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Review of Supportive Framework Conditions and Analysis of Current Challenges for Municipal Energy Transition

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REVIEW OF SUPPORTIVE FRAMEWORK CONDITIONS AND ANALYSIS OF CURRENT CHALLENGES

FOR MUNICIPAL ENERGY TRANSITION

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DOCUMENT STATUS

ERA-Net Smart Energy Systems (ERA-Net SES) is a transnational joint programming platform of 30 national and regional funding partners for initiating co-creation and promoting energy system innovation. The network of owners and managers of national and regional public funding programs along the innovation chain provides a sustainable and service oriented joint programming platform to finance projects in thematic areas like Smart Power Grids, Regional and Local Energy Systems, Heating and Cooling Networks, Digital Energy and Smart Services, etc.

Co-creating with partners that help to understand the needs of relevant stakeholders, we team up with intermediaries to provide an innovation eco-system supporting consortia for research, innovation, technical development, piloting and demonstration activities. These co-operations pave the way towards implementation in real-life environments and market introduction.

Beyond that, ERA-Net SES provides a Knowledge Community, involving key demo projects and experts from all over Europe, to facilitate learning between projects and programs from the local level up to the European level.

1 EXECUTIVE SUMMARY

While the majority of CO_2 emissions can be assigned to urban areas, municipalities have been the leaders of energy transition in the last decade. Numerous cities and towns have proposed ambitious goals and plans, but they still encounter barriers within the planning and implementation process. In this deliverable (D 2.2) of the FlexSUS project, we explore the barriers as perceived by four selected municipalities in Denmark and Sweden.

As part of Task 2.2 Market and regulatory barriers, D 2.2 contains an analysis of key challenges in the current institutional framework for selected municipalities in Denmark and Sweden and a review of supportive framework conditions and initiatives, primarily concentrating on heat systems. Data was collected through in-depth semi-structured interviews conducted with planners from the partner municipalities and elaborated based on an iterative process with relevant stakeholders.

We identify a number of regulatory, financial, organisational and technological challenges for successful energy transition. Overall, the findings show that regulation and permitting is the barrier occurring in each analysed municipality. Moreover, financing is a main barrier in less wealthy municipalities and those with smaller district heating penetration. Nonetheless, all the interviewed municipalities have ongoing activities (here called good practices), attempting to address some of the challenges and facilitate municipal energy transition.

We also find that regulatory barriers need to be tackled on the national level, while allowing more decision freedom for municipalities. In Denmark, some of the new legislation and measures announced in 2020 may be able to address the identified weaknesses in the regulatory and legal frameworks.

We recommend that, to the extent this is possible, the ongoing municipal initiatives are continued - and new ones are developed, based on lessons learnt from across different municipalities. We provide further recommendations in the Policy Brief, which compiles key “soft practices” that are favourable for the implementation of impactful initiatives in any municipality.

2 BACKGROUND INFORMATION

Deliverable 2.2. (D 2.2) contains a review of supportive framework conditions and an analysis of key challenges in the current institutional framework for selected municipalities in Denmark and Sweden. The review also makes recommendations on the adjustment of national, regional and local regulatory settings for an efficient future energy policy framework based on the technical-economic assessments of selected integration and regulatory options.

D2.2 is part of Task 2.2 Market and regulatory barriers, led by DTU MAN. Task 2.2 focuses on mapping of existing market conditions and identification of technological, organisational, market and regulatory barriers for implementation of renewable energy and energy efficiency, based on a qualitative comparison between current sustainability policies implemented by the need owners and the best practices compiled in Task 2.1. Regulatory assessment spans over adjusted tax systems, and operation and ownership structures for the energy systems and technologies that currently exist and those to be deployed in the future.

3 INTRODUCTION

Approximately 70% of global CO_2 emissions can be traced back to urban areas (UN 2011). While global and national commitments to greenhouse gas (GHG) emission reduction are crucial, in the last decade cities and towns have been the leaders of the energy transition. Thanks to their density, urban areas are usually well suited for common networked solutions such as district heating and public transportation (Ben Amer et al. 2020). The proximity of local government to citizens is also among the factors for faster policy implementation. Indeed, more and more municipalities worldwide become successful in implementing renewable energy and energy savings.

Sustainable energy transition in municipalities entails an alignment of urban and energy planning. In Scandinavia, heat planning has been part of municipal planning since 1970's. The Swedish Municipal Energy Resource Planning Act requires every municipal authority to provide a current energy plan, including an impact assessment for the environment, health and resource management. Danish legislation requires heat plans - while strategic energy plans are voluntary. However, several challenges still occur within the planning and implementation process across the national and local level in these countries, negatively affecting the possibilities for energy transition. To illustrate these challenges, this report maps the various obstacles perceived by municipal planners in Denmark and Sweden that slow down or limit sustainable transition. It also pinpoints good practices in these municipalities.

3.1 Case municipalities

This report focuses on four municipalities: three in Denmark (Holbæk, Lyngby-Taarbæk, Roskilde) and one in Sweden (Gothenburg). Table 1 presents key background information about these municipalities. More information about the respective heating systems and GHG emission goals are provided in sections 3.1.1-3.14.

Table 1. Overview of analysed municipalities

	Holbæk (DK)	Lyngby-Taarbæk (DK)	Roskilde (DK)	Gothenburg (SE)
Inhabitants (2020) (Danmarks Statistik n.d.)	71,558	56,209	88,276	580,000 (the city)
Area (sq. km) (Danmarks Statistik n.d.)	577	39	212	447 (Wikipedia)
Energy-related emissions in t CO_2 eq. per capita (2018) (Sparenergi 2021)	2.2	3.1	2.1	0.7 (2019) (Goteborgs Stad 2020)

3.1.1 Holbæk (DK)

As Figure 1 shows, the heat supply in Holbæk is dominated with natural gas, also in the core city - which is quite atypical for a Danish urban area (often supplied with district heating). District heating is distributed within three small district heating networks in the municipality.

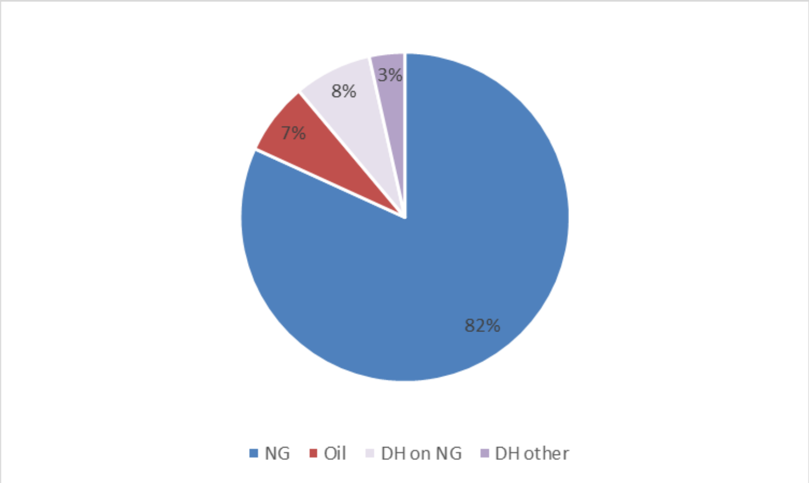


Fig 1. Share of heat consumption per fuel type in Holbæk in 2018 (source: (Sparenergi 2021)).

In 2018, renewables contributed with 15% of total energy consumption in Holbæk, primarily from wind power, solar PV and a small share of biomass (see Figure 2).

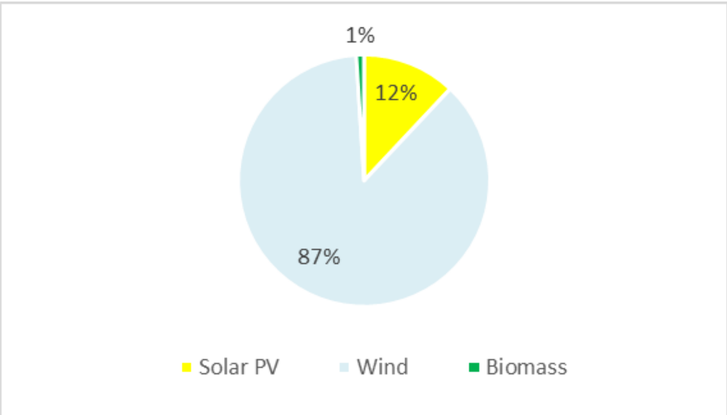


Fig 2. Types and share of RES contributing to the total energy consumption of Holbæk in 2018 (source: (Sparenergi 2021))

Holbæk municipality's GHG reduction target is in line with the Danish target of a 70% reduction in 2030 compared to 1990, corresponding to approximately halving current emissions in the municipality. The Strategic Energy Plan (SEP) (Holbæk Kommune 2020) from May 2020 focuses on: waste planning, expansion of wind energy, development of biogas, solar power, district cooling, energy savings and updated heating strategy. The SEP is to be revised once every election period.

Moreover, a new heat plan for Holbæk is being developed in order to help clarifying where district heating may be deployed or expanded and where alternatives and energy savings should be implemented. Holbæk municipality expects a further potential for geothermal, biomass (in rural areas), and solar power, which currently covers 8% of electricity consumption of municipal buildings. The energy solutions expected in the near future in Holbæk are: heat pumps, district heating (including low-temperature) and possibly hybrid heat pumps with natural gas boilers.

3.1.2 Lyngby-Taarbæk (DK)

As Figure 3 depicts, the heat consumption in Lyngby-Taarbæk is largely dominated with natural gas (used in larger installations for an entire multi-storey building (*blokvarme*) and single-house heating). District heating provides 23% of the heat and is produced mainly using natural gas, biomass and waste.

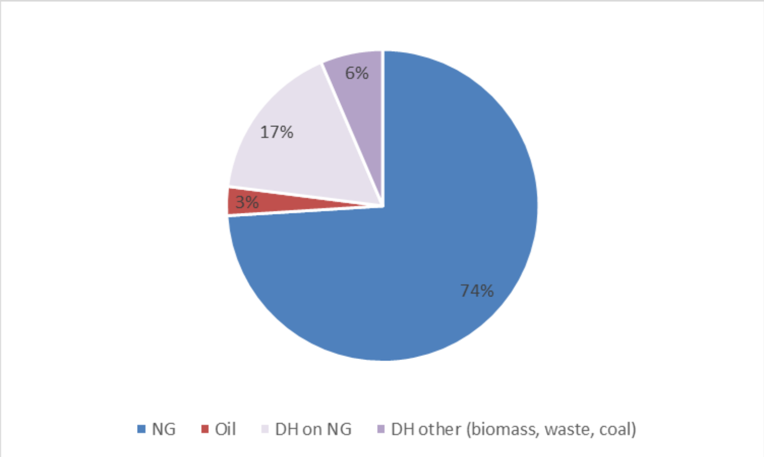


Fig 3. Share of heat consumption per fuel type in Lyngby-Taarbæk in 2018 (source: (Sparenergi 2021))

In 2018, renewables contributed with 4.3% of total energy consumption in Lyngby-Taarbæk, primarily from biomass, solar PV and biofuels (see Figure 4).

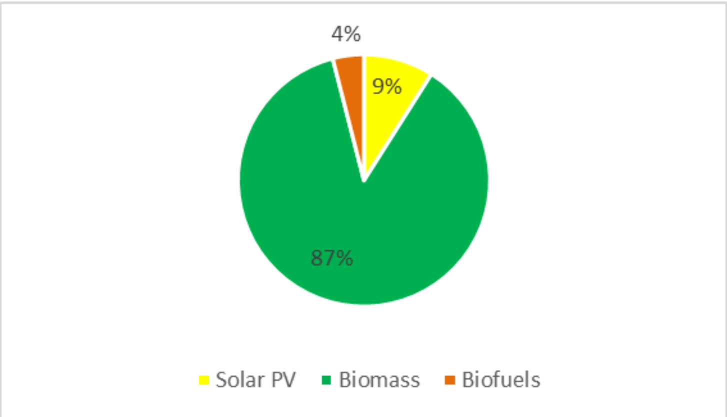


Fig 4. Types and share of RES contributing to the total energy consumption of Lyngby-Taarbæk in 2018 (source: (Sparenergi 2021))

The main energy strategies of Lyngby-Taarbæk municipality are: The Strategic Energy Plan (SEP) from 2013 (to be updated) and CO_2 reduction plans updated every 3-4 years. The municipality reached its 2020 target of 20% CO_2 reduction compared to 2008 already in 2015, and lowered emissions by 30%. A revision of the strategic energy plan includes an increased focus on low-temperature district heating. A combination of different supply types is deemed relevant: low-temperature DH and local heat pump boosters, especially in old housing, where energy renovation may not be feasible.

As stated by the current CO_2 reduction plan, Lyngby-Taarbæk has a goal of 25% CO_2 reduction by 2025 compared to 2015. The municipality is also part of Capital Region's target of electricity and heat supply free from fossil fuels in 2035 and transport sector in 2050.

3.1.3 Roskilde (DK)

As Figure 5 shows, the heat consumption in Roskilde is dominated with district heating, which provided 68% of the heat in 2016 and was produced mainly using biomass, waste, coal and natural gas. The individual natural gas boilers supplied 26% of the heat demand, oil boilers - 3% and heat pumps and electrical boilers - also 3%.

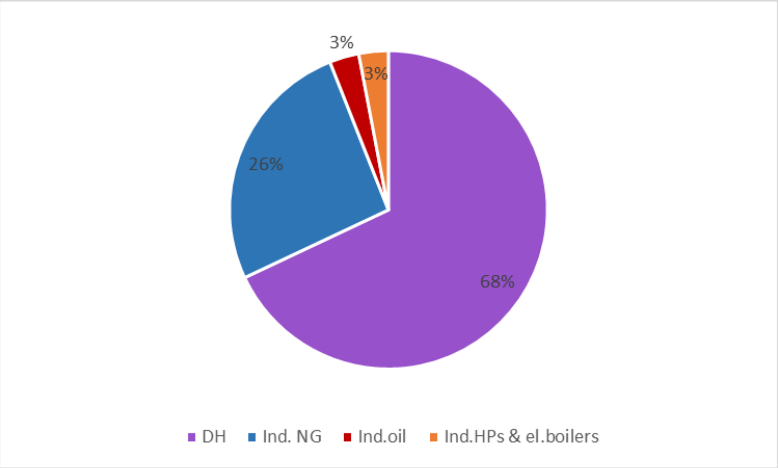
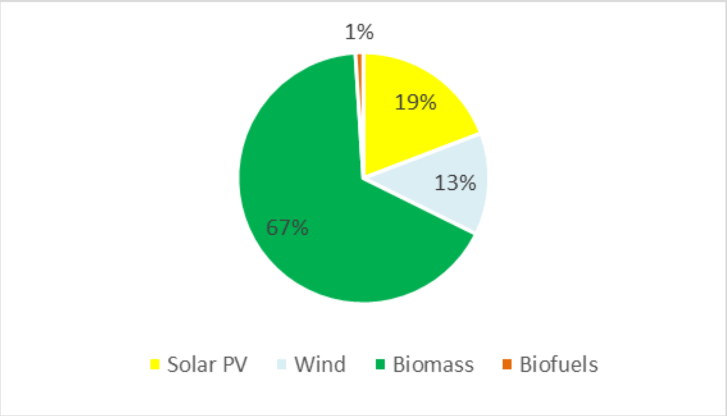


Fig 5. Heat consumption per fuel type in Roskilde in 2016[1] (EAEnergianalyse 2020)

In 2018, renewables contributed with 8% of total energy consumption in Roskilde, primarily from biomass, solar PV and wind (see Figure 6).



[1] The report was the municipality's preferred source for heat data - please note that the data is from 2016.

Figure 6. Types and share of RES contributing to the total energy consumption of Roskilde in 2018 (source: (Sparenergi 2021))

Roskilde's Strategic Climate and Energy Plan (SCEP) 2019-2022 is divided into three themes: green solutions among citizens and businesses, a sustainable municipality and green transition of the energy system.

The municipality has the following goals:

- 2% yearly CO_2 reduction until 2025 for municipality as business, starting from 2007
- CO_2 neutral electricity and DH supply in 2030 (based on 100% renewable energy)
- CO_2 neutral individual supply in 2035
- CO_2 neutral municipality as a business in 2035
- CO_2 neutral municipality as geographical area in 2040

The SCEP is followed by an action plan, which contains the actions to be undertaken in 2021-2022. In 2022, a new SCEP for 2023-2026 will be prepared. The reason for making action plans often is to be able to constantly adjust the course and activities so that the goals of the strategy can be achieved.

3.1.4 Gothenburg (SE)

The heat consumption in Gothenburg relies primarily on district heating based on waste, excess heat from industrial processes, biofuels and natural gas (about 25% heat production). Furthermore, there are many small-scale heating systems, which use biofuel, oil, natural gas or electricity as energy source. Solar heat use is a complementary part.

Figure 7 shows CO_2 emissions[2] from the energy sector in Gothenburg between 2007 and 2019, broken down by emission source. District heating is produced in a waste incineration facility and a natural gas CHP and provides a vast majority of heat in the municipality.

[2] Please note that his figure cannot be directly compared with respective figures for Danish municipalities, because it shows the overall energy system and not heat-only and because it shows CO_2 emissions and not fuel consumption per fuel type, thus omitting RES installations.

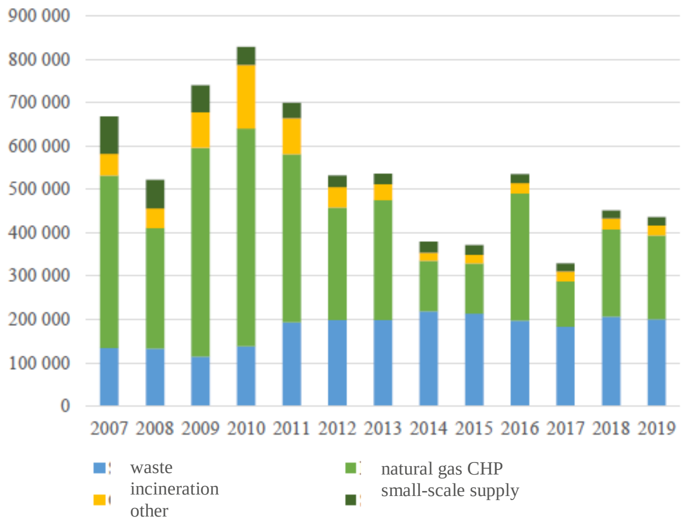


Figure 7. Carbon dioxide emissions (t CO_2) from the energy sector in Gothenburg in 2007-2019, broken down by emission sources (source: (Goteborgs Stad 2020).

The district cooling in Gothenburg is produced by cooling from the river and from district heating cooling processes. Biogas and natural gas are used in transport as vehicle fuel.

Gothenburg has several energy and emission goals. The city uses a 3-step approach in planning: Reduce used energy, use as much energy recovery as possible - and cover the rest with renewables. Gothenburg is also implementing an environmental management programme, where all departments have to conduct an environmental investigation.

By 2035, the municipality aims to reduce emissions to 3.5 t CO_2 equivalents per inhabitant and by 2050 to 1.9 t, reducing the climate footprint by at least 7.6% p.a. until 2030 aiming to reach zero carbon footprint as quickly as possible.

These goals are to be updated with the upcoming new strategy:

- By 2035, emissions of GHG within the Gothenburg geographical area to be max. 2t CO_2 eq. per person.
- By 2035, the consumption-based emissions of GHG by inhabitants of Gothenburg to be max. 3.5t CO_2 eq. per person.
- By 2030, all district heating derived from RES and industrial waste heat and waste incineration
- By 2030, the total use of primary energy for electricity and heat does not exceed 31 MWh per inhabitant.
- By 2030, the City of Gothenburg produces at least 500 GWh of renewable electricity and 1200 GWh of biogas.
- CO_2 emissions from road transport within the Gothenburg geographical area to decrease by at least 80% by 2030 compared to 2010.

3.2 Overview of regulation and key stakeholders

3.2.1 Denmark

3.2.1.1 Heat supply planning

The Danish Heat Supply Act and the project executive order regulate the overall framework for heat planning in Denmark (DEA n.d.). In general, each Danish municipality has designated areas according to the prevailing heat supply type: district heating, natural gas or individual supply (installations below 0.25 MW capacity). In some municipalities, buildings in these designated areas are imposed two types of obligations: to connect and to remain. Obligation to connect (*tilslutningspligt*) requires that in a designated district heating area a homeowner pay a connection fee to the district heating plant, even if the building is supplied with natural gas or other sources. Obligation to remain (*forblivelsespligt*) requires new or existing buildings to remain connected to a collective heat supply system (district heating or natural gas).

Since 2019, the municipalities may no longer require new areas (or those where existing local plans do not specify an obligation to connect) to be connected to the district heating network. However, existing district heating connections (or where a decision was made before January 2019) are exempted.

3.2.1.2 Climate and energy initiatives

In recent years, a number of strategies and policies addressing energy transition up to 2050 have been implemented in Denmark: Energy Agreement in 2018, Agreement on Climate Law in 2019, Climate Agreement for Energy and Industry and a governmental Climate Programme in 2020.

Furthermore, voluntary agreements have been made, e.g., by Danish District Heating Association where the majority of district heating companies associated has a goal of becoming CO_2 neutral in 2030.

3.2.1.2.1 Energy Agreement 2018

In 2018, all the parties in the Danish parliament signed the Energy Agreement, which presents measures towards reaching the goal of 100% RES in electricity consumption, 90% non-fossil fuel supply in district heating and 55% RES in energy consumption in 2030.

3.2.1.2.2 Agreement on Climate Law 2019

In 2019, all the parties in the parliament signed the Agreement on Climate Law stating that Denmark is to have a binding goal of 70% reduction of GHG in 2030 in relation to 1990 and climate neutrality in 2050. Each five years a subgoal for the next 10 years is to be set. Once a year a climate programme with short- and long-term initiatives for reaching the climate goals is to be presented.

3.2.1.2.3 Climate Agreement for Energy and Industry 2020

In June 2020, the Climate Agreement for Energy and Industry was adopted by the Danish parliament. It includes a number of initiatives towards energy transition, of which the following are relevant for this report:

- decreased processing time for complaints and compensations for citizens who live close to land windmills
- subsidies for electrification and energy efficiency in industry, biogas and other green gases

- subsidies for "green investments" for municipalities and regions
- tax reductions on surplus heat: to lapse completely for electricity-based surplus heat (data centers, supermarkets), and when surplus heat is certified or subject to a similar agreement that ensures energy efficiency at the surplus heat supplier
- abolishment of the requirement for particular DH plants to be able to produce both electricity and heat
- support for phasing out oil and gas boilers: tax adjustments, subsidy pools for phasing out oil and gas boilers, mapping of heat installations, abolition of consumer bindings and modernization of the socio-economic calculation requirements
- introduction of a legislation on sustainability of the wood biomass

3.2.1.2.4 Climate Programme 2020

In September 2020, the first yearly governmental Climate Programme was presented. It follows up on the goals and measures presented in previous climate strategies.

3.2.1.3 Key stakeholders

The key local stakeholders are: citizens, residents' associations, municipal councils, district heating producers, local renewable energy producers (incl. wind, solar, heat pumps, biogas, biomass), electricity distribution operators.

The key national/regional stakeholders are: the Danish government and parliament, Ministry of Energy, Danish Energy Agency, five Danish Regions, KL - Local Government Denmark[3], renewable energy equipment and EV charging station providers, Energinet (electricity and gas transmission systems operator), Evida (the state natural gas distribution company).

3.2.2 Sweden

3.2.2.1 Local energy plans

The Swedish Municipal Energy Resource Planning Act requires every Swedish municipal authority to have a current energy plan for the supply, distribution and consumption of energy, followed by an impact assessment indicating how the environment, health and resource management are affected by the plan's implementation.

3.2.2.2 Key stakeholders

The key local stakeholders are: citizens, residents' associations, municipal council in Gothenburg, Göteborg Energi[4], local renewable energy producers (incl. wind, solar, heat pumps, biogas, biomass), natural gas distribution company, electricity distribution operators.

The key national/regional stakeholders are: the Swedish government and parliament, Ministry of Infrastructure, Swedish Energy Agency, renewable energy equipment and EV charging station providers, Svenska kraftnät (transmission systems operator).

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[3] KL (Kommunernes Landsforening) is the association and interest organisation of the 98 Danish municipalities.

[4] Local producer of electricity, district heating and cooling in Gothenburg.

4 METHODOLOGY

Data for this deliverable was collected through in-depth semi-structured interviews conducted with planners from the project's partner municipalities and elaborated based on an iterative process with relevant stakeholders engaged in the FlexSUS project. The interviews explored barriers for sustainable energy and energy efficiency implementation in selected municipalities focusing primarily on the heat sector, but also considering electricity and gas use for heating and transport. The implementation of sustainable energy solutions in municipalities is affected by the techno-economic, regulative and institutional challenges - on the local and national level. To analyze them, we considered the literature discussing barriers to strategic energy planning (which creates frameworks for RES projects) and barriers to the specific technologies. We then conducted interviews to explore the barriers mentioned in the literature, confirm them or disprove in the local context and possibly identify new ones.

Table 2 shows the technology types mentioned in municipal strategic energy plans and the conducted interviews.

Table 2. Technology types discussed in D2.2, divided per sector

Sector	Technology type
Heating and cooling	Industrial excess heat Solar heat Geothermal Residential/small heat pumps incl. (district heating) company-owned heat pumps Hybrid systems (gas boiler and heat pump) District heating incl. low-temperature District cooling Energy communities Energy renovation in buildings (insulation, changing windows etc.)
Local electricity production	Wind Solar PV
Local gas production	Biogas Other renewable gases
Transportation	Electric vehicles Vehicles using biogas (Sweden)

The technologies are classified into four sectors - areas of municipal influence: heating and cooling, local electricity generation, local gas generation and transportation. These sectors are becoming more and more intertwined in an attempt to save energy, reduce CO_2 emissions and use intermittent RES.

In Denmark and Sweden, the district heating system is currently undergoing a rapid transition towards better efficiency and renewable fuels. While district heating is often the optimal solution for heat provision, it is infeasible to implement district heating in remote areas with less heat density, which is why heat pumps (or hybrid solutions) are another option. Energy renovation can technically be implemented in buildings supplied by any source of energy, but its feasibility depends on the type and age of the building and may also affect the feasibility of the heat supply option, especially in the case of district heating.

This report also focuses on barriers and good practices concerning local electricity generation, such as wind power (onshore and nearshore) and solar photovoltaics. It also analyses local renewable gas production and sustainable transportation options: electric vehicles and biogas-powered public transportation.

5 MUNICIPAL ENERGY TRANSITION: PERCEIVED BARRIERS AND GOOD PRACTICES

5.1 Municipal roles

The level of municipal decision power influences the possibilities to act. In Denmark, the requirement for heating project acceptance means that municipalities can facilitate the implementation of district heating if this is a least costly and most sustainable option. However, the national government decides the overall policy including legal frameworks, taxation and subsidy schemes. (Energistyrelsen 2013) mentions four roles a Danish municipality can play in strategic energy planning (from highest to lowest influence):

- Organization: can decide goals for municipal buildings, their implementation and incentives.
- Planning authority: influence through accepting or rejecting heating projects and developing local plans (including the location of wind turbines and PVs).
- Owner of supply companies: district heating companies in Denmark are either limited liability cooperatives or (fully or partially) owned by respective municipalities. In this way, they can influence the strategies of district heating companies.
- Partnerships, facilitation and information for citizens: online, through workshops, individual meetings with citizens and collaboration across municipalities and regions, as well as with other stakeholders.

Focusing on Sweden, in Gothenburg, the district heating company Göteborg Energi has been fully owned by the city since the mid 1990's, which results in municipality controlling the company and setting goals, conditions and standards for all activities in the city. This setup is common to many municipalities in Sweden, and has generally been quite successful. Such ownership model is considered an enabler for a transformation of the district heating systems from fossil fuels to recycled and renewable energy. Moreover, municipality-owned utility companies also tend to have lower prices than privately and state-owned ones.

5.2 Overview

The aim of this analysis is to identify technological, organisational, market and regulatory barriers for implementation of renewable energy and energy efficiency in municipalities. The report also identifies good practices related to these barriers. In general, we distinguish between two types of barriers: those perceived by the municipalities (derived from literature review and data collected through interviews) and modelled barriers (selected quantifiable barriers, identified through modelling) - understanding both is required for providing recommendations. Section 5 focuses on perceived barriers, categorised as shown in Table 3, which compiles the different barriers formulated by the interviewees.

Table 3. Typology of perceived barriers to renewable energy and energy efficiency in interviewed municipalities

	Holbæk (DK)	Lyngby-Taarbæk (DK)	Roskilde (DK)	Gothenburg (SE)

Barrier type				
Lack of acceptance	X	X		
Shortage of information/communication issues	X	X		
Coordination challenges	X	X		X
Political factors				X
Regulatory and legal barriers	X	X	X	X
Financing and business case	X	X	X	X
Policy uncertainty	X	X	X	X
Technical feasibility and infrastructure	X		X	X

Overall, the findings show that regulatory and legal barriers occur in each analysed municipality. Financing is a main barrier in less wealthy municipalities and those with smaller district heating penetration. An issue in wealthier municipalities is that there is no motivation to improve house insulation in order to save money and energy. In many cases, several intertwined barriers exist, often extrapolated due to insufficient communication and coordination across stakeholders. An example of technological barrier is that individual transport via EVs remains a challenge due to possible problems with electric grid capacity and insufficient charging infrastructure.

Not all barriers were mentioned for all types of technologies and in all municipalities, because not all technologies are under consideration in each case - and the planners do not have a full overview of plans of the local district heating companies and other potential investors. Sections 5.3-5.8 discuss the barriers in more detail.

5.3 3 x C: Communication, coordination, collaboration

A myriad of actors are involved in energy transition in municipalities and they all may perceive the reality differently and communicate in different ways. We identify three subcategories of this barrier type: lack of acceptance, shortage of information and coordination challenges.

5.3.1 Lack of acceptance

Among the difficulties for CO_2 emission reduction cited by analysed municipalities, direct opposition from citizens is prominent. It is possible to distinguish between three broad types of opposition: NIMBY effect, nuisance, and individual opposition.

The NIMBY effect ("Not In My BackYard") reflects the reluctance of individuals to see large-scale projects developing in their direct neighbourhood. This NIMBY effect is observed in Lyngby-Taarbæk against wind projects. The reason for the lack of acceptance is the visual disamenities from the existing wind turbines in Øresund already experienced by Taarbæk inhabitants. Presumably, this negative experience may mean that any future wind projects in that area will have to be reconsidered.

> For some citizens, the opposite of NIMBY effect occurs, e.g. Lyngby-Taarbæk finds a general interest in PV installations on the roofs as a way to show off, also using specially designed apps to track the electricity production.

Another type of opposition relates to the occasional nuisance and possible impact on shops caused by the road works necessary for the development of a sustainable energy solution. District heating expansion and upgrade activities are strongly affected by this form of opposition especially given the road works it involves, as revealed by three out of the four municipalities analysed. However, in Lyngby-Taarbæk, city planners indicate that the opposition is generally offset by a general wish for connecting to district heating, presumably seen as a green and reliable solution.

A third type of opposition is identified at the individual level, where households may refuse to adopt a new and cleaner energy equipment, either because they do not know about alternative solutions, or because their current equipment is still operating and does not need replacement. This situation is mentioned in Lyngby-Taarbæk and in Holbæk.

A better consideration of citizens or retribution with large infrastructure project may limit social opposition. Furthermore, developing less intrusive green energy technologies in cities, such as e.g. solar PV in Lyngby-Taarbæk, is a good example of socially well-accepted technology that receives a growing interest from the inhabitants. Moreover, supplying better information regarding alternative energy options, benefits of district heating and incentives for early adoption of green solution (replacement and incentive instrument for sunk cost) could be helpful. The layer of responsibility is the government and municipalities.

5.3.2 Shortage of information and communication challenges

Municipalities have a special communicative and educative role as facilitators of energy transition. Nevertheless, cities also suffer from unstable rules of the game when it comes to sustainability actions. Communication with inhabitants can be a challenge, because they often require clear answers, such as whether district heating is to be implemented in an area or not. In Denmark, this is difficult to answer well in advance, since municipal energy planning relies on governmentally decided specific project calculation rules, so-called socio-economic preconditions, which, according to municipalities, change too often. However, this situation could improve with new climate policies, where the project cost is no longer the main factor for decision-making.

Insufficient knowledge may be among reasons for abandoning low-temperature and excess heat district heating projects. A situation occurred in Lyngby-Taarbæk, where return water from a larger building (1 MW with old internal supply) could have been used in a nearby new building, but the project was not investigated. There may be a limited insight into the real potential of excess heat in the municipality, so Lyngby-Taarbæk would like to qualify this knowledge further.

Communication across institutions could be improved, e.g. with a running dialogue with DH company, gas company and, increasingly due to electrification, electricity company. Especially, when implementing EVs and converting to Power-to-Heat, the electricity grid needs to be sufficient. In addition, municipal empowerment in energy planning decisions and harmonisation across levels is crucial, since municipal employees share experiences across municipal borders. This approach would also help inhabitants when moving to another location.

5.3.3 Coordination challenges

A critical obstacle to the implementation of sustainability policies and measures at the municipal level arises from the fact that planners cannot control all the decisions of different actors. Rather, the municipal authorities are part of an ecosystem of stakeholders where each follows their own agenda. Hence, cities are often confronted with problems related to uncertainty of implementation, misalignment of interests, unsuitable mandate or sharing of responsibilities, or simply, lack of coordination between the involved stakeholders. In treating the coordination issue, we distinguish between *within* the municipality (internally and with utilities and citizens) and *outside* the municipality.

5.3.3.1 Coordination within the municipality

As expressed by Lyngby-Taarbæk, communication across institutions internally in the municipality would benefit from more coordinated efforts, to optimize the performance and reduce risks for misunderstanding.

Coordination is especially important when it comes to developing large-scale projects with relatively long implementation times and involving multiple stakeholders. In Lyngby-Taarbæk, a project has been drafted between the municipality, the DH utility and energy users to develop a district cooling system that showed positive long-term economic and environmental benefits. However, uncertainty regarding the timeline for development and the risk of delay in the delivery of cooling made one of the main stakeholders, a large industrial actor, to withdraw from the project. This ultimately terminated the project.

Similarly, implementing low-temperature district heating requires discussions with and among the supply utilities. This is illustrated with a situation in Lyngby-Taarbæk, when the municipality has encouraged the local DH company to deliver low-temperature district heating in different types of housing, and not only new houses, as was the pre-existing view of the DH company. Two other examples were provided during interviews with Lyngby-Taarbæk. First, coordinating with gas and district heating companies to find a win-win solution, instead of a legal case at the Energy Appeals Board[5]. However, the risk is that the conversion projects take longer time than expected. Another is managing the conflict of interests between HP provider and local DH company. This is a barrier for heat pumps within heat-as-service agreements, because it causes a risk of removing the business case from the DH company.

[5] Danish heat providers can complain to the Energy Appeal Board about municipal decisions to accept or decline a heat supply project proposal.

Finally, coordination with households relies on information campaigns and other local initiatives. In areas where heat supply is not mandated by a district heating utility, final heat users can choose which heating mean is most suitable for them. Municipal planners have therefore limited flexibility to support investment or replacement choices.

Gothenburg owns their DH company. Holbæk and Roskilde are co-owners of their local DH company, so they can participate in system planning discussions at the municipality level. In this way, they have an influence on the strategy (even though the DH company takes the final decision).
Holbæk municipality strives to be in dialogue with developers in new-built areas about a "sustainable heating solution" - any option that does not rely on fossil fuels (incl. DH expansion and energy communities). The local DH company in Holbæk explains business cases to customers in order to show them prospective savings by switching to DH.
Lyngby-Taarbæk holds events e.g. for larger housing associations on their experiences about energy savings.

5.3.3.2 Coordination with exogenous actors (*outside the city)*

Besides the coordination issues within the city, sustainable projects can be limited in their implementation by exogenous factors. One of the main challenges in cities is to lower the level of pollution from transportation. One main lever of action is to support the use of green fuels, including electricity. However, in some cities, the development of charging stations, which is a precondition for the uptake of electric cars, is limited by constraints on the electricity network. In Gothenburg, city planners warn against a risk of congestion on the transmission line that transports the electricity to the city. Even though the distribution grid at the city level is robust enough to accommodate for the increased demand from transport electrification, a bottleneck would appear at the higher voltage on the grid.

Improving the distributed generation and flexibility at the city level will help supplying own municipal energy need and allocating energy production efficiently in time, rather than upgrading the infrastructure. The layer of responsibility is national regarding support schemes and local regarding public buildings and distribution grid objectives in the requirements specification for urban development projects.

Examples of good practices around external collaborations in Denmark are:

- Intelligent Energi (iEnergi), a heating branch initiative examining energy flexibility and heat planning incl. EVs and the optimal makeup of DH and individual heating in municipalities.
- Cross-municipal projects e.g. Energy Across, allow to cope with common challenges, such as phasing out natural gas and increasing use of P2H.

Municipalities are involved in a number of subprojects under Energy Across e.g. on hybrid heat pumps, energy renovation and establishment of heat storage,

Developing energy communities (e.g. with common heat pumps) are among the activities Lyngby-Taarbæk is involved in.

5.4 Political factors

We define political factors as those linked to the dynamics in the decision-making process, which may challenge the speed of energy transition. This obstacle is present in Gothenburg, where short-term political mandates and energy actions are misaligned, preventing the implementation of renewables. In general, the mind-set of the broader public and politicians challenges the change towards increasingly sustainable systems. The local politicians have to be elected by citizens, but if they enact strong climate action, they may risk not being elected.

5.5 Regulatory and legal barriers

Well-designed legislative frameworks are crucial for successful energy transition - and regulative obstacles may prohibit any techno-economically feasible project. We identify two subcategories of this barrier type: regulatory bans and taxes, compensation and planning rules.

5.5.1 Regulatory bans on construction and digging

Policy and regulation influences the possibilities for implementing wind power, photovoltaics and EVs in municipalities. In Denmark, buildings worthy of preservation are regulated by the municipality, while protected buildings - nationally. Planners from Lyngby-Taarbæk consider architectural and cultural heritage regulations to affect the PV implementation the most. Additionally, installation on existing buildings may be limited by the existing roof structure, which may not be capable of supporting PV. Municipal PV facilities must be operated as utilities and sell the electricity to the buildings on which they are mounted, which increases the costs and bureaucracy, making it less interesting for municipalities. Implementing district heating in historic and cultural sites is also challenging.

> The Danish Energy Across initiative has suggested their associated municipalities to make PV strategies for larger roof areas and marginal spaces close to highways, where regulatory concerns are less applicable.

As pinpointed by Lyngby-Taarbæk, for wind projects, the local plans may state that an existing building determine the height for future buildings. In Holbæk and Roskilde, it is difficult to deploy wind turbines, due to distance requirements, which state that there must be min. distance of four times the total height of the wind turbine (from the ground to the wingtip) to the nearest neighbour. The distance to major roads and railways must be at least the same as the total height of the wind turbine. The lack of space restricts solar heating in Lyngby-Taarbæk and Roskilde. In Roskilde, geothermal energy is also restricted with lacking space.

5.5.2 Taxes, landowner compensations and planning rules

Several regulatory barriers hinder the utilization of the heat waste generated through industrial processes whether for feeding in the local district heating system or utilising for on-site heating of buildings.

Taxes on an otherwise "free" surplus heat are perceived as a barrier for companies to enter into excess heat supply projects in Lyngby-Taarbæk and Roskilde.

Additionally, the socio-economic calculation rules (which are about to change), and low natural gas prices are limiting factors. Besides, compensations to the landowners can further diminish the business case for heat waste reutilisation projects involving the expansion of the local district heating grid - especially when the project's economy is only slightly balanced. The compensation costs for landowners usually correspond to the decline in value of the property, but there are no rules as per levels. In Holbæk, where the utilisation of excess heat from a pharmaceutical company was considered, the compensation costs involved when crossing multiple different land plots with the pipeline had an impact on the business case for the project. Consequently, the project was dropped. Although some financing for the pipeline was later found, the district heating company did not want to proceed, because they thought it was too late.

In Gothenburg, the national regulatory framework hinders local production of biogas, making it not profitable enough. Biogas imported from Denmark is less expensive, whereas local production is taxed and thereby unable to compete. Moreover, in Sweden, there is a tax on burning fossil waste. Since it is difficult to differentiate between fossil and biomass-based waste, this type of taxation puts a challenge to waste incineration plants.

As stressed out by planners in Lyngby-Taarbæk, the existing socio-economic calculation prerequisites challenge the implementation of district heating, because the CO_2 emissions of each alternative are not well represented. This challenge is even reinforced with low natural gas prices. The new legislation proposal from government will expectedly give more decision freedom to municipalities.

However, new changes in the local and urban planning rules in Denmark may create challenges as well. Currently, there is a connection obligation in the natural gas areas and if customers want to install a heat pump, they have to apply for dispensation in the municipal board. According to planners from Lyngby-Taarbæk and Holbæk, removing the regulatory limitations (connection and stay obligation) means that the municipality is now more restricted in its heat planning and that utilities will be even more dependent on having an attractive price, to be able to attract customers. The planners expect that it could become more difficult to obtain a good business case for a DH system under the new regulation. In Lyngby-Taarbæk, this barrier may be offset by a general high demand for district heating from citizens.

The regulation around strategic energy planning is also crucial. The voluntariness of strategic energy planning means that gaining support for planning and regular follow-up and evaluation can sometimes be difficult. However, the increased focus on energy overall may increasingly mitigate this. As pinpointed by planners from Holbæk, the lack of standardisation of SEPs may make comparisons difficult, thus resources would be needed to be able to satisfy common a national documentation requirement.

Municipalities underline the importance of stricter CO_2 goals from a high administrative level, to see faster change, also considering that the political election cycle has an impact. Such an approach may also increase harmonisation between the different governance levels.

5.6 Financing and business case

We identify multiple obstacles to the uptake of sustainable solutions in municipalities that are due to the lack of financial means and sufficient business case to bridge the gap between "*what is good"* and the adoption. The financial issue applies to various actors in the city and therefore requires different and adapted policy actions. We distinguish between three categories of financial barriers: investment costs, lack of financial resources in municipalities and lacking supply chains.

5.6.1 Investment costs

Financing investment costs for energy projects is among the most important challenges, recognized by all interviewed municipalities.

Sweden is very successful in utilizing excess heat. In Gothenburg, around a third of heat supply comes from industrial excess heat from the refinery process, generating approximately 400 GWh excess heat. Many Swedish cities have several decades experience in recycling excess heat from energy-intensive industries (pulp and paper, iron and steel, and chemical industries) - and starting with datacentres. By recycling the heat, the Swedish industries can get free CO_2 allowances. In some Swedish DH systems, the heat can be exchanged with free cooling as a service and e.g. the cost of pipes connecting the industry to the DH covered by DH company[1] or investment subsidies for transmission lines or storage (Broberg Viklund 2015).

Swedish Klimatklivet (Climate step) provides subsidies for physical investments for companies for actions, which lower the climate impact of business or property e.g. energy renovations, charging stations etc.

At the household level, the cost of heat pumps is still too high for individual users and its financing is the largest barrier to adoption, especially in situation of early replacement, when the already installed heat source is still functional.

Subscription heat pumps is a solution where end-users pay a monthly fee for the HP, and the HP is installed and operated by DH company or another actor. This option is under review by the local DH company in Holbæk. They intend to become heat-as-a-service providers for individually heated houses/clusters. However, Lyngby-Taarbæk pinpoints that heat as service may remove the business case from the DH company (when it could be a feasible alternative). The layer of responsibility is: district heating company for implementation, municipality for communication and facilitation.

Similar concerns about costs are raised for the financing of energy savings actions that are up to the house owner and compete with other expenses as underlined in Holbæk and Gothenburg. In Lyngby-Taarbæk, it is further stressed that inhabitants are not interested in energy saving measures. The present authors presume that this is because the long-term economic benefit may not be a sufficiently large incentive for energy savings projects and needs to be supplemented with policy action. According to a planner from Lyngby-Taarbæk, energy efficiency is often short-lived actions by municipalities, although they require continuity, since there may be no local interest at a certain time. The advice on energy savings should be long lasting, uniform and follow the life events - e.g. be available especially when citizens buy a new house or grownup children move out.

Continuity may help financing institutions to support energy efficiency actions, especially if there are comparable conditions among municipalities. Moreover, energy savings would benefit from a national/regional coordination. All Danish municipalities agree that resources need to be allocated, in order to provide consultancy for inhabitants.

For investors in geothermal energy projects in Holbæk, exploration and drilling costs are the primary barrier for investors, despite existing potentials. Nonetheless, Holbæk knows about a project, which may be realised in an approximately five-year perspective.

In Roskilde, the high cost of electric vehicles is considered a barrier for their widespread implementation.

5.6.2 Lack of financial resources at the city level

In the analysed municipalities, there is a mismatch between their ambitions and the budgets for climate-related activities. In Denmark, strategic energy planning is voluntary, which means that municipalities only have small budgets for these tasks - which also have to compete with other climate and energy-related activities. In Holbæk, mapping of possibilities for energy efficiency measures is lacking and resources would have to be allocated, in order to provide consultancy for inhabitants.

Municipalities such Lyngby-Taarbæk cope with limited budgets thanks to well-functioning cross-municipal planning and involvement in many external projects.

In Roskilde, citizens can apply for an environmental pool (DKK 100,000 p.a.) for projects with the aim of improving climate and environment. Companies and associations can apply for a climate pool (DKK 200,000 p.a.) for projects and strategic collaborations on climate and related areas.

Lyngby-Taarbæk subsidise 50% of energy review of buildings - households, larger housing etc. The municipality also participates in an activity within the regional strategic energy planning project Energy Across on benchmarking of larger buildings to enable comparison among similar buildings, which helps building managers and owners to share experiences.

Swedish Energy Authority finances energy advisors for all interested municipalities. In Gothenburg, there are 3-4 publically accessible energy advisors working on company and citizen levels advising e.g. on solar panels, changing heating systems etc.

5.6.3 Lacking supply chains

In Roskilde, livestock farming is not widespread. Thus, possibilities for biogas production are limited due to lacking local supply chains for manure.

5.7 Policy uncertainty

Although in general uncertainty is not a significant barrier, municipalities acknowledge that it is difficult to navigate in uncertain national frameworks regarding e.g. the stability of energy policy, targets and budgets. For a faster transition, there is a need for stricter national goals, which may also help increase harmonisation between the different governance levels. The uncertainty and lacking continuity reveals itself for example when energy efficiency is just short-lived actions of municipalities. More continuity could enable financing institutions to support this area, especially if there are comparable conditions among municipalities.

Among Danish municipalities, Holbæk finds it difficult to navigate in uncertain national policy frameworks. In Sweden, for Gothenburg, the uncertainty lies in the fact that there is not a strong alignment on a national level: one party is very pro-nuclear, while others argue for removing all nuclear. Moreover, the Klimatklivet programme was expected to be discontinued by the new government, but was not eventually. On the local municipal scale, the uncertainty is less pronounced.

5.8 Technical feasibility and infrastructure

A well-developed energy infrastructure is crucial for successful energy transition. In this section, we focus on electricity distribution networks and district heating networks.

The state of the distribution network is among the decisive factors for PVs and EVs and is a subject of debate in all municipalities. An example is Gothenburg, where the distribution network works well at the moment, but is more uncertain looking into the future with significantly increased electricity demand.

There is little a city can do regarding upgrading the distribution network. Gothenburg suggest that the municipality is only able to influence this by decreasing their own power peaks in municipal buildings.

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In Holbæk, the high heat density part (city centre) is supplied by natural gas. The lack of existing DH infrastructure makes DH expansion, implementation of district cooling and utilisation of excess heat costly, mainly due to high investment costs caused by significant piping involved. Moreover, since Holbæk has many rural areas, a low heat density due to scattered housing makes it difficult to achieve a techno-economic feasibility. In Holbæk, it has been more difficult to implement low-temperature DH as part of a high-temperature network in individual houses than in larger (public) buildings, partly because of too low temperature (for buildings with insufficient heat saving measures).

In Holbæk, lowering the temperature would improve the economy of the DH plant significantly. In the municipality there are experiments with low-temperature DH involving different types of buildings, showing that it is important to analyse different setups for achieving project feasibility.

Among the barriers for electric cars in Roskilde are: user perceptions of acceptable range and insufficient charging station infrastructure. The current legislative framework hinders possibilities for municipalities to improve the infrastructure, but the municipal organization KL lobbies towards making the role of municipalities clearer and enabling them more decision power through suitable legislation (KL 2020). New policy is currently being discussed, giving municipalities possibilities for co-investing in the charging infrastructure.

6 CONCLUSION AND RECOMMENDATIONS

This explorative analysis is an attempt to identify common barriers that municipalities in Denmark and Sweden may come across. The analysed municipalities vary (e.g. in size, CO_2 emission level, population density), in this way also representing other Danish and Swedish municipalities of urban, rural and mixed characteristics. However, this report does not intend to represent the full picture for all 98 municipalities in Denmark and 290 in Sweden.

Overall, the findings show that financial, regulatory and legal barriers occur in each analysed municipality and coordination/collaboration issues are similar for all cases. Barriers to "sustainability action" in municipalities are interdependent (Burch 2010) and such situation also occurs in our study. In many cases, several intertwined barriers exist, often extrapolated due to insufficient communication and coordination across stakeholders. Not all barriers were mentioned for all types of technologies and in all municipalities, because not all technologies are under consideration in each case - and the planners do not have a full overview of plans of the local district heating companies and other potential investors.

Moreover, several municipal good practices have been identified. These are often solutions that address two or more barriers at the same time - and often do not require substantial municipal expenditures. This is important in the view of the limited municipal decision power and municipal budgets. We recommend that, to the extent it is possible, ongoing initiatives are continued - and new are developed, based on lessons learnt from across different municipalities. Further recommendations are presented in the FlexSUS Policy brief.

On the national level, regulatory challenges need to be addressed. In Denmark, some of the new legislation and measures announced in 2020 may be able to address the weaknesses in the regulatory and legal frameworks, which also are identified through our interviews. We deem that especially subsidies, tax reductions and changes in the project calculation rules (e.g., abolishment of the requirement to use natural gas prices for comparison in heating project applications) will accelerate the green transition in the heating sector in Denmark.

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ANNEX A – INTERVIEW PROTOCOL

<u>Introduction</u>

-What is your role in this organization?

-How is the work around energy planning organized in your municipality?

<u>Plans/goals</u>

-What plans and strategies regarding energy supply and consumption and CO_2 emission reduction does the municipality have? Do you have a strategic energy plan (or a similar document), who initiated it, if not, why? What targets do these strategies include? How would you assess your progress so far?

-How do you follow up on decisions - do you use indicators/assessment methods for decisions, other? How often?

-Do you collaborate with any stakeholders on energy planning? If yes, with whom, how and how often? If not, why? How are stakeholders included in the city energy transition plan?

-How is the long-term continuity of measures / decisions assured, does it follow the mandates of elected representatives?

<u>Barriers and possibilities</u>

-What are the existing local initiatives and frameworks for the implementation of renewable energy and energy efficiency in your municipality, if any?

-In general, what barriers do you see/anticipate in implementing the energy strategies and projects in your municipality? for specific technologies:

-use of excess heat

-district cooling

-solar heat

-geothermal

-inclusion of biogas and other renewable gases in the natural gas network

-low-temperature DH

-building insulation

-tradeoffs between heat savings (lower demand) and new equipment

-heat pump implementation

-Are DH -owned heat pumps an option? Why/why not?

-Is a hybrid (gas) heat pump an option? Why/why not?

-Are energy communities (common purchase of large heat pumps/biofuel/common heating network..) an option? Why/why not?

-DH expansion?

-What barriers do you see in the implementation of local wind power, solar cells (rooftop and field systems) and EVs?

-What barriers do you see for flexible buildings, such as price-depend use of DH or ”Smart grid ready” heat pumps (with short-term heat storage)?

- Do you see uncertainty as a barrier? In what ways?

-Is the voluntary character of strategic energy planning a challenge for you? Why/why not?

-DK specific: How will the Climate Agreement for energy and industry adopted by the Danish Parliament in June 2020 and the expected climate plan (as presented in May 2020) influence the future municipal energy planning? ,

-Which national frameworks are helpful/challenging for the municipality? Why?

-How would you assess the harmonisation between the national and local level of energy planning?

-What measures do you (plan to) implement to tackle these challenges and what more could be done on local, regional, national level?

-Where do you as a municipality have influence and where don't you? Would you like to have more/less decision power over implementation of renewables and energy efficiency?

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