Regional 'heat boomerang'.
Source: Leiedal Regionale Energiestrategie, 2020.

ENERGY MOBILITY AXIS

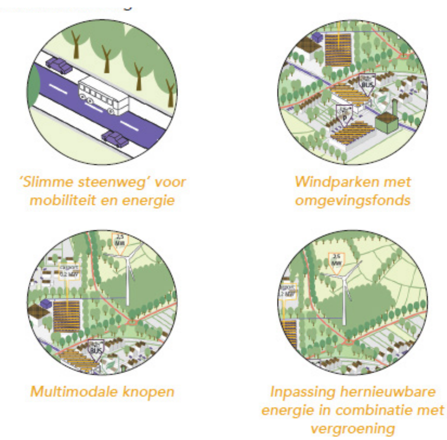
Spatial

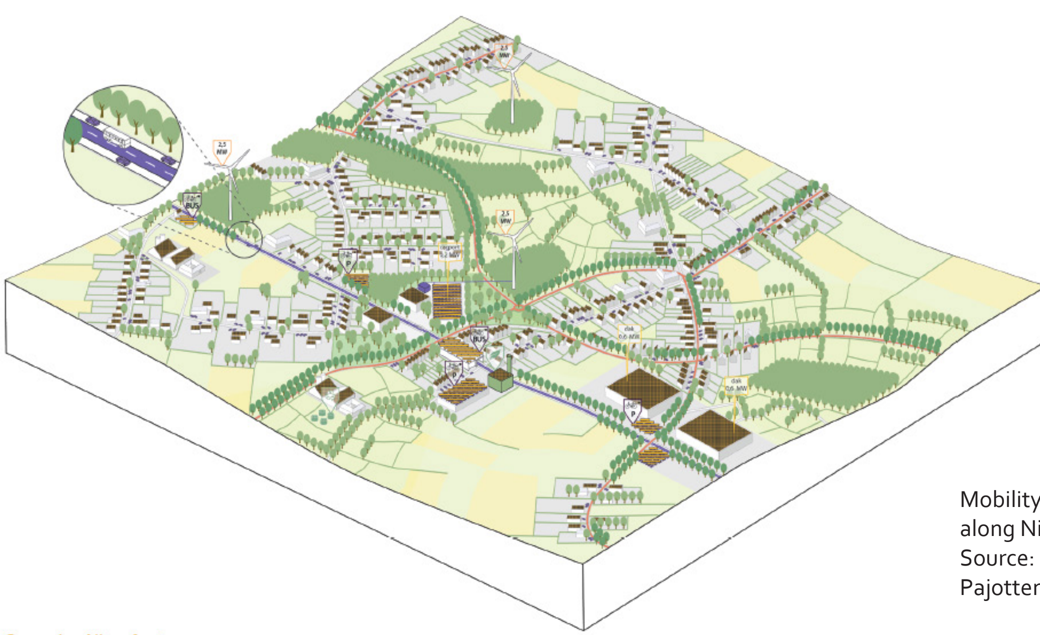
Integrate energy infrastructure, such as photovoltaic panels or charging infrastructure, along regional roads. Connect energy and mobility in multimodal hubs combining (shared) electric vehicles and bicycles, PV panels, charging infrastructure, neighbourhood battery, ... with bicycle storage, sharing and repair, parking cluster, public transport stop, parcel delivery etc.

Governance

Collaboration between diverse actors: municipalities, intermunicipal company, province, industrial park associations, public transport companies.

- Leiedal Regionale Energiestrategie
- Pajottenland landschapsvisie





Mobility and energy axis along Ninoofsesteenweg. Source: Landschapsstudie Pajottenland, 2021.

ENERGETIC VILLAGE

Spatial

Developing energy neutral village centres by integrating collective electricity production (PV) and storage, multimodal mobility hubs, collective heat production (biomass, geothermal) and storage, in combination with strategic densification projects while protecting open spaces around the village centre.

Governance

Support: intermunicipal company, province.

Facilitation: municipality.

Governance: village energy communities.

- Pajottenland landschapsvisie

Energetic villages and building clusters.
Source: Landschapsstudie Pajottenland, 2021.

ENERGETIC AGRICULTURE LANDSCAPE

Spatial

Combine energy and agriculture in selected rural landscapes. Re-introduce or strengthen small landscape elements (hedgerows, tree lines) for extensive local biomass production. Defragment and phase out dispersed ribbons and buildings. Develop farms as energy-neutral or energy-producing sites, including electricity and heat production through solar, biomass or small-scale wind, and energy storage.

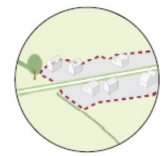
Governance

Coordination & facilitation: municipality, province, regional landscape organizations

Governance: farmers as landscape and energy curators: complementary business models for farmers. Farmers' cooperative.

- Pajottenland landschapsvisie
- Energiek landschap Lage Kempen

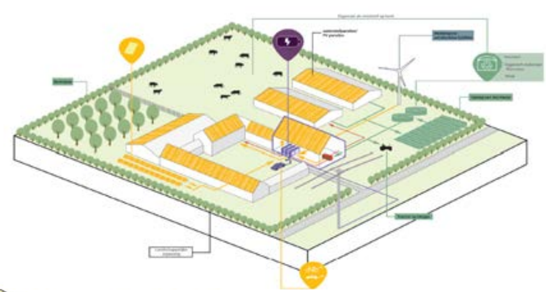
Typische Pajotse vierkantshoeves als energie-erven



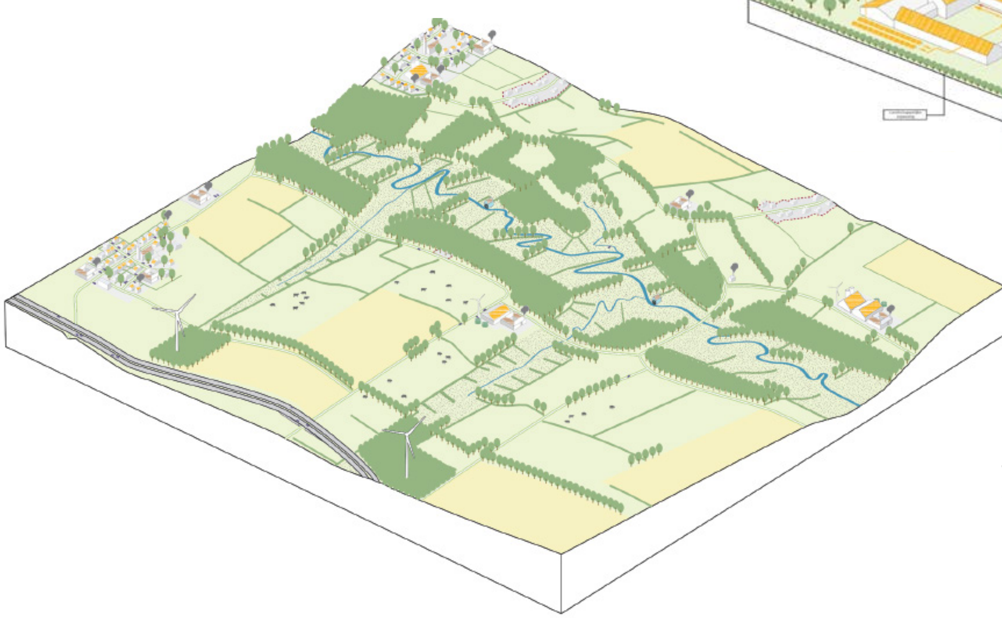
Ontsnipperen door het terugdringen van urban sprawl en inzetten op verdichting op maat

Oude watermolens worden terug in gebruik genomen, weliswaar met aandacht voor vismigratie

Bos of houtkanten worden aangeplant op steile hellingen waardoor erosie wordt tegengegaan. Onderhoud gebeurt binnen lokale logistieke keten met natuurbeheerplan



Farm as energy yard.



Energy shaping the agricultural landscape. Source: Landschapsstudie Pajottenland, 2021.

Annex - list of interviews

NR.	INTERVIEWEE	DATE
Exploratory/test interviews		
1	Energy consultancy - energy expert	30/08/2016
2	VITO - energy expert	02/09/2016
3	Energy cooperative and environmental ngo	24/10/2016
4	Regional Landscape Organization - biomass project coordinator	22/11/2016
5	Energy cooperative - coordinator	06/02/2017
6	City of Eeklo - spatial planner and energy expert	08/02/2017
Chapter 2 – district heating sector		
1	Burssels Region - energy policy expert	24/10/2017
2	City of Ghent - energy expert	06/11/2017
3	Sustainable energy association ODE - policy expert district heating	23/01/2018
4	Ghent University - researcher legal aspects district heating	13/03/2018
5	City of Antwerp - energy and heating expert	04/06/2018
6	Energy consultancy - energy expert	05/06/2018
7	Eandis - project manager district heating	05/06/2018
8	Regulator VREG - expert district heating	25/10/2018
9	Environmental Association - energy expert	06/11/2018
Chapter 3 – regional energy planning		
1	Flemish Department of Environment - policy advisor	17/06/2020
2	Province of Antwerp - spatial planner	09/07/2020
3	Province of Vlaams-Brabant - project coordinator	13/07/2020
4	Leiedal - urban designer	15/07/2020
5	City of Kortrijk - spatial planner	17/08/2020
6	City of Kortrijk - director climate and biodiversity	17/08/2020
7	City of Harelbeke - policy advisor	19/08/2020
8	City of Kortrijk - district heating ambassador and energy cooperative - business developer	20/08/2020
9	Leiedal - project manager energy	21/08/2020
10	City of Menen - alderman climate city of Menen	03/09/2020
11	Energy cooperative - project manager	19/05/2021
12	Labour union - policy advisor climate and energy	19/05/2021
13	Samenlevingsopbouw – energy and poverty expert	21/05/2021
14	Innovation cluster Smart Energy Region - director	07/07/2021
15	POM East-Flanders – project manager energy	13/09/2021

16	Fluvius – network management	23/09/2021
17	Social housing company - director	14/09/2021
18	Samenlevingsopbouw Oost-Vlaanderen – social worker housing and energy	27/09/2021
19	Energy consultant and energy cooperative	05/10/2021
20	Pajottenland vision- landscape designer	26/10/2021
21	Denderland vision - spatial designer	10/11/2021
22	Province of Vlaams-Brabant - project coordinator	29/11/2021
23	Province of East-Flanders – coordinator energy landscape	09/12/2021
24	Province of East-Flanders – spatial energy planner	09/12/2021
Chapter 4 – energy distribution sector (with Laura Deruytter)		
1	Former CEO Eandis and Fluvius	17/02/2020
2	Former CFO Infrax	22/03/2019
3	Fluvius staff 1 – strategy, district heating	09/04/2019
4	Fluvius staff 2 – strategy, market development	02/05/2019
5	Fluvius staff 3 – business, local energy services	08/04/2019
6	Fluvius – Board of Directors president	27/06/2019
7	Eandis – former representative in Board of Directors	04/04/2019
8	Fluvius – representative in Board of Directors	10/04/2019
9	Intermunicipal DNO East-Flanders – representative in Board of Directors	20/03/2019
10	Intermunicipal DNO Antwerp – former representative in Board of Directors	06/03/2019
11	Urban planning officer	18/03/2019
12	Energy cooperative	18/03/2019
13	Association of municipalities – energy and climate expert	13/03/2019
14	Labour union and Energy Democracy collective	14/03/2019
15	Energy cooperative and Energy Democracy collective	14/03/2019
16	Environmental Association – energy expert	06/05/2019
17	Labour union - energy expert	29/04/2019
18	Labour union - representative	13/05/2019
19	Academic energy expert	07/03/2019
20	Energy regulator VREG – director networks	08/04/2019
22	Flemish Energy Agency - director	13/05/2019
23	Social and Economic council – energy expert	11/10/2019
24	Social and Economic council – policy advisor	11/10/2019

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