Using Renewable Energy for Heating and Cooling: Barriers and Drivers at Local Level

An analysis based on a literature review and empirical results from local case studies

2017

D3.2 Report on the barriers and drivers including the interviews and the surveys on the regional and local level (one chapter per country and comparative analysis).

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Date of publication: 15/04/2016 updated 05/05/2017

The progRESsHEAT project

The progRESsHEAT project aims at assisting policy makers at the local, regional, national and EU-level in developing integrated, effective and efficient policy strategies to achieve a rapid and widespread penetration of renewable and efficient heating and cooling systems. Together with 6 local authorities in 6 target countries across Europe (AT, DE, CZ, DK, PT, RO), heating and cooling strategies will be developed by a detailed analysis of (1) heating and cooling demands and future developments, (2) long-term potentials of renewable energies and excess heat in the regions, (3) barriers & drivers and (4) a model-based assessment of policy intervention in scenarios up to 2050. progRESsHEAT will assist national policy makers to implement the right policies based on a model-based quantitative impact assessment of local, regional and national policies up to 2050.

Policy makers and other stakeholders will be strongly involved in the process, learn from experiences in other regions and gain a deeper understanding of the impact of policy instruments and their specific design. They are involved in the project through policy group meetings, workshops, interviews and webinars targeted to the fields of assistance in policy development, capacity building and dissemination. This report describes the planned communication and dissemination activities within the project.

Acknowledgement

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 646573.

Funded by the Horizon 2020 Programme of the European Union

Legal Notice

Years of implementation:	March 2015 – October 2017
Client:	INEA
Web:	http://www.progressheat.eu

Project consortium:

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1. Objective of the report and methodology

EU and national policies set a framework for the promotion of renewable energy technologies, but decisions for investments are actually taken by companies, home owners, cities, and communities at a regional and local level. For this reason the focus of this work (carried out within work package 3.2 of progRESsHEAT) lies with those who decide, accept and implement measures, with those who make the investment, and on barriers and drivers for such actions. It adds the human perspective to the description of technologies and innovations in the preceding technology analysis (work package 2), and the context in which the implementation of renewable energy use for heating and cooling may or may not succeed.

The main objectives of this report are to:

- describe existing barriers for using and implementing technologies at the local level, and identify ways to minimise and overcome these barriers with respect to the different circumstances and framing conditions of the target regions and
- identify the relevant stakeholders in the process of implementing renewable heating and cooling technologies at centralised and decentralised levels.

This report describes barriers and stakeholders at first on a general level, based on a literature review. In the following barriers and stakeholders are analysed on a local level, based on empirical results for the six case studies: Ansfelden (AT), Litoměřice (CZ), Helsingør (DK), Herten (DE), Matosinhos (PT) and Brașov (RO) (Fig.1).

Fig. 1: Map of the target countries, regions and case studies of progRESsHEAT

After the presentation of the results from previous research the empirical results for each case study are presented. The results of this work package leads to recommendations for other communities and regions in how to understand the human perspective, overcome barriers and use success factors (see also the fact sheets of best practices and success factors and recommendations on actions and policies developed in this project, Chassein et al. 2017) for the dissemination of renewable energy for heating and cooling at a local and regional level.

METHODOLOGY AND DATA SOURCES

The starting point of this work package is a review of the existing literature and studies on stakeholders, barriers and drivers influencing the diffusion of the technologies selected for analysis. For the purpose of this project *barriers are defined as factors inhibiting the use and implementation of (cost-effective) renewable heating and cooling (RES-H/C) technologies that can principally be overcome by suitable policies.*

Categories of barriers and their respective subcategories are defined based on the literature review. Then the rich, complex and diverse barriers related to renewable energies, with an impact on the heating and cooling sector, discussed in recent research, are explored and categorised. For this purpose literature with a general scope on energy and a specific scope on renewable energy for heating and cooling is analysed. The stakeholder analysis is important in order to understand the multi-dimensional characteristics of barriers, and to identify which stakeholders have to be involved in the process.

In order to obtain in-depth insights about the case studies, stakeholders, barriers and drivers are described at a local level. The case study descriptions draw on data from primary and secondary sources. Primary sources are as follows (Tab. 1):

Tab. 1: Primary Sources for Case Study Description

Primary Sources	Description
1. Interviews with local partners of the progRESsHEAT project	Local project partners connect local stakeholders to the project and have a good overview of the case studies from the local perspective. Six interviews were conducted, one for each case study. These were conducted in English using a semi-structured interview guide (attachment 1). Execution and analysis was made by the social science research team of IREES. One object of the interview was to get broad insights into the case studies and maybe compile an initial hypothesis about barriers to be addressed. Another aim was to “train” the local partners to conduct interviews with local stakeholders subsequently.
2. In-depth interviews by phone or face-to-face with local stakeholders	The first hypotheses, and their inclusion in the interview guidelines, were developed based on the literature review and interviews with local partners. The interview guideline (attachment 2) was structured mainly by technology: energy supply conditions, barriers against the use of solar thermal heating, biomass, biogas, waste usage, deep geothermal energy, heat pumps, district heating, excess heat,

	barriers against other technologies, energy saving issues, stakeholders in the energy transition process, framework conditions and transferability of the case study. The target of the expert interviews was to identify the main factors and barriers related to renewable energies and energy efficiency occurring in the municipalities investigated. The experts shared their experiences, difficulties and opportunities, when trying to foster RES-H/C technologies in their environment. The interviews were conducted by the local partners with "interviewer training" from IREES. For each case study 1-4 experts were interviewed by the local partners in their respective national language. In total, 14 expert interviews were carried out across all the case studies between February and May 2016. The experts were either representatives from the municipality, the local energy supplier or local energy agencies. The experts were chosen so that they could contribute to several renewable technologies, ensuring that at least one interviewee was contributing to any one of the interview topics of the interview guideline. Some were made face-to-face using the semi-structured interview guideline, while some were conducted as paper and pencil questionnaires. The answers were translated back into English and analysed by the social science research team of IREES.
3. Survey with relevant local target groups	In order to gather more reliable information on a broader basis at the local level, a survey was conducted in each case study. The purpose was to obtain information on what hinders and what fosters the use of RES-H/C technologies. The topics and target groups of the surveys were developed together with the scientific and local partners and the surveys were conducted in the period from June 2016 – January 2017 with following issues and target groups: <u>AT – Ansfelden:</u> Which company is using which energy source and why? (target group: companies in Ansfelden; n=20) <u>CZ – Litoměřice:</u> How can citizens be motivated, stimulated and supported in their use of renewable energy and energy efficiency measures? (target group: residential sector in Litoměřice; n=99) <u>DK – Helsingør:</u> What are drivers to choose a heating source based on renewable energy? (target group: residential sector in Helsingør; n=35) <u>DE – Herten:</u> What are the barriers or drivers to choose a heating source based on renewable energy? (target group: households and companies in Herten; n=25) <u>PT – Matosinhos:</u> What are the barriers or drivers for solar thermal, biomass and heat pump technologies for heating purposes in the residential sector? (target group: designers and installers in Portugal; n=14) <u>RO – Brașov:</u> What would attract consumers to connect/re-connect to DH? (target group: households, energy responsible for public buildings and enterprises in Brașov; n=110)

Secondary sources are project documents and additional documents (Tab. 2):

Tab. 2: Secondary Sources for Case Study Description

Secondary Sources	Description
1. progRESsHEAT Deliverable 3.1: Report on policy framework (Holländer et al. 2016)	Heating & cooling: Policy frameworks in six European cities, their regions and countries. Report on current regulations, support policies, and other related framework conditions at EU, national, regional and local levels for the target countries. Additionally it contains a comparative assessment of specific characteristics of successful regulations and policies from a local perspective.
2. progRESsHEAT Deliverable 2.1: Fact sheets status-quo of energy demand (Büchele et al. 2016b)	Status-quo of energy demand for heating and cooling in the building and industry sectors, energy supply and district heating networks for all case studies.
3. progRESsHEAT Deliverable 3.3: Summary of empirical results (Chassein et al. 2017)	Boosting renewable energy in heating and cooling. Fact sheet of best practices and success factors and recommendations on actions and policies for six case studies.
4. Minutes from local and national Policy Group Meetings	Policy Group Meetings (PGM) are held regularly throughout the project with relevant policy makers at the local and national level in the case studies. Topics include current findings from the project, and next steps to be done. One PGM has been held in each of the participating municipalities.
5. Minutes from the cross-municipality exchange workshop	An experience-sharing workshop gathering all project partners and open to local stakeholders (mainly policy makers) provides participants with the opportunity for face-to-face exchanges. These are highly motivating and productive. Such a workshop was held in March 2016 in Helsingør with at least one city representative from each case study taking part.
6. Additional documents	Information related to relevant measures or programs in the municipalities related to climate protection and energy supply activities within the case studies.

The results of the interviews and the secondary sources were the basis for a computer-assisted content analysis. Using the qualitative analysis software Atlas.ti the documents were coded (see codes in attachment 3), the relationship between the codes was analysed and the principal topics were identified. The coding process is based on grounded theory approach (Strauss and Corbin 1996). Codes and theories are constructed from the data itself through an iterative process (Charmaz 2014) by selecting topics that recurred most frequently across all interviews. It is a widely recognised method to analyse qualitative data.

As qualitative methods are based on single experiences and subjective evaluations (see chapter 3 as well), this method was supplemented by a survey in each case study (attachment 4), with a larger sample size that allows quantitative analysis. The results of the surveys should contribute to the barrier analysis, enable generalisation and comparison, and offer robust results. For Litoměřice and Brașov this kind of analysis was possible. In the other case studies, however, just small sample sizes could be reached. This is why these results are more the basis for discussion in policy workshops than used as additional arguments in this report.

2. Literature Review

In order to get an overview over relevant barriers, drivers and key stakeholders in the process of implementing renewable heating and cooling technologies a literature review was carried out, providing a more theoretical perspective. Subsequent to the literature review descriptions of the case studies follow in chapter 3 according to the structure of this chapter.

2.1 Definition and classification of barriers for implementing renewable heating and cooling technologies

There are many definitions of barriers with emphasis on different dimensions (Reddy and Painuly 2004; Reddy et al. 2009; Verbruggen et al. 2010; Sherriff 2014; International Renewable Energy Agency (IRENA) 2015). For the purpose of this project, barriers are defined as inhibitive factors for the use and the implementation of renewable heating and cooling (RES-H/C) technologies, which can principally be overcome by suitable policies. For example, a lack of information concerning excess heat technologies might be overcome by choosing a specific communication strategy. In addition, there are frame conditions that lead to non-use of RES-H/C technologies. For example, it is not possible to use geothermal heat if the geological condition of the ground does not allow it. These are outside the scope of our analysis, as they are not addressed by policies.

A wide variety of classifications can be found in the literature for barriers and drivers for renewable energies. Some differentiate specific categories, others just list the factors. In an extensive report on district heating and cooling potentials and barriers across Europe, Andrews and colleagues (2012) group these factors under three main categories: the financial, the institutional and the technical. Panoutsou et al. (2010) use the same to describe barriers for influencing potential uptake of biomass for heat, power and biofuel technologies. IEA (2009) refers to these three categories but has two additional ones: the legal and the behavioural. These five categories can be found in different studies that name them slightly differently with similar contents. For instance Nitsch and colleagues (2012) examine political, economical, structural, and demographical factors. Alternatively, Doble and Bullard (2008a, 2008b) look at the demand and supply side separately and prioritise the categories information gap, lack of experience, resources, technological, market and regulatory. Dolman et al. (2011) narrow these categories of barriers for renewable heat to technological suitability, supply capacity, time discounting, institutional factors, hidden and missing costs, regulatory and administrative costs, risk perception and awareness. Reitze et al. (2012) bundle the factors and the barriers separately while stressing the following aspects: finance, information deficit, psychosocial aspects, administration, law, technology, and the long and short term position in the cycle of production. The UK Department of Energy and Climate Change (2014) also uses similar categories: awareness, information, economic, financial, technical and institutional. The classification of barriers as identified by a BPIE survey (Economidou et al. 2011) are: financial, institutional and administrative, awareness, advice and skills and in addition, separation of expenditure and benefit. Pîrlogea (2011) looks particularly at Romania and differentiates between administrative barriers, technological and technical barriers, market barriers and economic barriers. Ecorys et al. (2010) have a look on barriers affecting all kind of renewable energies and specific renewable energies (large and small scale).

For the modelling of the development of renewable energy sources based heating and cooling in Austria, Haas et al. (2007) used these following, rather quantifiable, factors: the price of energy, funding, the price of greenhouse gas emissions, potentials of renewable energies (e.g. availability of biomass, solar energy or environmental heat for heat pumps), emission coefficients, the change of the housing stock and the lifetime of the installations. With this they highlight another category: the environmental issue. This is also addressed by Paar and colleagues (2013) in the summary evaluation of biomass, biogas, geothermal energy, solar thermal energy, excess heat and water heating from surplus wind energy. Environmental and resource factors are also considered as drivers and barriers by Fischedick and colleagues (2010), besides policy goals, economic factors, social and societal factors and specific perception of renewable energies by target groups.

Reddy (2013) summarises most of the above named categories in three types of barriers: **financial-economic, institutional-structural and market oriented, and perceptual-behavioural**. *Financial-economic* factors can be understood as factors that limit financial feasibility or profitability. This can relate to the initial investment as well as to the ongoing costs and benefits. *Institutional-structural and market oriented* factors can affect feasibility of an implementation. For example political, legal or product related frameworks have to be considered. These factors may also have an impact on the economics of an investment. Additionally, stakeholders as individuals are taken into account within the *perceptual-behavioural* factors, which considers, for example their knowledge and awareness. This categorisation is regarded as a good summary of the categories depicted above and worked best with the description of barriers below (Tab. 3). Besides the categorisation of the barriers based on characteristics, Doble and Bullard (2008a, 2008b) as well as Reddy (2013) suggest looking at the supply and demand sides separately (Tab. 3). These are defined, for the purpose of this project, as:

- **Supply-side barriers**: inhibitive factors for the *implementation* of renewable heating and cooling (RES-H/C) technologies.
- **Demand-side barriers**: inhibitive factors for the *use* of renewable heating and cooling (RES-H/C) technologies offered by the supply side (either resulting in them using an alternative non-renewable fuel or in deciding not to replace existing heating equipment entirely).

Ensuring security of energy supply is seen as the responsibility of power plants and grid operators (Jürgens and Haller 2015). Supply should therefore be sustainable, reliable and affordable for consumers. Intermittency and, especially, peaks of energy demand are a challenge for energy suppliers. On the other hand, renewable energies cannot guarantee stable energy supply. In this context, both increased flexibility of energy generation and flexibility of energy demand (e.g. through flexible tariffs) are necessary. Finally, demand and supply have to match. The differentiated examination of demand and supply provides a more detailed look at barriers and how they can be changed to become drivers, and helps to identify the actors who have to be addressed more accurately.

Tab. 3: Categorisation of Barriers for Renewable Heating and Cooling

Supply-Side Barriers	Demand-Side Barriers
financial-economic	*financial-economic*
• development costs (transaction costs) • initial costs (equity capital, investment prioritisation, payback time) • operating costs (maintenance costs, taxes, regulatory costs / land use taxes)	• initial costs (investor-user-dilemma, payback time, net-additional costs, product life cycle, opportunity costs) • operating costs (maintenance costs, energy tariff, taxes)
institutional-structural and market oriented	*institutional-structural and market oriented*
• infrastructure • regulations • technology suitability • policy framework (see Holländer et al. 2016) • multi-stakeholder issues	• energy demand • building stock • policy framework (see Holländer et al. 2016) • separation of expenditure and benefit • multi-stakeholder issues
perceptual-behavioural	*perceptual-behavioural*
• bounded rationality • trained workmen	• uncertainties • knowledge / awareness gaps • trained workmen • risk and loan aversion

The barrier analysis shows that the line between the categories is blurred and some barriers are very dependent on each other. Sometimes it is not very clear how a barrier should be categorised (e.g. infrastructure development is an investment with initial and operating costs but it is also a structural barrier with underlying regulations and restrictions) other barriers apply to both supply and demand side (e.g. trained workmen). On the other hand as Revell and colleagues (2010) point out, barriers can also be drivers (e.g. making renewable energies efficient enhances their impact on greenhouse gas emissions but the share of energy mix decreases making the positive effect invisible). Success factors are discussed in detail and adapted to the local framework in the fact sheets (Chassein et al. 2017).

The supply and demand of renewable energies is particularly connected with two other aspects at the implementation level: 1) increasing energy efficiency which means decreasing energy demand which contributes to the emission reduction target, and 2) demand side management (DSM) which means enabling load shift and therefore integration of renewable energies into the energy system (driver). Energy efficiency could, on the one hand, be a barrier for renewable energies, making it no longer economically efficient to provide renewable energies if energy demand decreases. This might have a negative impact on the basic rate of energy tariff. On the other hand it could be easier to use renewable energies if demand is low. Both “energy efficiency” and “demand-side management” are not the core focus of this project and are well explored (Strbac 2008; Reddy et al. 2009; Reitze et al. 2012; UK Department of Energy and Climate Change 2014). The focus of this report is on barriers to renewable energies.

2.1.1 Supply-side barriers

Main actors:	energy suppliers (heating and cooling), in some cases in cooperation with the municipality
Additional actors:	local professionals (technology providers, planners / installers / craftsmen), finance corporations

Financial-economic barriers

Reddy et al. (2013) categorise “profitability barriers” which are barriers to the cost effectiveness of projects. On the one hand, there is the initial investment as development costs and on the other hand there are operating costs such as technology performance, sales volume, and energy price.

Development Costs

Whether to invest in a new renewable energy system or not is based on the **need to replace the existing energy system** (Dolman et al. 2011). This need can either result from a poorly working old system or arise from the political will to renew the system in favour of renewable energies to reduce GHG emissions. Both issues can also apply. If the equipment in place is still working, depending on the expected lifetime, this could be a serious barrier to renew it without further incentives (Dolman et al. 2011). Policy can influence this issue by setting or changing requirements for the energy system.

Before investing in a new technology, potentials and alternatives have to be examined. For example, business plans and feasibility studies are needed. The first investment is therefore in **research and development** (R&D). Considerable time and effort is absorbed in gaining access to useful information needed for decision making. External experts might sometimes be necessary and information about policy and technical requirements needs to be developed (Dolman et al. 2011). Usually external costs are not internalised when comparing different alternatives (International Energy Agency (IEA) 2009).

The next step is the acquisition of partners (local professionals, banks for capital loan etc.) to outline the project and its costs more precisely (Dolman et al. 2011). According to the IEA (2009) there is a **shortage of skilled personal** able to properly conceive renewable energy systems in many countries, especially in small and medium-sized companies. The development of a new system or technology requires specific knowledge of planners as well as of manufacturers of the hardware (Dolman et al. 2011; Horbach 2014). Due to the relatively new age of most the renewable energy based technologies there is a lack of skills for their installation. In fact even though for some technologies training possibilities are available, experiences reveal that engineers and other technicians in charge of installation work are often too busy to undergo such training.

Initial costs

For the start-up of a new technology, there has to be an initial investment. This depends very much on the characteristics and maturity of a technology (Connor et al. 2013).

The relatively important **high up-front investment** needed for renewable energies (especially district heating) can discourage potential investors (International Energy Agency (IEA) 2009; Dolman et al. 2011; Paar et al. 2013). In order to finance big projects, capital has to be available. If there is not enough equity capital, loans are necessary. Creditworthiness is based on the bank criteria which tend not to be designed for investment into renewable energies (Reitze et al. 2012). In this regard, Jossart et al. (2012) identified three core factors that influence the **provision of capital** by the banks in the renewable energies sector. Above all, the banks should be able to provide long-term credits due to the nature of investment related to renewable energies. A good alternative would be for the banks to obtain funds from some institutional lenders (e.g. pension and insurance funds) who usually support long-term credits. The third factor is the impact of bank regulations on asset-liability mismatches. Sometimes internal regulations of companies hinder the acquisition of long-term credits. Another consideration is usually the **payback time** of an investment.

In some cases (e.g. district heating) there needs to be **investment in heat transport and distribution**. Infrastructure is typically the responsibility of the municipality. If an infrastructure project meets the EU recommended rate of return of 3-4 % the municipality may adjust the market environment so that private investors can start to build the system (Andrews et al. 2012: 176, Annex5). It is also clear that the distribution system cannot be upgraded customer by customer, but over an area as a whole. This can take decades and various authorities have to be committed (Andrews et al. 2012: 41, 178).

Operating Costs

When a new technology is implemented, the **maintenance** of a large scale plant is classified under operating costs. Assumptions concerning operating costs have a big influence on the investment decision and depend much on the technology under consideration.

The **energy tariff** provided determines the rates of return of initial investment. Governments can influence this energy price through taxes on energy supply which are usually allocated to the energy tariff (Andrews et al. 2012: 177). Haas et al. (2007: 30) assume that energy prices for renewable energies (biomass, wood chips, pellets, split logs) will increase, but not as much as the prices of conventional energy sources (oil, gas, electricity) (see Nitsch et al. 2012: 5).

“Operating costs” are the most uncertain factor in the calculation. This uncertainty is influenced by policy regulations related to taxes, directives and subsidies, and market and environmental issues (see below). Other factors are the technical performance and the reliability of the fuel supply. Volatility of electricity and fuel prices make it very difficult for any other investor besides the utility company to supply district heat, for example. This is because capital loans cannot be obtained without having any certainty over future costs. Another reason is that customers have to be enticed away from the current energy supplier (Andrews et al. 2012: 177). There may also be

“hidden costs” which cannot be calculated precisely, such as time costs, costs of a reduced level of service, engineering related costs etc. (Dolman et al. 2011: 12 / section 4; Doble and Bullard 2008a: 7).

When resources for investment and operating costs are managed separately - as is often the case for large companies - the decision to invest faces internal conflicts of interests.

Institutional-structural and market oriented barriers

Infrastructure

The **density of an energy system** (i.e. the number of connected consumers per metre of pipe) is an important factor for various reasons. Low densities mean high costs of investment per customer and high costs of distribution per delivered energy unit. Of course this also means that utilities do not have any incentive to invest in measures that decrease energy demand (Andrews et al. 2012: 178). Besides, “heat losses and resource depletion from pipes and components, increase with lower heat density” (Hurtig 2010: 10). On the other hand, district heating systems pipes are larger than those used for natural gas, for example. This is particularly a barrier in already high density areas (Doble and Bullard 2008a, 2008b).

Referring to Andrews et al. (2012: 176) “Unless a developer can be sure he will have close to 100 % of the heat market he is not likely to invest in district heating based on combined heat and power (CHP-DH).” This is especially aimed at the investment in infrastructure. Besides low heat system density, a **free market** means high risk to an energy supplier. If the government can grant monopoly powers to energy suppliers there is much less risk. They are also in a better position to borrow capital at low rates and there is little need for equity capital. The acceptance of users might however be affected when there is an enforcement to use a certain energy supply instead of freedom to choose between alternatives. Additionally, the prices charged by monopolies tend to be higher than those of a competitive market.

Regulation

Regulations vary from country to country as well as at the local level. Permissions and support (financial and operational) from governmental authorities for a new project are often necessary (International Energy Agency (IEA) 2009).

Land use regulations can hinder or foster investment in infrastructure. Andrews et al. (Andrews et al. 2012: 15 / 77) suggest that in order to foster more investment in district heating based on combined heat and power, a certain level of governmental guarantee is needed, as is the case for other power and water networks. This guarantee is partly ensured through land use regulations in the form of a pre-granted planning permission, the ability to compulsorily purchase land, road breaking, land crossing rights and market / planning mechanisms. Without this new infrastructure, planning is associated with much effort and administrative barriers (Doble and Bullard 2008a).

Technical regulations could, for example, refer to the installation of meters and comply with monitoring, verification, and reporting protocols. The installation of domestic heat pumps is linked to the allowance to replace standard radiators with large heat emitters. Space considerations also have to be made (Dolman et al. 2011: 21). Fees payable to obtain permits or licenses, such as planning permissions might be necessary (Dolman et al. 2011: 13) and utilities need to be well informed about the regulations so that they can be aware of the presence of eventual risks.

Building law or similar regulations which set conditions of building quality can be assumed to be quite a stable regulation (Haas et al. 2007: 31) but also have to be taken into consideration. In Germany, for example, tenants are not obliged to accept any kind of refurbishment (Reitze et al. 2012: 76–78). Depending on the type of refurbishment, and whether the tenant considers it as a discomfort, tenants are allowed to reject refurbishment projects, or request an abatement of the rent.

Administrative procedures

In the EU study of Ecorys et al. (2010) several barriers that occur with every kind of renewable energy (large scale and small scale) are identified including lengthy procedures, too many authorities involved, lack of experience of civil servants, inhomogeneous application of laws and unclear administrative framework (Fig. 2).

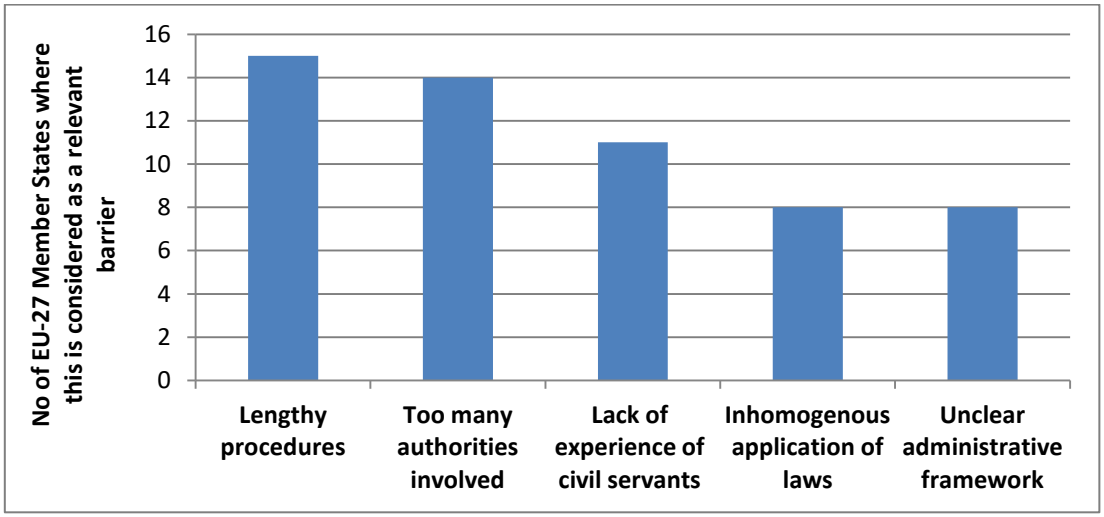


Fig. 2: Sources of administrative barriers for all kind of renewable energy
Source: Ecorys et al. (2010: 22)

For large scale renewable energy systems the most important administrative barriers are insufficient spatial planning, the “not in my backyard” (NIMBY) attitude and environmental requirements. A huge barrier for small scale systems is permission for building integrating technologies. All these barriers together cause troublesome procedures on the supply side (Pîrlogea 2011). It is typical that stakeholders working in different areas will have different and sometimes contradicting interests as they view the questions from different perspectives. For this reason there might be contradicting interests of policy programmes.

Technology

Of course “a single energy technology cannot emerge as the ultimate solution to Europe’s energy challenges” (Sanner et al. 2013: 11). The primary energy demand for heating and cooling across all 28 European countries is primarily met by fossil fuels like natural gas or coal (75 %) and 18 % by all renewable energy technologies together (Reiter et al. 2016: 82). The integration of renewable sources in the heating system also has to satisfy some suitability factors (Doble and Bullard 2008a, 2008b; Dolman et al. 2011; Andrews et al. 2012; Paar et al. 2013; Sanner et al. 2013). Suitability effects are the feasible technology supply and the technologies for end-users. Suitability is also closely linked to the performance of a technology.

Technology specific grade and equality of heat: Does the quantity of heat that can be produced by the technology, match up with the end-user requirements? As a matter of fact, across all the renewable sources, high-temperature process heat (over 250 °C) can only be produced economically by biomass and biogas. However, not all industrial processes can use biomass due to the requirements of temperature, the combustion purity, and the need for precise temperature control. On the other hand, heat pumps work best with a low output temperature and therefore should just be used in insulated buildings with low energy demand. The same also applies to district heating and cooling and combined heat and power. This does not exclude the fact that district heating and cooling is more suitable for regions with a high annual heat demand per dweller. Thus, the northern countries will have lower grid costs compared to regions with lower heat demand. Solar thermal systems or excess heat supply are also unlikely to meet heating needs. Another example is biomass supply that was, in some cases in the early days, unreliable or subject to very volatile costs (Awudu and Zhang 2012). This is due to the more individual nature of the businesses and the variety of providers, which contrasts with gas / oil supplied through networks.

Technology specific space requirements: Some renewable heating technologies have some spatial requirements for their implementation, which do not exist in conventional technology. Solar thermal utilisation, for example, depends on the orientation of the roof (needs to be south-faced), ground source heat pump collectors require significant space in individual buildings, and biomass boilers require stores and delivery access, which makes them difficult to be used in densely built-up areas. For the use of geothermal heat, thermal resources need to be located near the population centre, and fields to grow crops and landfill sites have to be available for biogas. Some other considerations like noise and air quality concerns are seen as barriers for the use of biomass, particularly in densely urbanised areas. The noise level problem also holds true for some kinds of heat pumps.

Specific economical barriers due to the technologies used: Renewable energy based technologies face economical barriers in various ways. Individual heat pumps, for example, are less efficient and lead to higher costs than central heat pumps. This is also the case for biomass. This is a highly mature technology in the existing building stock but the system performance can still be improved. District heating and cooling is more suitable for densely built residential areas. Commercial buildings are, however, not suitable as they are only occupied for a certain amount of hours each day. In addition, district heating and cooling is more economically efficient for regions with high annual heat demand per dweller. This is why there is a general competition between district heating and low energy houses (Battisti 2015).

For other technologies, the integration into the energy system can be costly. Solar thermal is one such example where running costs, including maintenance costs, are low but the solar collector and additional components (hot water storage tank, pump station, piping, controllers, etc.) are expensive (Fig. 3). High up-front costs can also be expected from biomass, geothermal heat and biogas. Additionally, biomass has high ongoing costs due to the fuel used. For certain technologies additional investments are necessary. District heating systems are rather more efficient when used for low temperature demand, meaning that the insulation has to be enhanced and there is a need to adapt the infrastructure since the size of the pipes used for district heating are greater than those used for natural gas. In general, it can be expected that costs decline as demand rises and then technologies are further developed.

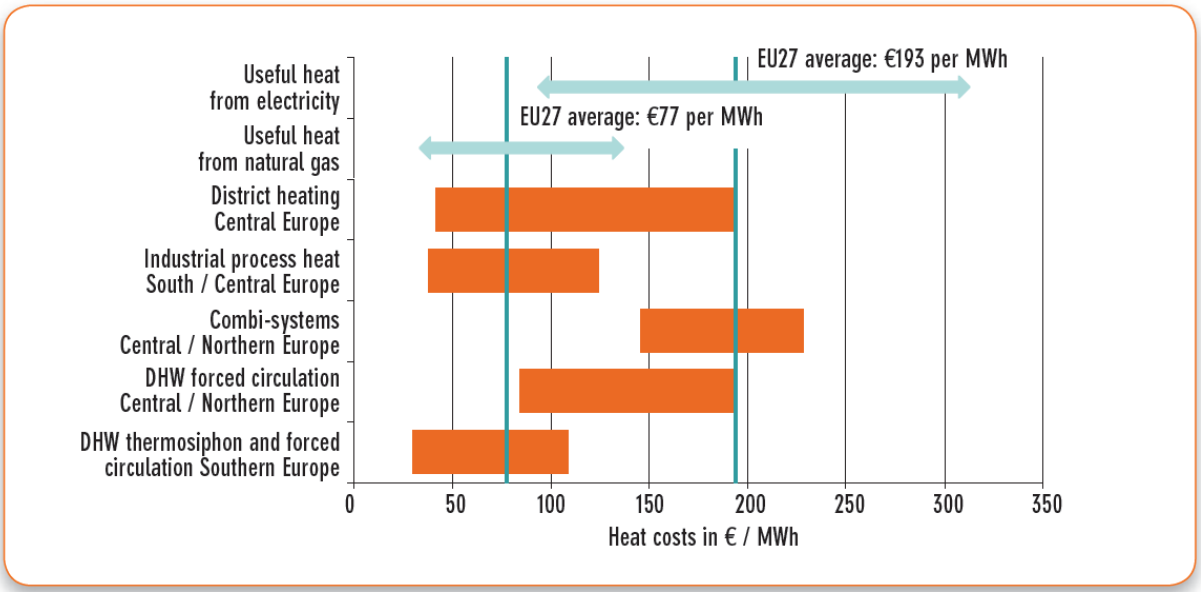


Fig. 3: Comparison of heat costs between different solar thermal applications in different regions and costs of useful heat from electricity and natural gas
Source: Sanner et al. 2013: 15, based on data from ESTIF and EUROSTAT

Technology specific regulations: Regulations are still tied for some technologies. Gaining a lasting permission for ground water heat pumps for example is very difficult. The regulation on recycling of organic waste and the use of waste water and its organic fraction also influences the potential for biogas production. The Ecodesign Directive sets (minimum) standards in the EU regarding the environmental friendly performance of products[1]. The implementation in national law and the monitoring of the directive can differ across countries. On the one hand the EU Ecodesign Directive stimulates innovation but on the other hand it is more difficult to bring new products into the market.

Contract issues for technology use: For some technologies as for example excess heat contracts have to be concluded between excess heat supplier and the user(s) of excess heat.

[1] http://ec.europa.eu/growth/industry/sustainability/ecodesign/index_en.htm

The user is usually interested in long-term contracts, bringing the supplier in a difficult situation regarding guarantee of energy supply. Neither the supplier nor the user would be willing to cover the risks. Besides that contractual commitments or governmental planning restrictions may disallow many district heat suppliers to abandon gas-fired boiler or combined heat and power plants in favour of renewable energy solutions.

Market Share

The current development of renewable power capacity is promising and increasing at a significant rate (International Energy Agency (IEA) 2014; International Renewable Energy Agency (IRENA) 2015). Investments in renewable power have risen to high levels supported by long-term political frameworks and a variety of financing sources. In particular, prices (USD / kWh) for photovoltaic and wind energy have been declining since 2010. Despite the geographical diffusion of technologies and the market becoming more competitive, the “renewable energy use for heating and cooling face slower growth and persistent policy challenges” (International Energy Agency (IEA) 2014: 7). These challenges are, for example, regulations and prescriptions as well as market risks. Growing competitiveness might be beneficial for the diffusion of renewable energies but policies still have to stimulate investment.

Multi-Stakeholder issues

In general it could be a problem to bring all the relevant stakeholders together to facilitate an investment decision.

Perceptual-behavioural barriers

Bounded Rationality

Most business models assume consumers to be rational actors what means they assume that investment decisions are rational decisions, particularly if a huge investment has to be made. Ramos and colleagues (2015) provide a very good overview on major behavioural “failures” that deviates from the rational theory of choice (Tab. 4). It depicts that rationality is bounded and therefore a barrier for the supply side as behaviour is not predictable and financial issues may not be the only factor affecting an investment decision. Seen from the demand side, bounded rationality could be both a barrier and a driver for renewable energy (e.g. if a problem is framed by sustainability issues).

Tab. 4: Deviations from rational theory of choice (Ramos et al. 2015: 7)

Behavioural failure	Explanation
Framing	The way a problem is framed impacts the final decision
Preference reversal	There may be differences between values and choices which result in reversal of preferences
Preference intransitivity	Preferences may not be consistent, and may form on the spot, resulting in intransitive cycles
Dependence on irrelevant alternatives	Alternatives that should be irrelevant become very important for the final decision
Endowment or “status-quo” effect	Tendency to value more what we have, or the starting situation
Gambling and insurance	Partly based on the latter (the starting or reference point), people will have different attitudes towards risk depending on its magnitude and starting point
Sunk cost fallacy	People consider sunk costs in their decisions, although they should not, based sometimes on self-discipline or stability of decisions
Mental accounting	People allocate different expenses to different categories, as a way to deal with complexity in budgeting
Dynamic inconsistency	Preferences change when decisions come closer
Limited attention	People are not able to use all the available information due to time or effort constraints
The paradox of choice	More options result in less utility (maybe because of larger regret)
Emotions	Emotions, altruism, and social norms, may have a significant effect on decisions

Trained work craft

For the installation of a large scale heating plant, **trained plumbers and heating** system engineers are needed, but are often scarce. The need for trained engineers and plumbers is a factor for every new technology (Doble and Bullard 2008a). All those involved in selling and evaluating a heating system (energy supplier officers as well as energy advisors) need information about the new technology (Dolman et al. 2011; Doble and Bullard 2008a; International Energy Agency (IEA) 2009).

2.1.2 Demand-side barriers

Main actors:	all end users from all sectors (e.g. residential sector, commercial sector, public sector)
Additional actors:	NGOs, media

Heating energy is used by all sectors and most of them also use cooling. Space heating demand depends on the outside temperature/season. NGOs and the media play a special role in the demand side because they communicate certain needs of the consumers to the supply side.

Financial economic barriers

All the financial factors are based either on unforeseeable developments or on real existing financial constraints.

Initial costs

The party who bears the initial costs might not benefit at all from the savings (Dolman et al. 2011: 11). Another factor for investment in insulation or retrofitting is whether the building is used by the owner (i.e. the investor) or whether it is rented, highlighting the known **investor-user-dilemma**. In the case studies of this project most of the houses or flats are owned by private house owners (Tab. 5). Some owners show a reluctance to retrofit a rented building when they are not guaranteed to recover the costs. In fact it is clearly not possible to transfer all the investment costs to the users since the landlords cannot easily increase the rent. This is the result of a potential conflict with the associated tenant market. The discomfort caused by refurbishment works can also lead to a conflict that some owners would not want to engage in. Ultimately, if the investment would only benefit the users without a pay back, then the incentive for the owners to invest is rather low. IEA (2009: 3) refers to the term of “split incentives” as an institutional barrier in the case of large companies (property developers) or public services. Diverse factors have to be taken into account for the majority, among other things, the profitability, the ecological aspects and the particular economic and familial situation of the owners. Decision making also occurs in owner communities through formal processes (e.g. owners' general assembly) which need considerable time. The question can even be more difficult in cases of quarrels in a community of heirs, as interpersonal dislike can hinder decision making (Reitze et al. 2012: 94).

Tab. 5: Estimated share of rented and owner-occupied houses/flats in the case studies

case Study	rented house/flat	owner-occupied house/flat
AT – Ansfelden	20 %	80 %
CZ – Litoměřice	30 %	70 %
DK – Helsingør	40 %	60 %
DE – Herten	50 %	50 %
PT – Matosinhos	20 %	80 %
RO - Brașov	10 %	90 %

Source: Estimated numbers of local partners or internet portal for real estate

An important limiting factor is, in the eyes of investors (private households, companies, and organisations), the **long recovery periods of the investment**. As noted by IEA (International Energy Agency (IEA) 2009: 3) "investors are looking for short 'pay-back time' while the investment offers long-term benefits". In fact few private house owners have an incentive to invest in energy restoration with a recovery period of twelve years or more, as a survey of the German Federal Ministry of Transport and Digital Infrastructure (BMVBS) showed. According to the results of this survey, 47 % of the households would decide to invest for a recovery period of five years maximum, while only 18 % would be willing to invest when the recovery period is of eight years and this drops to 3 % for a recovery period of twelve years or more (BMVBS 2007: 35-36). The reason for this could be the expectation of moving house and the uncertainty of incorporating the investment costs in the sales price (Dolman et al. 2011: 135). "A range of evidence suggests that many consumers – both firms and other organisations and households – impose very stringent criteria in evaluating this trade-off, for investment in non-core business activities in general and for energy-related investment in particular. The rates used are often higher than interest rates or other relevant costs of capital to which investors have access." (Dolman et al. 2011: 133; see also: Linares and Labandeira 2010; Daim et al. 2013; Broberg Viklund 2015; Petzke 2009).

Every company has a so called **"core business"** which is well tested, relatively stable and risk free. Therefore the focus and know-how is on this "core business". Renewable energies are not usually the "core business" of companies. Since maintaining the production or the service is the first priority of companies, they are more likely to invest in innovations when this has an immediate impact on their day-to-day business. Investing in "new" technologies means that a closer look at their impact is necessary. This means a much lower payback time (3-5 years) is expected for investment in new renewable energy systems than for a standard investment (Andrews et al. 2012). Furthermore the **net-additional costs,** over and above those of a reference technology, are taken into account (Pîrlogea 2011).

An average user will not invest in a new technology before the **end of lifetime** of the currently used technology (10 years minimum) even if it might be economically valuable (Haas et al. 2007: 37). Most of the decision makers will change nothing until functional shortcomings arise.

For households without their own capital, and companies with a **lack of equity capital** for the investment in energy-saving measures, and particularly for those living in detached and two family houses, there is some reluctance to invest in projects through a loan, due to the above mentioned uncertainties.

Deciding on one investment always means that another investment cannot be made. This is known as "**opportunity costs**". In addition time and resources are necessary to search for information, come to an acceptable agreement and sometimes setting up a contract which is called "**transaction costs**". The access to useful information needed for decision making absorbs considerable time and effort for private enterprises. Energy management sometimes requires a certain level of professionalism even for the application of funds which is, for example, not available to small companies. The lack of information then leads to cost inefficient decisions or a reluctance to invest. For instance some companies invest in separate individual measures instead of wider measures which are theoretically more cost efficient. This is mainly due to the fact that many investors prefer to invest, as a precaution, using their own capital, thus avoiding the need for external advice (Reitze et al. 2012: 94–95). With scarce resources such as capital, time, management attention or other key factors, consumers do not assess every opportunity in detail and tend to turn to "core business" (e.g., for companies to increase production or for households to improve comfort). The time needed to research new technologies could be a barrier and produces the need for a higher value of a new technology. "In such cases, it can be perfectly rational to undertake only those projects or purchases that achieve a (very) high rate of return or advantageous payback periods." (Dolman et al. 2011: 133f.).

Operating costs

Maintenance costs play a role on the demand side as well looking at heat equipment and individual heating installations.

Energy tariffs will play a decisive role in the decision taken by the users. In fact the predicted scarcity of resources and the increasing price of energy will lead to an increasing demand for energy-efficient solutions (Reitze et al. 2012). In addition, the trending wish for energy-autarchy, leads to more investment in renewable energy sources. In most cases the energy price for renewable energies is lower than for conventional energy and therefore the initial costs can be made up. This is, for example, the case for efficient heat pumps, solar thermal or biogas but less so for biomass (Dolman et al. 2011: 10). However it is not just the savings that determine the "discount rate" which is the "trade-off between up-front and ongoing costs and benefits" (Dolman et al. 2011: 133). According to Andrews et al. (2012: 44) district heat price levels are increasing throughout Europe. As noted earlier, Haas and colleagues (2007: 30) assume that energy price for renewable energies (biomass, wood chips, pellets, split logs) will increase, but not as much as that from conventional energy sources (oil, gas, electricity) (see also: Nitsch et al. 2012: 53).

There is the obvious situation that energy sources with high **taxes** remain less popular, which is still largely the case for renewable energies. Here a firm political will is needed. The trending wish for energy-autarchy can foster investment in renewable energies. Yet the taxes on self-produced energy can slow down investment.

Institutional-structural and market oriented barriers

Energy demand

The characterization of energy demand affects the feasibility of renewable energies. Local geographical or cultural factors can be barriers to renewable energies. In the **residential sector** energy demand is strongly connected to climatic conditions and seasons. This is why in Denmark, for example, there is almost no need for cooling which might be slightly higher in Portugal. In the **non-residential (service) sector** heating and cooling demand depends on the type and usage of a building. Heating and cooling loads are typically higher than in the residential sector. The challenges here are flexible, adaptive technologies that can be used for heating and cooling (Sanner et al. 2013). Heat demand in the industrial sector varies significantly by industrial process. Temperature levels required can be particularly different, and range from low temperature levels (up to 95 °C) to high temperature levels (over 250 °C).

Cooling demand is increasing in Europe. According to Jossart et al. (2012: 14), around 260 TWh of electricity is currently used to cover the need for cooling in Europe and the trend is upwards. Scanner et al. (2011: 10–11) support this point of view by showing some reasons for an increasing cooling demand in contrast to the heating demand. Climate change and the subjective feeling that ‘cooler is better’ for productivity are the first reason. Numerous new buildings and the technical equipment of large commercial buildings – as usual – also contribute to increased demand. Scanner et al. (2011: 11) suggest that the technology to face this demand should be accordingly green in order to avoid more carbon emissions.

It can be assumed that the number of heated buildings is increasing and that the building quality is also increasing (Haas et al. 2007: 36). Therefore, all in all, the heating demand is not increasing, but is more or less stable over a period of 20 years.

Building stock

The complex regulatory framework for sites of historic interest is a barrier for refurbishment projects. As a consequence, buildings of historic interest generally require demanding refurbishment solutions resulting in high costs but low user satisfaction due to the restrictions on the perceived quality of living (Reitze et al. 2012: 95).

According to a study from the Building Performance Institute Europe (BPIE) of 2011 (Economidou et al. 2011), buildings across Europe vary greatly in terms of age, size, ownership / tenure and location which in turn have an influence on the energy performance, and impacting policy measures and investment decisions (Fig. 4). Large proportions of old buildings (built before 1961)

can be found especially in Denmark and the Czech Republic in 2011. Regarding the tenure of residential buildings, in Romania almost every dwelling is owner-occupied while in Austria or the Czech Republic just about half of the dwellings are owner-occupied, the others being privately or publicly let. Romania also stands out with high proportions of rural locations of buildings.

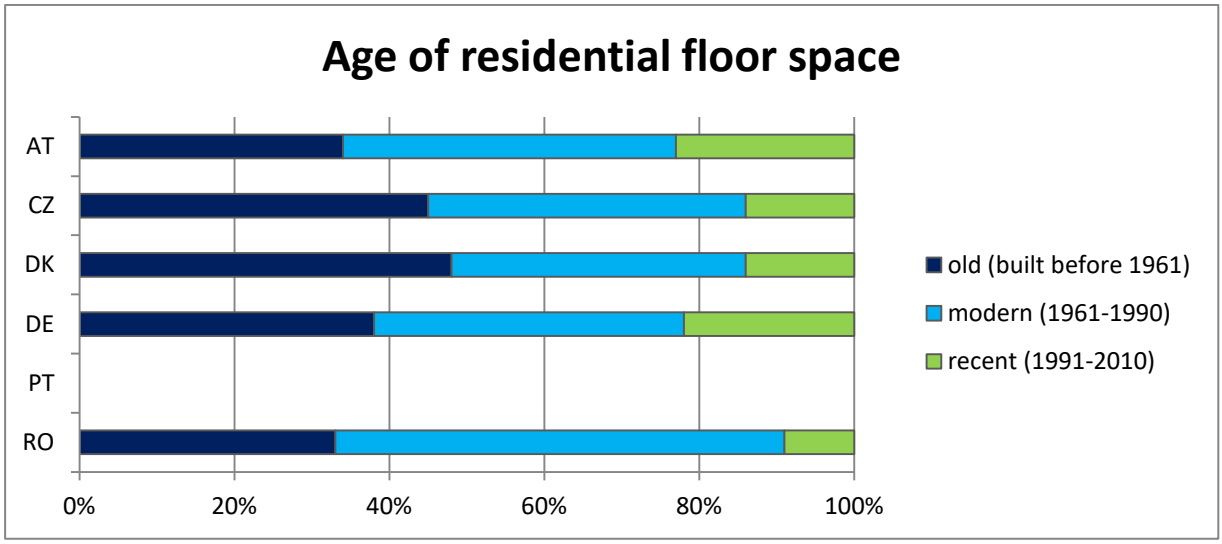


Fig. 4: Age of residential floor space in the case study countries
Source: Economidou et al. (2011)

Multi-Stakeholder issues

In general it could be a problem to bring all the ideas/intentions from the supply side together with the expectations from the demand side and facilitate usage of investment.

Perceptual-behavioural barriers

Uncertainties

The problem with renewable energy-related policies is that they do not always present a long-term continuity which leads to **uncertainties at different levels** (Dolman et al. 2011; Reitze et al. 2012; Krémer et al. 2005):

- Uncertainty of own future
  A first general uncertainty is related to the fact that private households are sometimes concerned about their own financial future which cannot be completely predicted. Becoming unemployed, for example, would be a difficult situation to handle. This would be particularly difficult where a loan had been taken out for the investment. Companies are subject to the same sentiment, even though in their case an investment generally improves their business activities.

- Uncertainty of regulations
  A change of regulation, for example related to taxes and social measures, can also have consequences on the financial situation of households. Uncertainty about financial incentives will prevent investors incurring up-front costs.
- Uncertainty about development of the energy price
  Likewise, the development of the energy price is unpredictable and can become a driver or a barrier as it has been the case in different European countries during the last three decades. The concern about dependence on fuel price fluctuation and the availability of fuel supply will affect the decision on a new heating system.
- Uncertainty of performance
  Investors might lack confidence of the performance of the technology, its lifetime, or its ability to meet heating needs. If there is no standard for technology performance this uncertainty can be a problem especially for companies with heat as a core business (e.g., industrial process heat). This is especially the case for heat pumps, combined heat and power, solar thermal systems and excess heat. Home owners might have concerns about the impact on the value of the home of a non-standard heating system. “In general, there is agreement that perceived performance risk is likely to produce decisions that are observationally equivalent to higher hurdle rates.” (Dolman et al. 2011: 135).

Reddy and colleagues (2009: 152) talk about uncertainties as risks that are a “special category of barrier with a probability distribution”. This means that the perception of the investor, on how likely an event will occur, determines the extent of the barrier.

When people are dealing with uncertainties, some biases which are depicted by Ramos et al. (2015: 7) affect their behaviour (Tab. 6):

Tab. 6: Biases when dealing with uncertainty (Ramos et al. 2015:7)

Behavioural failure	Explanation
Representativeness / Conjunction fallacy	People look for internally-consistent stories, even if they go against probabilities. It is also used when people extrapolate small samples to large ones
Availability	People make judgments about the probability of events by how easy it is to think of examples
Anchoring	Estimates are biased by the number initially provided
Gambler’s fallacy	Based on misconceptions of randomness, people are not able to estimate the likelihood of random sequences
Selection bias	When the sample selected is not random, results will be biased
Aversion to uncertainty	People assign lower utility to results for which probabilities are not known

Knowledge and awareness gaps

Lack of knowledge at different levels is a barrier to decision making in favour of renewable energies.

Households and companies have little knowledge because of the low level of professional property management. Since there are few people who know how to implement / maintain renewable technologies, companies and households will not run the risk of trying new solutions. The actual status quo and the saving potentials are not well known and the effectiveness of renovation is misjudged. There are also some “myths” regarding certain refurbishment measures based on a few negative cases that lead to **misinformation** of the public. This particularly occurs among owners of one or two family houses, and are actually due to incorrect workmanship (Reitze et al. 2012: 92). Complex systems requiring some effort in their operation are also well appreciated. There is for example the misperception that variability leads to a lower comfort.

Furthermore, **technology possibilities might be insufficiently disseminated**. Actual studies are, for instance, based upon the traditional higher temperatures (120 °C flow) which significantly diminish the apparent cost effectiveness (Andrews et al. 2012: 13; Paar et al. 2013: 40ff.). It is also not sufficiently well known that, for example, modern multifuel boilers and feeding conveyers have been adapted, and new technology solutions have come into the market (Jossart et al. 2012). The limited awareness of technologies can be even more profound as some consumers do not even know that renewable energies exist (Dolman et al. 2011: 14–16). Also, due to the lack of knowledge of the renewable energy based technologies, some consumers do not trust them to work as well as the conventional ones or do not ask for specific services (Kampman et al. 2015: 237).

However, a lack of knowledge does not always mean a lack of information. Sometimes there is actually **too much information**, which does not help to identify which is relevant. Decision makers are then exposed to the information from service providers (architects, craftsmen, management of joint ownership etc.) who can also be self-interested. Consequently the information is not always impartial (Reitze et al. 2012: 92).

Trained work craft

Similar as on supply side **trained local professionals** are an important factor for investing in renewable individual heating equipment but trained plumbers and heating system engineers are often scarce (Dolman et al. 2011; Doble and Bullard 2008a; International Energy Agency (IEA) 2009).

Risk and loan aversion

Shifting to renewable technologies (e.g. renewable heat) is not an easy decision as it means abandoning conventional fossil fuel boilers which are “a mature technology with a track record of predictable performance” (Dolman et al. 2011: 13). Different factors favour conventional fossil fuel

boilers which are perceived as a low risk alternative; they are widespread, the required fuel inputs are relatively easily available and consumers are familiar with them. Since consumers want to run the lowest risk possible, when faced with two investment alternatives with similar expected returns but different risks, they would choose the technology with the lower risk (Jossart et al. 2012). This **risk aversion** influenced behaviour typically increases with increasing age of the investor. Anyway, a more visible investment (e.g. new bathroom) is usually preferred. Furthermore, discomfort and temporary disadvantages caused by the refurbishment are other reasons for refurbishment projects not being executed.

One strategy for consumers to overcome risks is to use simplified **decision rules**. "Higher hurdle rates may be used within organisations or implicitly by households as a decision mechanism to compensate for the likely existence of costs that may not have been adequately accounted for within the calculation of a project's net present value (thus closely related to a correction for optimism bias)." (Dolman et al. 2011: 13 / 135).

The owners of one family or two family houses are sometimes concerned about not being able to properly lead the refurbishment project to the end, and therefore they do not run the **risk of starting** (Reitze et al. 2012: 93).

2.2 Drivers for implementing renewable heating and cooling technologies

Drivers can be described on the one hand as factors that promote investment in renewable energies and on the other hand factors that can overcome barriers (Reddy et al. 2009: 164). As mentioned above barriers have been examined which can principally be overcome by suitable policies. Three policy approaches have been identified by Holländer and colleagues 2016 to be relevant: command-and-control instruments, incentive regulation instruments and knowledge building instruments.

Command-and-control instruments

Regulations regarding heating equipment should be as simple as possible and in the best case standardized. An EU label for technologies would be favourable for (further) market development (ECORYS Nederland BV (ECORYS) et al. 2010). Moreover a European standard for infrastructure approval procedure especially for trans-national networks can simplify the development of a European grid. Also clear and strong regulations for the connection and access to the grid are necessary.

Laws have to be transparent and law-enforcement clear for example integrating monitoring including random controls and sanctions (ECORYS Nederland BV (ECORYS) et al. 2010).

The investor-user-dilemma can be encountered by **facilitating landlords** to pass a part of refurbishment costs on to the tenants and stop tenants from opposing to the works (ECORYS Nederland BV (ECORYS) et al. 2010). In addition the use of renewable should be an increasingly

important factor to determine the value of the property. Another incentive could be to simplify investment of energy equipment installed on buildings owned by third parties.

Obligations for utilities to integrate renewable energies and/or increase the efficiency of their energy supply structure (as it is the case in Denmark) could be a big driver (ECORYS Nederland BV (ECORYS) et al. 2010).

Obligations for new buildings and existing building stock can promote investment in renewable energy as well as **obligations on large scale heat/cooling generation** (Holländer et al. 2016).

Incentive regulation instruments

Fundings, in the meaning of investment grants which are not repayable (Haas et al. 2007: 31), help to overcome initial cost barriers but are also issue to uncertainty when funding is missing in the future. Jossart et al. (2012:36) add that beside the EU funds and programs for the energy sector there is a variety of funding possibilities national and local levels in the different Europeans countries which was examined separately (Holländer et al. 2016). Programs should not be overly complex and should not require substantial paperwork (Dietz et al. 2013; ECORYS Nederland BV (ECORYS) et al. 2010).

The current ecological trend can foster investments in renewable energies in many ways. Being “green” and taking over responsibility of the environment is particular positive for the own image of business as well as of politicians. Companies can do public relation work with their green orientation. They can become more credible and thus connect with larger potential customers, among whom the environmental awareness is increasing. This is why wherever measures are taken, their visibility for the persons using the building (public and workforce) should be ensured. This is possible through **awards and certifications** or visible displays showing the amount of energy produced (ECORYS Nederland BV (ECORYS) et al. 2010; Reitze et al. 2012).

Necessary financing opportunities as **soft loans** should be provided for consumers willing to invest in renewable energy. It should also be possible to combine different funds (ECORYS Nederland BV (ECORYS) et al. 2010).

Operating support via bonus or **feed-in tariffs** and fiscal incentives as for example **tax reductions** can help to overcome financial barriers as well (Holländer et al. 2016).

In order to facilitate large scale plants the provision of (low priced) **open areas** would be beneficial. Also **low temperatures** within the energy system would facilitate several renewable energy technologies (Müller et al. 2014).

Knowledge building instruments

To overcome the lack of (the right) knowledge/information, almost every big city in Europe offers **energy advice services** which support private households, public bodies and companies in energy and building related investment decisions by providing situation-specific information on

technical, financial and practical issues. The creation of a specialized energy agency is also a good way of fostering the transition.

Networks of companies have proved effective. Examples from Germany and Switzerland have shown that networks foster more investment in energy efficiency because of the trust level among the network members. The networks typically provide a platform for personal meeting of different actors facing similar problems discussing informal and exchange practical experiences (Reitze et al. 2012, 2012: 43–46).

Very often public buildings use renewable energy or district heating first or are renovated. Public buildings could therefore serve as an **example** for other investors.

In order to avoid risks of protest all relevant local stakeholders should be involved, setting up a **participation process** (ECORYS Nederland BV (ECORYS) et al. 2010).

Investment in **research and development** of renewable energy could promote innovative solutions and enhance market development (ECORYS Nederland BV (ECORYS) et al. 2010).

Awareness raising campaigns should be available for all possible investors for renewable energy (homeowners, companies, managers of public buildings, professionals, financing institutions). This should be combined with visible, easy accessible, understandable, comprehensive, comparable and constantly updated **information** (ECORYS Nederland BV (ECORYS) et al. 2010). Here several means of communication should be used, complementary to the target group (website, online helpdesks, and telephone hotline). In addition, campaigns and competitions help create media attention. Consistency of presented information is crucial for the effectiveness of the campaign. In order that information is perceived as reliable and independent provider of information is necessary.

Training of professionals (planners, designers, installers etc.) regarding renewable energy technologies is a crucial measure in most countries giving workshops and seminars. To make trained professionals visible this should be accompanied by certification and in the best case with a publicly available list of certified professionals (ECORYS Nederland BV (ECORYS) et al. 2010). In addition renewable energy technology should be integrated in the educational programmes of trainees.

In conclusion, there is no “one for all” solution to enhance renewable energy for heating and cooling but it’s essential to take country specific framework conditions into account and develop a bundle of driving measures well adapted for the individual case (see Chapter 3 of this report and Chassein et al. 2017).

2.3 Relevant stakeholders for implementation of renewable energy

For the implementation of renewable energies in an energy system for heating and cooling, the involvement and cooperation of several stakeholders on both the supply and demand side is necessary (Reddy 2013). Even if the users (demand side) cannot influence investment decisions directly, investors (supply side) usually care about the user's needs. Some stakeholders may simultaneously be investors and users of renewable energy (e.g. the municipality or the energy supplier). Depending on the actors considered, the impact of a barrier can be, for example, inadequate financial support (financial institution), no investment (investor), lack of policy support (political institutions), choices of another alternative (consumers), or low quality of implementation (equipment manufacturer). The analysis focuses on the stakeholders influenced by particular barriers and the actors with the power to create, reduce or remove certain barriers (Reddy et al. 2009).

For this purpose we made an overview of all stakeholders who *could* be involved in the decision process and describe their *possible* motivations. Different stakeholders have different characteristics (Otto-Banaszak et al. 2011). Their motivations can either be for or against a renewable heating / cooling solution. The differences between stakeholders include their role in the diffusion process of renewable energies, their motivation to use, promote or prevent investment in renewable energies and their power or means of impact. Their below describe characteristics are partly based on the study of Otto-Banaszak and colleagues (2011; Otto-Banaszak et al. 2011) as well as on the description of Reddy et al. (2009) and Henning et al. (2011). The following stakeholders are described in more detail below:

- Authorities
  - National / regional authorities
  - Local authorities
- Final energy consumers
  - Businesses
  - Households / Residential sector
- Energy supplier
- Technology Suppliers
  - Local professionals
  - Producer of technologies
- Other
  - Finance corporations and insurance companies
  - Energy agency and energy advisors
  - Action groups (citizens, NGOs)
  - Media
  - Research and development institutes

2.3.1 Authorities

National / regional authorities

The perspective of government authorities includes, among other aspects, national development goals, living standards, social equity, environmental benefits, self-reliance, and energy security (Reddy et al. 2007). Their focus depends on the priorities and target setting within a country / region. For this purpose, there is a need for a good connection to independent research. National and regional authorities also set regulations and legislative framework, complemented by incentives for certain investments / behaviour (expert interviews). Election periods can be important as they may hinder the modelling and implementation of long-term strategies; they may be highly influenced by the media and interested in general visible options (Otto-Banaszak et al. 2011). Another conflict of interest lies in the dual role of governments as both consumers and suppliers of goods and services. Governments have the power to stimulate, support or accelerate investment in renewable energies by various command and control instruments (e.g. legal and institutional framework, regulations as performance standards, incentives, programmes, grants, tax incentives) (Reddy et al. 2009). Property rights issues and legislations, as well as cost efficiency, are always at the back of the mind of politicians (Henning et al. 2011; Otto-Banaszak et al. 2011). They are in the same position as local authorities regarding most areas. In contrast to local authorities, however, national authorities have to allow for the national political landscape and international agreements regarding climate policy (expert interviews).

Local authorities

Most of the characteristics of national / regional authorities also apply to local authorities. The municipality links higher-level authorities with citizens and therefore plays an important role in "coordination of and leadership among local actors" (Otto-Banaszak et al. 2011: 225; see also expert interviews). In addition local authorities are owners and managers of building. Municipal buildings that are energy efficient or use renewable energies can be held up as an example (Henning et al. 2011). This has the greatest effect if the measure is publicly visible. Mickaityte and colleagues (2008) state that "Buildings refurbishment implementation is closely related with countries and public interest". A specific restriction for local authorities can be the budget for energy related investment, even if measures can save long-term costs. Different energy related directives might, however, have a positive effect on the energy related budget of municipalities (Henning et al. 2011). Another barrier is the (relatively) short legislative period of (usually) four years; it is very difficult for local authorities to plan investments over more than one legislative period.

The most important local political decision-makers are the mayor, the agency of urban planning, the building authority and the environmental department. Their motivation is to ensure that citizens have a protected environment and advise the policy makers on this topic. They usually cooperate closely with researchers who evaluate the performance and potential costs and benefits of measures. If there is any local climate plan it plays a (smaller or larger) role in their decisions whereas the plan itself can be motivated by several factors: emission reduction (CO_2), combating of air pollution, promoting renewable energies, primary energy reduction, cost reduction, employment enhancement, economic growth (GDP), and implementation of

(inter)national action plans. Additional tasks of local authorities are: administration of property, increasing the value of property, and securing of stable and long-term energy supplies through long-term concepts and strategies. Consulting services can be offered for energy efficiency, renovation and energy saving measures.

2.3.2 Final energy consumers

Businesses

The business sector and its organisations and networks (e.g. chamber of commerce) have profit interests (Reddy et al. 2009). They want to save (energy) costs and acquire customers to remain competitive in their markets. The use of renewable energies has to be economically efficient when compared to other energy resources. They could also be motivated by public opinion (for example, by providing a green image) and social acceptance of their actions. In the last ten years companies have started to consider sustainability concerns. They can also generate incentives through the management and production of their own energy on site. Companies first have to realise that non-market needs of consumers and their interests in environmental issues have to be taken into account (Reddy et al. 2009). The business sector is closely connected with governmental issues, through the regulations determined by the government, administration issues and lobbying politicians (Otto-Banaszak et al. 2011). Regarding the Energy Efficiency Directive (2012/27/EU), companies (defined by the total annual energy consumption) have the obligation to carry out an energy audit every 4 years.

In the service sector **commercial buildings** (buildings from the service sector that are not public, such as shopping malls, restaurants, hotels) and **office buildings** can be found. Comfort is a priority in commercial buildings and working conditions are the focus of office buildings. In both types of buildings a green image can be beneficial. The **chamber of industry and commerce** can have an influence on decision making processes of their members.

Industrial companies are especially important because of their huge demand for heat / cooling compared to other consumers, and because of their potential to feed in excess heat into the grid. From this perspective industrial companies can have a dual role as both consumer and supplier. This could, however, be interpreted as an opportunity rather than as a conflict of interest.

Manufacturing industry that produces the renewable energy technologies see below.

Agricultural sites are not only users of heat but may also deliver biomass or biogas. There can therefore be a large impact if a farmer is interested in investing in renewable energies. Farmers are also sensitive to economic incentives. Subsidies and compensation are important factors for farmers, along with coordination of their actions and traditional aspects (Otto-Banaszak et al. 2011).

Households / Residential Sector

House owners who live in their (single) house can decide about investment for themselves; they benefit directly from the investment. House owners, or ownership communities, of rented houses focus on the economic issues regarding investment and do not necessarily benefit themselves from renovation (investor-user dilemma) (Reddy et al. 2009). A “green image” of the house which could be verified by the European energy performance certificate could, however, be a sales argument. The problem arises with tenants in rented single or multi-family houses that are not, as in most cases, involved in decision processes and the house owner does not care about energy supply (investor-user dilemma). In many countries it is even the case that investment by the tenant into a rented house, even when improvements are made, has to be removed when the tenant moves out of the house. It is therefore very unlikely that tenants will install renewable energy based heating technologies in rented houses. Another theory states that people rate the current situation more important than future well-being.

Cultural differences in energy-using behaviours and regional conditions which could affect the economics of investment in renewable energies must be taken into account (Reddy et al. 2009).

A big issue for house owners when they make investment decisions is the time they expect to live in their house and the uncertainty of incorporating the investment costs in the sale price of the house. Based on rational choice theories, households want to maximise their benefit from investment just as companies do (Reddy et al. 2009). Additionally, the current situation is usually considered to be more important than future well-being. There are many more barriers that apply to households, such as knowledge gaps or risk avoidance which are described in detail below. According to Reddy and colleagues (2009) the main effort in the residential sector should be applied to new buildings and major replacements. The social environment (friends, family, neighbours, colleagues etc.) can substantially influence the decision making processes of private investors. Policies and technology development can be influenced by private consumers (Otto-Banaszak et al. 2011).

Housing companies are institutions that sell and let houses, and manage real estate. They are very concerned with consumer attitude and good publicity and therefore might be interested in a “green image”. There are municipal housing companies which focus on social housing, for example, and are dependent on political decisions. Some housing agencies (e.g. “Housing Agency” in Ireland) explicitly support and promote sustainable communities.

2.3.3 Energy suppliers

Energy suppliers provide and sell (different types of) energy to end users. Profit and consumer acquisition motivates their actions. They might bear a share of the costs for technologies provided and are therefore interested in the cost efficacy of a new technology. Usually they are interested in preserving existing systems which are successfully proven. In most countries the energy suppliers are private, and so, in this case, the one who decides to make a supply renewable might not be the one who is actively involved in its implementation. This often results in an attempt by the government to exert more power over the energy supply. In Germany, for example, there is a mixed picture and some utilities are run by the municipality. Denmark is a

very special case where energy suppliers are non-profit organisations. Table 7 shows the owner structure of the energy system in the case studies. Sometimes politicians sit on the board of utility companies and might represent contradicting interests. Public utilities can play an important role in energy transition if they offer more environmental friendly heating within their portfolio which is economically competitive and thus affordable for low income households. For such a portfolio, market competition at the local / regional level might be beneficial. According to Reddy et al. (2009) the most effective approach to change the system is a collaborative effort between the government and (energy) businesses.

Tab. 7: Owner structure of energy supply in the case studies

Case study	Owner structure
Ansfelden (AT)	Energy suppliers mainly private, municipal share: 35%
Litoměřice (DZ)	Two private energy suppliers => plans of the city to buy the district heating company
Helsingør (DK)	Two municipal co-owned companies (uncommon in Denmark) DH system 100 % owned by an independent energy supplier
Herten (DE)	Energy supplier is a subsidiary company of the municipality. Municipality owns the district heating grid.
Matosinhos (PT)	Energy suppliers are private but infrastructure is municipal.
Brașov (RO)	Part of the energy supply is private, the rest as well as transport and distribution is public.

2.3.4 Technology suppliers

Local professionals (Planner / designer / installer / craftsmen / chimney sweeps)

Planners, designers, installers, and craftsmen are actively involved in the implementation process of directives and specifications through the execution of the measures. Their incentives are large profits and consumer acquisition. It is very important that the work force has the education and knowledge to implement a particular technology as the lack of trained work force could be a barrier.[2] As some technologies cannot easily be implemented, installers are challenged by finding specific solutions and combinations of components which results in using same technologies by the installers every time without thinking about innovative technologies (Sanner et al. 2013). They often have an intense relationship with customers who rely upon their products, services and expertise (Reddy et al. 2009). Craftsmen and chimney sweeps etc. are often overlooked, however. These are the experts who have personal contact with households. People trust them and what they recommend plays a big role.

[2] Article 14 of the RES Directive (2009/28/EC) requires EU Member States to provide, by 31st December 2012, certification or equivalent qualification schemes for installers of building-integrated biomass stoves and boilers, shallow geothermal energy systems, heat pumps, photovoltaic and solar thermal systems so that they can be mutually recognisable.

Producer of technologies

Technology providers (manufacturer) of renewable energy systems or heating systems have to put effort in developing the technology and adapt it to the needs of the local professionals (see above) and consumers. For the diffusion of a technology it might be relevant to have national companies to produce this technology which would be interested in trained workmen for its implementation. It would therefore be important to built networks of technology providers, local professionals and consumers and foster exchange of demand and supply issues to find the right balance between functionality and simple handling (Sanner et al. 2013). Additionally it has positive effects on the national economy if the technology is funded by the government. It provides manufacturers with the incentive to develop new solutions and improve existing practice. Strategic alliances between industry and energy service companies could also provide opportunities to organise a market for advanced products (Reddy et al. 2009).

2.3.5 Other

Energy agency and energy advisors

The role of the **energy agency** is to raise awareness and provide information on energy related topics. Stakeholders from energy agencies impart (inter)national climate plans to politicians and investors can ask the energy agency for advice. They interact closely with the public and can raise social acceptance of legal requirements. Energy agencies are important for the reproduction and sustainability of energy related policy measures (Reddy et al. 2009). **Energy advisors** consult investors in person and on-site, and help them to find the best solution regarding energy consumption. They can therefore have a big influence on investment decisions.

Finance corporations and insurance companies

Domestic **financial institutions** provide finance through leasing and term loans. A financial analysis is normally required to make an investment decision. Profit is also a focus of banks, but local banks have a special interest in financing public projects and raising external visibility. Banks are often linked with commercial activity that generally degrades the environment (e.g. nuclear power companies). However there are also financial institutes with an eco-efficient approach that have a special willingness to consider an improved environmental performance project more proactively (Reddy et al. 2009).

Insurance companies play a role if significant uncertainties are expected, for example security aspects of solar thermal installations.

Action groups (citizens, NGOs)

Action groups such as citizens' initiatives, environmentalists or NGOs can have diverse interests such as climate protection, renewable energies or land protections. They might be personally

involved in the transformation process and their decisions could be influenced by emotions. Their actions may be driven by incomplete information or a very narrow view of nature or personal environment and related legal responsibilities (Otto-Banaszak et al. 2011).

Media

The media plays an important role in affecting public opinion and influencing politics (Otto-Banaszak et al. 2011). It informs the public about what is happening. Media channels of all kinds distribute information and they can influence society's perception of specific technologies and topics. This process might be selective and a lack of information from the citizens can be abused for forming a unilateral opinion.

Research and development institutes

Manufacturers are often small companies with limited research capabilities (Reddy et al. 2009). Research and development institutes help decision makers to take all relevant aspects into account and take over transaction costs. In addition they develop innovative solutions for individual problems and help to find the optimum result (Reddy et al. 2009). They might have technological, human and physical capacity, accumulated over years using public resources. The work of research and development institutes provides demonstration sites that could be used to convince investors. These institutes identify potentials for the usage of renewable energy or energy efficiency measures and provide recommendations on how they can be utilised (Otto-Banaszak et al. 2011).

3. Barriers, drivers and stakeholders identified within the case studies

As depicted in the data description above (chapter 1) the case study descriptions are based on interviews, project documents and information material from the municipalities. Despite interviewees having been experts in the local situation with various experiences it should be noted that the interviewee statements may deviate from reality. It is also reasonable to assume that the set of interviewees was influenced, to some degree, through their selection by experts, who favour the scope of the project that is pushing renewable energy. Nonetheless subjective statements may reflect the opinion pattern of stakeholders in general. In order to gather more reliable information on a broader basis at the local level, a quantitative survey was conducted in each case study with different issues and target groups (households, companies and technology designers and installers) depending on the research question most relevant for each case study. Whenever possible, information from the interviews and the surveys was crosschecked against publicly available data (secondary sources) and against the evaluation of the scientific team of this project. Despite these limitations, the approach of this paper is an important complement to purely technical analysis of objective information, synthesizing the opinions of experts from many different backgrounds as well as opinion from other relevant stakeholders.

The barriers and drivers identified in the interviews are analysed for all relevant renewable energy technologies and alternative technologies such as combined heat and power or related topics such as refurbishment of buildings. As district heating is the technology in focus in most case study cities, it should be stressed that district heating is not a renewable energy technology in every case: In Ansfelden district heating is biomass based, in Litoměřice it is coal based, in Helsingør it is partly based on biomass and excess heat and partly on gas fired combined heat and power, in Brașov district heating is based on gas. Despite this it is treated as renewable energy technology for two reasons: 1) it is principally an efficient heating technology and 2) in general it is easier to integrate renewable energy into district heating networks than in a stock of decentral heating systems. Besides district heating industrial excess heat is a more renewable-equivalent heat source. As a by-product of industrial processes it can lower the cost of energy and reduce overall emission from electricity generation. A more detailed analysis based on energy demand for heating and cooling, potential assessment and modelling of various scenarios can be found in other publications related to the project (Büchele et al. 2016b; Büchele et al. 2016a; Bramstoft Pedersen et al. 2016; Petrović 2016)

3.1 Austria: Ansfelden

The municipality of Ansfelden has a population of 15 822 inhabitants. It is located in the central part of the region of Upper Austria. Ansfelden is situated at an elevation of 289 m above sea level. The commercial sector is quite well developed in Ansfelden and several shopping centres and large stores are located along the highway which passes through the municipality. Furthermore, the municipality is also home to an industrial paper plant.

In Austria and Ansfelden, biomass covers the larger share or renewable energy for heat, followed respectively by heat pumps and solar thermal heat. Available heating options in Ansfelden are

district heat (delivered by a wood chip fuelled biomass heating plant) and several individual heating options such as gas, oil, heat pumps or electrical heating (see fact sheets status-quo of energy demand, Büchele et al. 2016b). District heat and gas are direct competitors in the municipality. The municipality owns 25 % of the district heat supplier, the remaining 75 % are privately owned. Several private companies and farmers deliver biomass for the district heating. A second biomass plant and an extension of the district heating grid are planned. The pulp and paper industry in Ansfelden produces a large amount of industrial excess heat that could potentially be fed into the district heating grid. Renewable energy and energy efficiency considerations are a key aspect when planning the development of the municipality's infrastructure.

In the following, barriers, drivers and stakeholders in Ansfelden have been identified by conducting a company survey with 20 participants (please be aware that this survey is not representative) and expert interviews with 3 central actors from the municipality and the regional government.

Additionally, inputs from pre-interviews with local partners, discussions at the Policy Group Meetings, the Cross-Municipality Workshop and project meetings were taken into account.

3.1.1 Relevant technologies and barriers in Ansfelden

The most important renewable and sustainable energy technologies in Ansfelden are:

- biomass (fed district heating)
- excess heat
- heat pumps
- biogas
- solar thermal

Biomass plays an important role in Upper Austria. Biomass is produced within the region Upper Austria. A large number of biomass district heating grids now operate in Upper Austria (>300) and more than 4 500 jobs have been created in the biomass heating sector. A wood chip district heating plant was constructed in Ansfelden in 2009. The interviewees see further potential of biomass for private owners as well as larger installations. 41 % of Upper Austria is forested land and there is potential to increase the use of forestry biomass. However, it remains a limited resource. Currently, the biomass used for district heating comes from local farmers and the region, with part also coming from neighbouring countries. There are plans to build a second biomass-fed district heating grid. However, there are financial constraints since biomass is currently more expensive than gas. According to experts from the municipality, “Gas prices are currently so low, it makes it very difficult for us, as a public body, to carry out large-scale biomass projects (such as the planned biomass district heating plant).” and “There are many buildings that are connected to the gas network. Since the connection is already there and gas prices are currently low, people are not so eager to change energy sources.” According to the interviewees, besides the low gas price, there is also too little motivation to take action towards climate protection through both centralised and decentralised installations. For individual installations, the

investment costs for changing the heating systems in the building are an additional barrier. On a positive note, the experts see no negative effect of the use of biomass on air quality in the region. One expert points out that biomass boilers are mainly used in rural areas where air quality issues are not such a big problem due to the lower population density. Overall, biomass is a strong priority for the interviewed decision makers: “When building, renovating or working on public buildings in Ansfelden, we prepare the buildings so that they can be easily converted to district heating once the plant is built”. The energy agency (OÖ Energiesparverband) conducts awareness raising activities about renewable energy sources including biomass. All interviewed experts agree that the use of biomass should be encouraged through measure such as subsidies, improvements of laws and regulations, awareness raising activities and information campaigns.

The **district heating** grid in Ansfelden is fed by biomass and is therefore 100 % renewable. It is not available everywhere in Ansfelden, but there are plans to build a second district heating grid which should be fed by biomass as well (see above). Although some interviewees see economic challenges of feeding the second district heating network with biomass, for the mayor of Ansfelden, there is no alternative. Another source for the district heating grid could be large amount of excess heat produced by the pulp and paper plant. However, the paper plant is a few kilometres away from the district heating grid (see below). Additionally, an objective is to attract more consumers to connect to the existing district heating grid. Currently, there are almost 150 buildings (totalising around 1 450 units) connected to the biomass district heating system. Nevertheless, around 75 % of the buildings in the municipality are still heated with fossil oil and gas. Many of these boilers are probably old and will need to be replaced in the near future. There are currently 8 public buildings (of a total of 28) connected to the district heating network, thus there is still a large potential to increase the share of space heat supplied by renewable district heating via both grid extension and increasing connections to the grid. Representatives of the municipality state that they “are proud of (the) biomass district heating system in Ansfelden” and that there is already a favourable approach in place in the municipality for the implementation of such technologies. If thermal renovation of more buildings took place, the nearly 100 % renewable target for space heat could be more easily achieved. However, as one interviewee states, decreasing buildings heat demand tends to decrease the profitability of district heating for the district heating company. Various subsidies from the regional and national government are available for connecting to a district heating grid and for building a district heating plant. Depending on the subsidy, these are available for municipalities, private companies and for apartment buildings.

All interviewed experts agree that **combined heat and power** is currently not feasible in Ansfelden, either in combination with district heating or coupled with industrial excess heat. According to the experts, this is the result of the relatively year-round constant demand for electricity in comparison to the seasonally variable demand for heat.

The interviewed experts perceive the potential of **excess heat** in Ansfelden to be very large. This potential comes from the pulp and paper factory that produces a large amount of excess heat. There are also small and medium sized companies in Ansfelden, but no other large producer of excess heat. The municipality demonstrates interest in feeding the excess heat from the pulp and paper plant into the district heating grid. In addition, it could be financially advantageous for the pulp and paper industry to sell its industrial excess heat to the district heating network. According to the interviewees the “challenges to be overcome with such a project include the need for a

long-term contract and back-up systems". There have been discussions between the paper industry, the local district heating company and the city of Ansfelden as to how best make use of the industrial excess heat for district heating. So far, it has been determined that the temperature of the company's waste water could be suitable. Additionally, it is foreseen that a commercial area will be developed in proximity of the pulp and paper plant, offering additional advantages.

According to the experts, the potential of **heat pumps** is perhaps not high enough for large projects on a municipal level, but there could still be interesting options for individual buildings or small projects. One expert depicts that natural conditions are favourable in the region, as they are in many places. There are many buildings and planned projects (especially single family houses) where heat pumps could be used as heating system. Several experts observe an increase in the installation of heat pumps in the private, public and commercial sectors. The cooling system of the newly built town hall is also supplied by a ground water heat pump. When public building projects are planned, heat pumps are considered as a potential option and are assessed on a technological and economic level. As one interviewee says, heat pumps could also be a possibility for new residential developments. The challenge for the residential sector is that "clients who are looking to heat their building with renewable energy sources do not appreciate the fact that the electricity used might not come to 100 % from renewable resources". According to one expert, large scale heat pumps could utilise waste water e. g. from the pulp and paper industry. Another expert contradicts this idea and says that large scale projects are not economically viable. In the view of one expert, some barriers have been overcome through various measures: there are subsidies for the installation of heat pumps; electricity providers are required to offer information on the energy mix of their products; and some electricity providers also sell "renewable electricity" packages. Nevertheless, the expert points out that more actions could be undertaken in this field.

The interviewees see a potential, although limited, for **biogas** in Ansfelden: "There is material (organic waste) available that could be used as input for the biogas plants, but only in a limited amount in comparison to the potential of other renewable energy sources". The pulp and paper plant already utilises its own waste lye as a source of energy. All of the experts agree that biogas should be supported, e.g. through a subsidy for technological innovation. Biogas has already been supported with subsidies such as feed-in tariffs for biogas plants. The barriers for decentralised biogas installations mentioned by the interviewees include: it is not economically advantageous; it is a technology that can only be used in very specific situations; it is not as flexible as other application; it is difficult to get the permission to build a biogas plant; and the technology is not yet mature enough. A large biogas plant project has been considered in the past but evaluated as not economically feasible for the municipality.

There are many individual **solar thermal installations** in the municipality. One reason is the financial incentive offered by the regional government (in the past there was a funding by the region and the municipality). Nevertheless, according to the interviewed experts, there is still potential for growth and a lot of free (large) roof tops that could be used for photovoltaic or solar thermal installations. "The amount of solar thermal installations could probably at least double". The energy agency (OÖ Energiesparverband) conducts awareness raising activities on renewable energy sources including solar thermal heating. The experts agree that both individual and grid connected solar thermal installations should be further supported and encouraged, especially since the installation of new solar thermal systems is decreasing. Although one reason

for the decrease, according to the experts, is the decreasing popularity of the technology, people might still be encouraged to purchase them if the price of the installations decreased.

Potential for (district) **cooling** is mainly in the hotels, large buildings and shopping centres. One interviewee points out that “this topic is still too little known and it is a question of costs and economic viability”. The cooling of the newly built town hall is supplied by a ground water heat pump. There could be a large potential to cover cooling demand through heat pumps in other buildings throughout the municipality.

The experts agreed there is a high **potential for retrofitting** of existing buildings. In Ansfelden, there are many old buildings. The building stock was enlarged throughout the years and the buildings vary in age (most buildings were built from the 1950s up to recent years); 40 % of all buildings were built between 1960 and 1980. Most public buildings were built between 1950 and 1970. Ansfelden is a municipality that experienced a large growth of population over the years. Some public buildings such as kindergartens or schools have already been refurbished to increase energy efficiency. The municipality is working at improving the building stock one building at a time, though the municipal budget is limited. In addition, many of the buildings are still heated with fossil oil and gas boilers which are approaching the end of the service life and will need to be replaced in the near future. Drivers for renovation are very strict thermal-quality requirements for new buildings (including the requirement of how much cooling a building is allowed to need) linked to funding and information campaigns. Strict regional building standards must be followed in order to access subsidies for new buildings and refurbishments. Advice in analysing the energy efficiency of buildings and in identifying interesting measures and how they can be implemented together with subsidies can help to foster renovation. Such a service is offered by the OÖ Energiesparverband.

Photovoltaic is a big topic in Ansfelden due to comprehensive funding programmes and contracting. 7 of the 20 interviewed companies think of or already use photovoltaic systems. However, experts notice a decrease in the willingness to feed PV electricity into the grid (caused by a drop in feed-in tariffs) and an increase in the attempt to use a larger percentage of it on-site. A study from 2014 has shown that, despite that Ansfelden lies near a geothermal active area, there is no significant potential for **deep geothermal plants** in Upper Austria. All experts confirm this evaluation. **Wind** energy is seen as not relevant for Ansfelden as well. Reasons for this are that there is not enough wind and the regional policies do not currently favour wind power.

3.1.2 Drivers in Ansfelden

The following section presents an overview of the drivers that were identified in the interviews. The drivers are described in more detail in Chassein et al. (2017).

Status quo of actions in the municipality to (further) promote renewable energy

- Various subsidies are available from the regional government for private households, businesses and public bodies for different energy efficiency and renewable energy investment measures as well as for connecting to district heating.
- The municipality makes renewable energy a priority when developing projects.
- Energy and climate goals have been defined.

- There are several people responsible for energy issues within the municipality (energy in public buildings, energy planning, energy aspects of urban development, etc.).
- The thermal-quality requirements for buildings have been tightened (including the requirement of how much cooling a building is allowed to need). New public, residential and commercial buildings and renovations are adjusted to these new requirements as they are a condition to accessing subsidies.
- There are subsidies for the installation of renewable heating systems.
- Electricity providers are required to offer information on the energy mix of their products. Some also sell "renewable electricity packages".
- The energy agency (OÖ Energiesparverband) conducts awareness raising activities about renewable energy sources.
- Companies in Ansfelden have a high motivation to invest in green technologies.

Planned measures to (further) promote renewable energy

- The industrial excess heat from the paper industry could potentially get fed into the district heating network.

Recommendation for policy measures to (further) promote renewable energy

- Renewable energy services could be considered in a project's planning phase. If they prove to be a valid option (technologically and economically), they should be encouraged.
- Help in analysing the energy efficiency of public buildings and in identifying interesting measures and how they can be implemented to promote energy savings (such as the service offered by the OÖ Energiesparverband) should be continued.
- Strategic long-term planning and forward thinking helps to reach the targets.
- Biogas should be supported somewhat more. Large biogas plants could be supported, for example, through a subsidy for technological innovation.
- The use of biomass should continue to be encouraged through subsidies, improvements of laws and regulations, awareness raising activities and information campaign measures.
- Many of the older buildings could benefit from refurbishment measures, especially thermal renovation.

3.1.3 Stakeholder analysis Ansfelden

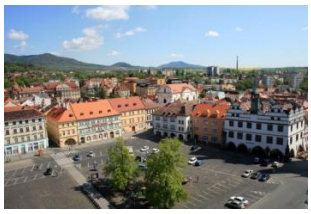
Tab. 8: Detailed description of stakeholders in Ansfelden

Stakeholder	Description
National and regional authorities	The main subsidy programmes are funded and implemented by the different departments of the regional and national governments. These authorities can offer subsidies to encourage the development of targeted technologies. The regional government is in charge of developing and implementing the energy strategy and action plan at the local level and of defining regional building regulations.

Local authorities	The municipality (mayor of Ansfelden, city council and their team) plays an important role by deciding how to renovate and heat all public buildings. The municipality is also a main decision-maker at the local level regarding the future development of the district heating network. The municipality is working with a local energy distribution company on various projects related to energy efficiency, renewable heating and cooling. It is very interested in increasing the quantity of renewable energy produced and used in Ansfelden. Municipal leaders strive to better understand the local needs and potentials.
Businesses	The most significant player is the large pulp and paper industry in Ansfelden. This company could offer a large amount of industrial excess heat and benefit from feeding it into the district heating grid. The industrial excess heat represents a very large heat resource that could be used in the district heating network. However, organisational constraints (see below) represent a large challenge. Apart from the pulp and paper industry, there are small businesses and large shopping centres in Ansfelden. These companies, at least those who own the building they are located in, decide whether they use renewable heating/cooling or not. Internal specifications regarding the maximum debt level of a company could, in certain cased, be a barrier to conduct renewable energy projects.
Households	Households in single family houses have decision-making power on which energy systems they install in their houses and whether they refurbish them. They are motivated by issues like reducing their energy costs, user convenience (e.g. less work and lower space requirements for their heating installation) or contributing to environmental protection.
Energy Suppliers	In Ansfelden, there is the district heat supplier and the district heat and gas supplier. The company that sells and distributes gas in the region of Ansfelden and the district heating company are in competition for clients. Both companies promote their services and products in order to increase their market share. However, neither of the two networks is available throughout the entire municipality. Forest owners supply biomass (wood chips that are used in for the biomass district heating plant). They can motivate the city government to promote the use of local resources and the creation of local jobs. They also have an interest in having a large stable client for their biomass products, such as biomass district heating.
Finance corporations and insurance companies	Financial institutes have a very limited role in Ansfelden regarding energy supply.

Local professionals (planners / designers / installers / craftsmen / chimney sweeps)	Heating and cooling installers are a group of high importance for the market penetration of RES-H/C. Producers of specific technologies (for example: to couple the pulp and paper industry to the district heating system) will be needed and could play an important role in the success of the project. In Austria, for example, installers are trained as apprentices in a so-called dual training system that consists of both a practical training in a company (an apprenticeship) and attending a vocational school. New degree courses have been developed in the recent past and the OÖ Energiesparverband, with its "Energy Academy", runs various courses for energy advisers, professionals and representatives of municipalities in response to policy changes and technology innovations. If installers of renewable energy systems are well trained and offer good services, they can increase the trust in these technologies Local building developers (planners, contractors and architects) are important because they decide what energy sources and technologies are used in their project. These stakeholders' motivation can go two ways: They are not the ones paying the buildings' operational costs and, therefore, are not interested in energy efficiency. However, they are able and willing to design energy efficient buildings if it helps them to win tenders where energy efficiency and renewable energy are made priorities. Local chimney sweeps assure the functioning of individual biomass, oil and gas-fired heating systems. They have direct contact with their clients and would not benefit from their clients connecting to district heating.
Energy agencies and energy advisors	The energy advice service of the OÖ Energiesparverband supports private households, public bodies and companies in Upper Austria in energy and building related investment decisions. The OÖ Energiesparverband offers advice services, manages promotional and awareness raising activities and manages energy-related regional funding programmes. The OÖ Energiesparverband manages a team of specialised energy consultants for a range of target groups and sectors. The target groups cover all energy users and many energy producers in the region. The energy advice service is a key element in the regional energy policy. In substance, they provide product-independent and situation-specific information on technical, financial and practical issues.
Action groups (citizens, NGOs)	-no information-
Media	-no information-
Research and development institutes	-no information-

3.2 Czech Republic: Litoměřice



The city of Litoměřice, on the confluence of the Elbe and Ohře, is situated approximately 60 km northwest of Prague at an elevation of 136 m above sea level. The city, with its 24 101 inhabitants, is characterised by historical buildings and a service and commerce economy. The city is part of several projects and initiatives to promote the sustainable (low-carbon) energy approach (e.g. Energy Cities, Covenant of Mayors, and municipal Association of Local Energy Managers).

The district heating supplier is private but there are plans of the city to buy the district heating company. There are two energy suppliers for coal and gas. Another big player is the "energy heating company", responsible for the installation of heat pumps and individual solutions. The main heating plant, that supplies the district heating grid of Litoměřice, is a coal incinerated plant (see fact sheets status-quo of energy demand, Büchele et al. 2016b). District heating is available in most areas, except in the city centre due to historical reasons. The biggest project regarding the energy system is the geothermal plant which started being developed 10 years ago. One aim of the city is to increase its sustainable reputation and to make living in Litoměřice more attractive because of stable and low energy prices.

In the following, barriers, drivers and stakeholders in Litoměřice have been identified by conducting a household survey with 99 participants and expert interviews with:

- Litoměřice Municipality (Head of the Environmental Department)
- Helia Pro (energy supplier)

Additionally, inputs from pre-interviews with local partners, discussions at Policy Group Meetings, the Cross-Municipality Workshop and project meetings were taken into account.

3.2.1 Relevant technologies and barriers in Litoměřice

A general barrier is that there is little support for renewable energy – financial and operational – for Litoměřice from the national level. Besides this, there are no targets set for development of renewable energy in Litoměřice (see Holländer et al. 2016). Despite that several projects related to renewable energy are conducted.

The most important renewable and sustainable energy technologies in Litoměřice are:

- the planned geothermal plant
- extension of the existing district heating grid
- solar thermal heating
- individual (ground water) heat pumps

The biggest potential for renewable heat in Litoměřice comes from the planned **geothermal** plant which is a pilot project in the Czech Republic but not yet implemented. The target is that up to

70 % of the energy demand for district heating might come from the geothermal energy generation. According to the interviewed experts the most crucial issue why the geothermal project is currently stagnating, are significant investment requirements (about 50 Mio. EUR). Currently a consortium, consisting of nine academic partners and the municipality, is looking for money to build, drill geothermal wells and subsequently heating the plant. The geothermal energy project was already supported, from external sources from the Ministry of Education, Youth and Sport, which allowed establishing new research infrastructure for geothermal energy. In addition, in 2006 the Ministry of Trade subsidised drilling the first geothermal exploratory well in 2,1 km depth that provided important data for the scientific project. Another barrier is the pressure from competition from current heat suppliers, which are owners of the grid and they offer cheap heat prices (due to coal combustion) in comparison to other Czech district heat plants. This is related to access to the distribution network. Additionally, restrictions of utilisation due to ground water protection, balneology, seismic activity, etc. have to be taken into account as indicated by the interviewees[3]. There are no concerns about risks known by the interviewees what is confirmed by the survey. In order to raise acceptance for geothermal energy the project was accompanied from the beginning by an awareness and information campaign: A textbook of an exemplary geothermal plant (Fig. 5) was created during a common project of Litoměřice and Dresden in 2014. This Czech/German brochure was distributed during various events both in Dresden and Litoměřice.

Fig. 5: Information Campaign Geothermal Energy in Litoměřice and Dresden in 2014 "ENERGIE Z HLUBIN"

In addition a good communication during the whole geothermal project realisation and preparation was implemented: the project has been discussed with the public, and seismic monitoring has been conducted by the Czech Academy of Science since 2014. As the household survey shows the geothermal project is well accepted by citizens but further information is needed. The municipality has committed itself to provide stable and financially sustainable prices and according to the experts this is the main reason why people support the project. This hypothesis cannot be confirmed by the survey: 1) The selection of this reason by the respondents is on rank eight. 2) Just one third see price instability as a serious problem in Litoměřice but many of them (15 from 31 people) say that the geothermal energy project will guarantee price stability. There are no concerns about risks known by the interviewees what is confirmed by the survey (Figure 6).

[3] Studies were provided during construction and land use permitting procedures and a set of measures was provided by the Czech mining Authority and by the Ministry of Environment. From the technical point of view water protection is not an issue as the wells will be continually cased in 4 Km. Seismic activity has been monitored since 2014 and induced seismicity will be one of the main research topics and carefully managed during drilling and post-drilling and operation phase. Calculations and modelling has to be proved by real data from measurement.

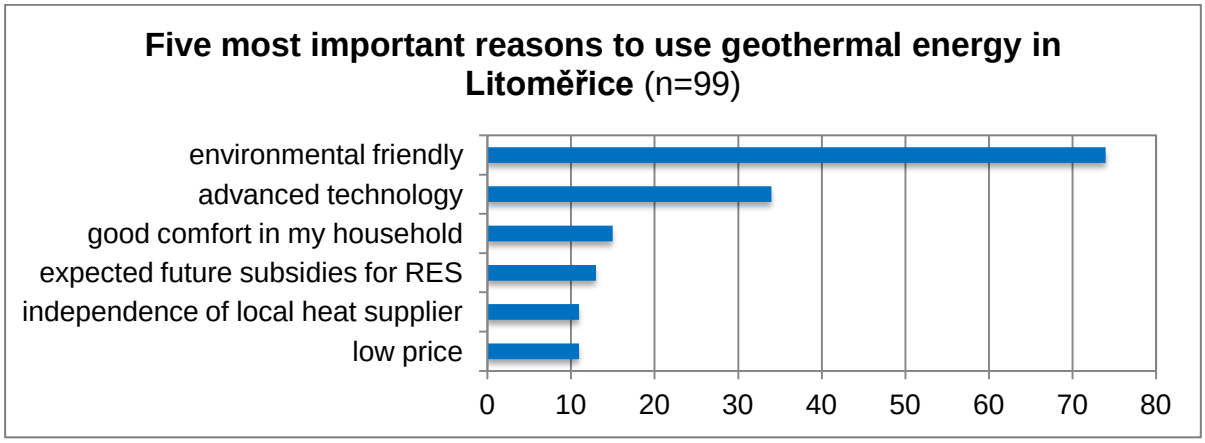


Fig. 6: Results from the survey in Litoměřice: Geothermal Energy

Another investment option with a high renewable energy potential is the extension of the existing coal fired **district heating** grid in Litoměřice. Currently, 75 % of the heated buildings use district heating. Studies regarding the extension of district heating in Litoměřice show that the city centre doesn't yet use district heating because of historical reasons. According to the experts, however, it would be possible to extend the pipes to the city centre as there are no prohibiting land use regulations or similar. In addition respondents of the survey expressed their wish to extend district heating infrastructure to the city centre. It would also be possible to connect more buildings in other areas to the existing grid. District heating from coal combustion is currently much cheaper (about 150 CZK = 5,50 EUR per MWh) than fossil fuel alternatives so this would be a big incentive for the households to connect to the existing district heating grid, where possible. Significant influences on the choice of energy supply can be realised through raising awareness of district heating systems and its comparison against individual heating. As the survey shows, however, many people already use district heating and they confirm that it works good. Overall the acceptance of this heating technology is high. One financial barrier is that there is no guaranteed purchase price of electricity, because a geothermal energy plant can also produce renewable electricity (co-generation) mostly during the summer season and feed in tariffs can make the geothermal project more economical feasible. Another barrier is the district heating pricing system which inhibits energy savings. In Litoměřice, the heat price consists of a fixed part and a flexible part - as is the case in most of the other case studies. When less energy is consumed the share of the fixed price per unit will increase. According to the interviewees, another barrier is losses within the district heating grid. In order to make district heating in Litoměřice "green" it is important to push the geothermal project which should be used to feed into the district heating grid.

The use of **combined heat and power** is rated as "not economical" by the experts.

Solar thermal heating is another significant renewable energy component in the town. It is supposed to cover 10 % of the heat demand in households, according to the interviewees. Barriers to this technology in Litoměřice are high investment costs of individual installations and the fact that large scale plants cannot compete with low prices of heat from the district heating source. Besides that, the interviewees indicated that the good quality of agricultural land prevents

its use for the installation of large-scale systems, because in spatial planning, it is preferred to use this land for agriculture purposes. An above-average occurrence of fogs and overcast sky in Litoměřice, compared to the Czech Republic average, is another barrier, and contributes to the reason why the interviewed experts tend not to recommend centralised solar heating systems. However, since 2008 the city of Litoměřice has been providing incentives for individual solar thermal collectors on the rooftops of buildings, or on house skins, with good results.

Heat pumps can also be used as an efficient heat supply in Litoměřice, according to the interviewees. There is a significant potential for individual heat pumps from the water system as the ground water has a temperature of up to 12 °C and there are mild winters. This is especially interesting in the municipality because a heat pump company responsible for the installation of heat pumps and individual solutions is located in Litoměřice. Individual heat pumps are already used for some public buildings and some households although it is not combined with district heating. For an efficient use of heat pumps a low-temperature distribution system is necessary. This is a barrier for two reasons: 1) it became clear in the interviews that there is a knowledge gap regarding conditions for the efficient working of heat pumps and 2) the interviewees believed it makes no sense to invest in heat pumps without investing in the heat distribution system. This means high investment demands. Drivers could be subsidies e.g. boiler subsidies and information campaigns to raise awareness.

In the case of **biogas** there is minimum potential, solely within the water treatment plant, and there is no potential for **biomass** because of the lack of agricultural biomass in the dry region according to the experts. Besides that, one interviewee stated that some households do not use boilers correctly when incinerating biomass in boilers. The depletion of organic carbon in agricultural and forest soils is another problem, and there is an unsuitably devised subsidy policy at the national level, regarding the co-incineration of biomass within electricity production; so the biomass is mostly purchased by the big energy companies, which benefit from the subsidy. Thus the potential of the biomass for plants is reduced.

With regard to potentials in Litoměřice for other renewable technologies photovoltaic has been prominently promoted by an exemplary and award winning funding campaign (see also Chassein et al. 2017). Due to this many solar panels are installed on the rooftops which can be seen from afar, as one interviewee pointed out. Only little potential is seen for hydropower, wind energy and excess heat use in Litoměřice.

Cooling is not yet a topic of interest; it just exists in some buildings but the interviewees do not see there being a big demand for it. Instead of introducing cooling measures, one interviewee suggested an awareness campaign for renovation so that the buildings will not need much air conditioning.

Experts see a high **renovation potential** of buildings in Litoměřice; rehabilitation and restoration is not comprehensive, and the maintenance of the majority of properties has been neglected. This was confirmed by the survey participants: 70 % of them agreed that investment in energy refurbishment of buildings in the residential sector in Litoměřice is very important. Barriers to perform comprehensive renovations could be unwillingness, and lack of information, according to interviewees. In addition, low investment measures (e.g. change of doors or windows) are preferred. There is no incentive to do more than the required EU energy standard. Most houses

are owned by private house owners which should be a chance for investment promotion because there is just little investor-user dilemma (see above). There is quite a new programme for household buildings but people are not really aware of it. Another programme, the green investment scheme, started 5 years ago and although households might know about, it does not seem to be sufficiently flexible. What is missing is a fund for social housing.

Currently the temperature level used in the district heating grid is about 110-130 °C and high energy losses make it worth thinking about the reduction of temperature levels. Investment priority, however, is given to the geothermal plant.

3.2.2 Drivers in Litoměřice

The following section presents an overview of the drivers that were identified in the interviews. The drivers are described in more detail in Chassein et al. 2017.

Status quo of actions in the municipality to (further) promote renewable energy

- Energy independency is a big topic for the municipality.
- The city is very active regarding sustainable energy supply and use.
- The award winning funding campaign for photovoltaic cells could be a best practice example (The town's motto: 'Who gives quickly gives twice').
- A communication process within the geothermal project since the start of the project.
- An awareness raising and information campaign (ENGAGE) with posters of important people standing up for the environment was implemented in spring 2016. ENGAGE is a participative communications campaign implemented by European local authorities. They use this initiative as a communication tool to share the Covenant of Mayors objectives locally.[4]
- Since 2008 the city of Litoměřice has been providing incentives for individual solar thermal collectors on the rooftops of buildings, or on building envelope.
- Other exemplary campaigns include the installation of solar systems into common municipal property, e.g. solar bench[5].
- There is a round table which regularly discusses energy topics (Project READY21) and a forum for enterprises.
- There is close cooperation with neighbouring municipalities. Together with three other Czech cities, Litoměřice set up a municipal Association of Local Energy Managers in November 2014.
- District heating is well accepted in Litoměřice and should be extended to the city centre.

Planned measures to (further) promote renewable energy

- Financing a geothermal plant

[4] http://www.energy-cities.eu/ENGAGE
[5] http://www.energy-cities.eu/Sit-and-connect-First-solar-bench

Recommendation for policy measures to (further) promote renewable energy

- Setting an indicative target for renewable energy in a binding document (currently lacking).
- Reduce losses of the heat distribution system.

3.2.3 Stakeholder analysis Litoměřice

Tab. 9: Detailed description of stakeholders in Litoměřice

Stakeholder	Description
National and regional authorities	Little support for renewable energy.
Local authorities	Litoměřice's public administration is progressive in energy issues at the local level and is responsible for setting up the energy goals and the agenda for the municipality. The public administration further monitors and evaluates the applied measures and prepares good practice examples for other municipalities. In Litoměřice there is the Municipal Energy Savings Fund (ESF) which should encourage manager of public buildings to invest, for example, in insulation, measuring the energy saved in the subsequent year(s). 30 % of the financial saving goes back to the public organisation, 30 % goes to the Energy Saving Fund (ESF), 35 % goes to the municipal budget and 5 % to the commission fund (allocation approved by mayor). Sharing the benefits is a big motivation for people to invest in energy savings and therefore the programme is well appreciated. About 15-20 % of public buildings in Litoměřice are already insulated and about 20-25 % use renewable energies.
Businesses	The city of Litoměřice is characterised by a service and commerce economy. For office buildings there is a good and well accepted programme to implement energy efficiency measures. There is a company in Litoměřice which is responsible for the installation of heat pumps and individual solutions. Their focus is on renewable energy sources and energy savings and they work closely with the municipality. The role of industrial actors is described by one interviewed expert as "bearer of innovations" and their motivation to invest in renewable energies might be a corporate social responsibility (CSR). As they offer new technologies they have influence on the commercial application of new technologies both for central supply as well as individual sources. There are no known energy efficiency networks or demand side management (DSM) systems but there could be potential for this. There is a forum / round table for enterprises, regularly discussing energy topics that can be used for the project.

Households	The motivation of households in Litoměřice to invest in renewable energies relates to financial issues on the one hand and autarchy issues of partial independence on external suppliers on the other hand. There is a funding programme for energy efficient and renewable energy measures in family houses and multiple-dwelling houses. District heating is currently much cheaper than alternatives so this is a big incentive for households. Consumers are expected to realise more energy efficiency measures and change their heat supply from individual gas boilers to district heating. Consumers are also motivated to use renewable energy (heat pumps, solar systems) by providing good examples from public administration and also by supporting schemes such as the municipal fund for solar systems. A big potential for energy savings lies in changing behaviour through information campaigns. Regarding buildings, rehabilitation and restoration is not comprehensive and the maintenance of the majority of properties has been neglected. In Litoměřice there is a funding programme (IROP, see Holländer et al. 2016) addressed to owners of residential buildings and associations of owners of housing units in order to enhance public services and living conditions for the inhabitants of regions.
Energy Suppliers	There are two private providers of district heating operating within the City of Litoměřice: Energie Holding and Helia Pro. Both of them are involved in the process of improving the energy profile of the city and they cooperate in the geothermal project establishment. Despite that sustainability is not a priority of the private energy suppliers. There is a conflict between the private owner of the district heating plant (with the aim to maximise profit and no priority on investment into grid to lower the losses) and the City (with the priority to build the geothermal energy plant to stabilize the heat price and to provide citizens' own renewable energy source).
Finance corporations and insurance companies	-no information-
Local professionals (planners / designers / installers / craftsmen / chimney sweeps)	In Litoměřice there is a training deficit for installers and craftsmen and all people concerned with a building according to the interviewees. They need training into new standards and this is a nation-wide problem. Manufacturers of heat pumps and solar systems play a big role in Litoměřice. Their motivation is corporate social responsibility (CSR), efforts to sell their own equipment, as well as identification with the long-term vision of the town. They can provide financial incentives, examples of suitable installations, and raise awareness.

Energy agencies and energy advisors	-no information-
Action groups (citizens, NGOs)	Non-governmental organisations in Litoměřice prepare awareness-raising campaigns and education programmes, and present examples of suitable installations and communicate with pupils. Their motivation is the identification with a given idea.
Media	-no information-
Research and development institutes	-no information-

3.3 Denmark: Helsingør

The municipality of Helsingør is located at the sea and has a total population of 61 613 (2013) inhabitants living in the main city and smaller surrounding villages. The city is a transportation hub with frequent ferry connections to Helsingborg, in Sweden. It is also an important tourist destination with many holiday homes and there were several major industries (e.g. a shipyard) which are now closed, leaving only light industry. Through several activities (e.g. improvements in the public, trade, industry and households sectors) greenhouse gas emissions have already been reduced but nevertheless, the municipality has ambitious long-term goals. Helsingør is part of the Covenant of Mayors. It has subscribed to the climate strategy of the Capital Region of Denmark and has a climate agreement with the Danish Society for Nature Conservation.

The high share of biomass of renewable energy for heating in Denmark is represented in Helsingør as well with heat pumps as another important technology. Urbanised areas of Helsingør are covered by district heating, whereas in the rural areas the heat demand is mostly met by individual oil-fired furnaces (see fact sheets status-quo of energy demand, Büchele et al. 2016b). District heating constitutes currently 35 % of heat supply options in Helsingør thus showing a possible potential to increase. The main energy plants supplying Helsingør are: a decentralised combined heat and power plant and heat-only boilers situated in the municipality and partly a waste incineration plant located outside Helsingør. District heating is supplied from municipality-owned companies Forsyning Helsingør (88 % total sales) and Hornbæk Fjernvarme (12 % of sales).

In the following, barriers, drivers and stakeholders in Helsingør have been identified by conducting a household survey with 35 respondents (please be aware that this survey is not representative) and expert interviews with:

- Helsingør Municipality (Head of Climate Change Secretariat, Head of Section – Nature and Environment, Energy Planner)
- Helsingør DH Utility (Head of Planning, Network Planner)

Additionally, inputs from pre-interviews with local partners, discussions at Policy Group Meetings, the Cross-Municipality Workshop and project meetings were taken into account.

3.3.1 Relevant technologies and barriers in Helsingør

The most important renewable and sustainable energy technologies in Helsingør are:

- replace gas-fired combined heat and power with a biomass-fired combined heat and power feeding into district heating grid
- large heat pumps and individual heat pumps
- excess heat from waste water treatment plant and waste incineration plant

A public **district heating** network covers the major part of the urbanised areas and supplies households, public buildings, private businesses and others from various production plants, including waste incineration, gas-fired combined heat and power, and biomass boilers. The main competition is between natural gas and district heating. According to the interviewees district heating has high supply security in Helsingør and the participants of the survey rated it as a reliable technology. The owner structure of the district heating system (see above: district heating company is partly owned by municipality but, however, the DH system is 100 % owned by an independent energy supplier) together with the non-profit regulation of district heating companies partly hinders investments according to the climate action plan. Other barriers are high initial investment costs that require long term planning which could be affected by changes in the regulatory regimes (for example tax regime), as one expert points out. In the course of optimising the district heating network, the supply temperature has recently been reduced in some parts of the network to less than 65 °C. The utility company continuously conducts additional feasibility studies to identify energy saving potential within its area. The municipality will also focus on measures intending to expand the district heating network to both existing houses and new buildings. One barrier is that some companies don't want to be dependent on single systems, according to the interviewees. Another interviewee does not see much potential to expand the grid: The district heating coverage in Helsingør is very comprehensive in all urban areas; only some consumers are using gas for heating due to existing binding regulatory structure (made in favour of natural gas usage), which are currently disputed. The participants of the survey mainly used central heating with oil (21 out of 35) but in general supported district heating and plans to extend the district heating grid to rural areas. Many of the municipal buildings have already switched from gas and oil boilers to district heating. The tax regime is very unfavourable to solutions to make district heat "green" and prevent useful energy attempts such as using surplus energy for district heat and excess heat from shopping centres, although it is relatively easy to combine different supply options. This is supported by another expert who sees only little scope for a higher rate of renewable energy: "the only way to reach 100 % renewable energy would be to construct large-scale heat storages, which would be costly, compared to the benefits". Single buildings are not connected because of technical calculations and some don't want to be dependent on single systems. Interviewed experts see a conflict with renovation measures: "district heating coverage is expected to increase (69 %) and then decrease because of energy efficiency and lower energy demand".

Gas fired **cogeneration** is one source for district heating in Helsingør and "electrification" is a big topic. Even if combined heat and power is the most efficient technology electricity prices currently are too high in relation to gas prices so district heating is more fed in by gas boiler. It is planned by the energy supplier to construct a new biomass combined heat and power plant to replace an existing gas-fired combined heat and power plant (gas/oil will only be used as emergency backup or at peak load). The new combined heat and power plant to come into operation from 2017-18 will have to import biomass (probably wood pellets) from abroad, because the local biomass resources are very limited comprising agricultural waste (straw) and garden waste. Small scale combined heat and power plants have been subsidised but this subsidy is going to be removed.

From 2017 the gas-fired combined heat and power will be replaced by a **biomass**-fired combined heat and power plant, resulting in the heat production becoming almost entirely fossil-free. Although there is a loose agreement to make district heating renewable, according to the interviewed experts there are doubts about whether biomass is really CO_2 neutral, because the

biomass is an imported product. The new plant to come into operation from 2017-2018 will have to import biomass (probably wood pellets) from abroad, because the local biomass resources are very limited comprising agricultural waste (straw) and garden waste. The straw may be better used in small local boilers and in individual households and farms in the rural areas. Recently, producers and traders of wood pellets agreed on the requirements for certifying their fuels sustainable. Such certification has been a precondition for the utilities to import and use biomass fuels. The fact is that biomass is not taxed as is every other energy resource and the world market can supply sufficient biomass resources at reasonable prices. This was a topic of political debate, but the new government is a minority government and very influenced by the right wing (some of them are even reluctant to believe in climate change). They have stopped subsidies and taxation reform. These uncertainties about the national government imposing taxes and charges on biomass fuels are making decision-making difficult. At present, large biomass boilers and combined heat and power are very competitive. Indeed some households and farms in rural areas are using boilers for straw or wood pellets, but they are few in numbers. It could be worthwhile to consider promoting individual biomass boilers in rural areas as oil-fired boilers are being phased out. Drivers would be national regulations towards oil-based heating and the un-taxed biomass fuels. Regulations on ambient air pollution would practically disallow biomass boilers in urbanised areas. Moreover space for storage of the biomass fuel would most often be a deciding barrier, besides the significant manual work needed to feed and clear the boilers.

Heat pumps would be the best way to use the surplus wind energy but the tax regime is a big barrier (use of electricity is heavily taxed). 23 out of 35 participants from the survey agreed that there is an urgent need for taxation reform in Denmark favouring renewable energy. From a societal and financial viewpoint, the experts claim that large heat pumps would be a very good way of feeding energy into district heating systems. They see potential for heat pumps, both individual installations and large-scale for district heating. Heat pumps are usually fed by ground water or sea water or geothermal energy (very risky). There is currently no large heat pump installed in Helsingør; there are just some decentralised ones for the secondary high school fed by ground water. Using the heat from the cooling compressors is becoming popular e.g. from those at supermarkets. A model found in other cities is for the utility company to buy and install heat pumps in households (contracting). Legislation prohibits the removal of installed service equipment from buildings, however, even if it is the property of the utility company. This is a serious barrier for the utilities in making business models. Individual air-water-heat pumps are applicable everywhere (if they are not too noisy) and lead to a reduction of about 50 % in energy price. Informed users accept that heat pumps are very good. The strategy is to combine advice with attempts to convince the population. It is very feasible to switch from gas boilers to heat pumps. Main potential for individual installations is in rural areas (typically air heat pumps or ground water heat pumps); several installations are already in place. This would become increasingly relevant when the oil furnaces are banned in rural areas (national policy). Barriers, according to the interviewees, could be relative high investment costs (other renewable energies have so far been more competitive). In addition there has been some uncertainty about long term energy efficiency and mechanical reliability in the past.

The municipality will support sustainable heating facilities such as **excess heat** from waste water treatment plants. Currently excess heat from the waste incineration plant is used for district heating. The waste from households is decreasing, however, as recycling increases and consumption falls due to the economic crisis; this is why the waste incineration plant is oversized,

waste is currently imported and the plant is not economically feasible. Heat which is used to cool the supermarket or an IT storage company in Helsingør could have excess heat potential. However the tax regime is a barrier for using excess heat from shopping centres.

Solar thermal plants are not very common. Just few individual households use it, and these are typically outside the district heating grid. There is certainly a technical potential for solar water heating, however the installations will only be financial feasible outside the district heating areas, according to several interviewees. Another expert stated that the technology has matured and its long-term performance proved at a reasonable price. Combinations of solar water heating and gas heating installations are seen in gas supplied areas, but not in any significant number. In some few areas there can be town planning regulations banning such installations. In other areas the building orientation can be unfavourable or the roof construction not strong enough. Some district heating utilities are constructing large solar water heating plants able to feed into the district heating systems. Barriers for large plants could be the necessity of costly large scale heat accumulators, lack of space for the plant or the summer heat production is already covered by other sources.

According to the interviewees there is (limited) potential for **biogas** in Helsingør. Sludge from wastewater treatment plants are already fermented in tanks at the plants and the produced energy utilised to bring down the energy consumption. The increasing future separation of the fractions of the household and commercial waste will produce a good amount of waste for biogas production in a plant located either inside the municipality or in a neighbouring one as one interviewee stated. Another expert counters that it is more likely that the amount of waste is stagnating. The amount of agricultural waste is limited and mainly utilised as natural fertiliser in the farmland. Helsingør constructed some years ago a biogas plant, but it has been closed due to operational difficulties; the chosen plant didn't work in the actual scale and the sorting of fractions wasn't working as expected. A barrier is that the investment costs are too high compared to the outcome. The expert state that in principal, waste usage should be promoted examining the possibilities but at the moment Helsingør Municipality has no active policy regarding this area

In the interviews it was said that **geothermal energy** is no longer feasible with the new government as it is too risky; until recently, national government was planning to subsidise and offer kind of 'insurance' scheme, but this has now been abandoned. General analyses indicate a potential for deep geothermal energy, but the cost of exploration has so far been prohibitive for any further action this is why comprehensive studies still have to be conducted.

Regarding technologies only photovoltaic plays a role but investment costs, fed in tariffs and taxation are barriers. There is limited potential for local wind energy due to planning restrictions and no potential for small hydropower, according to the interviewed experts.

Currently 1 % of cooling is supplied by district **cooling** but the potential is estimated to be up to 43 %. The utility company currently has no plans offering district cooling for two reasons: (1) the demand is limited, and (2) the current national tax regime does not favour the use of large heat pumps. In general district cooling is just feasible for consumers already participating in the network. One expert stated that it is now becoming popular to use the heat from cooling compressors e.g. from the supermarkets.

Helsingør has previously carried out **renovation** actions to reduce emissions in the public sector and renovated seven such buildings. In 2014 it was decided that another 70 buildings should be refurbished. This will include, among other things, new insulation and a replacement of old windows. Although many of the public buildings have been connected to the municipality's district heating network, there is still a number of buildings that use gas and oil boilers. It is therefore intended to connect all of the public buildings to the district heating network. As experts say, there is no conflict between insulation and renewable energy but it has to be in balance. The municipality will primarily support innovations generating energy efficiency gains (e.g., insulation of houses), especially in areas that are outside the district heating supply area. If there is investment in low/zero energy buildings it could be very expensive for the utility company to extend their supply (very small turnover). For this, an obligation from the municipality to connect to the collective heating system is needed, even if it may be cheaper to use alternatives. Renovation measures are being promoted by information campaigns. From the survey we know that investment in energy refurbishment of buildings in the residential sector in Helsingør is seen as very important (21 out of 35 respondents). Like a number of other Danish municipalities, Helsingør is considering getting aerial thermal imaging of all buildings; citizens and businesses can already borrow thermal cameras at the Helsingør Energy Centre that can be used to analyse the buildings' properties and their insulation.

3.3.2 Drivers in Helsingør

The following section presents an overview of the drivers that were identified in the interviews. The drivers are described in more detail in Chassein et al. 2017.

Status quo of actions in the municipality to (further) promote renewable energy

- Several measures have been undertaken or are being promoted to increase the sustainability of the municipality (Holländer et al. 2016).
- Recently, producers and traders of wood pellets agreed on the requirements for certifying their fuels sustainable. Such certification has been a precondition for the utilities to import and use biomass fuels.
- Energy labelling is obligatory when selling a house.
- There has been some phasing out regulations for underground tanks and there is an obligation to remove old boilers depending on which material they are made of. This measure is accepted by the population.
- Biomass is not taxed.
- A concept of climate ambassadors is organized in Helsingør: one employee has been assigned the special role of acting as climate ambassador in each department or sector (financial, health care, etc.) within the municipality. This creates a knowledge network throughout all the municipal departments and the municipality.
- Energy efficiency investments and energy saving measures are not subject to budget limits in Danish municipalities. The Climate Secretary has an own budget to realize initiatives.
- From national government the district heating supplier has every year an energy saving obligation (typically around 2 %), which it achieves either within its own system or it buys

the savings from the consumers who shall document their energy efficiency projects to receive the payment.

- Energy Service Companies (ESCOs) have been supported and contracted by the municipality to increase renewable energy supply and renovation in all municipal buildings. The fee is calculated from the baseline to the saving.
- Involving the local stakeholders and inhabitants turned out to be an important success factor in current projects.

Planned measures to (further) promote renewable energy

- The energy supplier has decided to construct a new biomass combined heat and power plant to replace (in 2017-2018) an existing gas-fired combined heat and power plant.
- Tax shift in favour of heat pumps is promoted by the Danish Energy Association
- Until recently, national government was planning to subsidise and offer kind of 'insurance' scheme for geothermal heat, but this has now been abandoned.
- For large-scale power to heat plants, the past and current taxation regime for the electricity has been prohibitive. This may change, however, within the next few years.
- The existing binding regulatory structure made in favour of natural gas usage is currently disputed.
- Expand the use of garden waste, biomass and landfill gas in the production of electricity and district heating.
- Establish a new biomass combined heat and power to replace the natural gas fired unit in 2018 (decision made in November 2015).
- Use of waste heat from wastewater treatment plants.
- Exploiting possibilities to use geothermal heat as an alternative heat source.
- Exploiting possibilities to implement large scale solar thermal facilities into the district heating supply.
- Investigate possibilities to establish additional biomass-fired boilers on the Skibstrup Waste Center and in Kvistgård.

Recommendation for policy measures to (further) promote renewable energy

- The local plumbing companies could be urged or even subsidised to examine the scope for installations with focus on non-district heating areas.
- Promotion of individual biomass boilers or heat pumps in rural areas as oil-fired boilers is being phased out.
- For individual heat pumps new business models must be introduced, where the financing and responsibility for maintenance and performance rest with the energy supplier or installation provider.

3.3.3 Stakeholder analysis Helsingør

Tab. 10: Detailed description of stakeholders in Helsingør

Stakeholder	Description
National and regional authorities	The ministry for Climate and Energy represents the authority with overall responsibility for energy issues. It determines the political agenda and it is further responsible for negotiations and debates in the Danish parliament as well as for proposals of legislation. The municipalities are primarily responsible for ensuring the implementation of the overall targets defined by the central administration. To ensure that the regional efforts are in accordance with the national long-term goals, the local governments in Denmark work jointly with the Ministry of Climate, Energy and Building. As a result of the agreement in 2012 a pool of 19 million DKK has been established to provide liquidity for local experiments with strategic energy planning (Ministry of Climate, Energy and Building, 2013). Nonetheless, the municipalities are also given sufficient scope to set their own agenda and engage in various initiatives. Some political signs show new directions that can mitigate climate change which is seen as critical in the energy sector and the industry associations. Substantial investments are needed on a stable policy platform to provide a stable future. According to the interviewees, the industry is currently very vulnerable.
Local authorities	In Denmark there are important regulative incentives for the municipalities, producers and private consumers to foster improvements in energy efficiency and to motivate users to change to renewable energies. For example, the agreements require towns such as Helsingør to set up a measurement system that allows for an effective monitoring of heat and hot water consumption in Danish households and public buildings (see Holländer et al. 2016). Helsingør's public administration is responsible for setting the political agenda for energy for the municipality. It is responsible for ensuring that the municipality meets the predetermined national goals and is able to set additional, regional specific objectives. The public administration further monitors and evaluates the applied measures and approves district heating projects if socio-economically feasible. The climate secretariat of the municipality is the implementing body of the energy-related actions. It has an important role as it plans, coordinates and carries out the various initiatives that are related to the promotion of energy savings and the expansion of renewable energy

	sources in the heating sector. Many Danish municipalities are exempt from public budget restrictions with regard to energy efficiency investment. This is also true for Helsingør. Climate Secretary has an own budget to realize initiatives. The municipality currently works with strict requirements on energy performance as well as energy saving measures in all public buildings. Moreover, public buildings will be connected to the local district heating network. On-site cogeneration units (e.g. for the supply of hospitals) may only be used with special approval from public authorities. The authorities have to ensure that there is no possibility of connecting the respective area to the district heating. Besides that, municipal and regional buildings are obliged to regularly renew their energy labels. Moreover there is a conformance contract between municipality and Energy Service Companies (ESCOs) for public buildings (see below). According to the interviewees "One underlined challenge is the low influence the municipality has on upstream district heating, i.e. heat generation. Although, the heat distribution company is owned by the city, the district heating company has been operating independently for four years. As a result of this separation and a knowledge gap means, the municipality now has less influence on heat plans within the city, e.g. related to the district heating network. The municipality, however, needs to participate actively when the district heating company develops heat plans in order to achieve the climate goals. The municipality started a programme to enhance energy renovation. The programme that focuses on private homeowners and local craftsmen contains four key actions: 1) Provision of heat detectors, available for everyone, 2) Free online energy checks with individual recommendations, 3) Visits of energy consultants for home owners with very high saving potentials, 4) Training of 40 local craftsmen in climate and energy solutions.
Businesses	Many office buildings in Helsingør are connected to district heating. Single buildings are not connected because of technical calculations or fear of dependence on a single system, according to the interviewed experts. Expansion of access of households and businesses to the district heating network is a primary goal of the municipality. Network for companies exist in order to identify energy efficient measures.
Households	In Helsingør, many (funded) measures have already been realised (see Holländer et al. 2016) and they are well accepted by the population. These include phasing out of old boilers, obligatory labelling when selling a

	house, energy advisors providing suggestions for every area of a house. Long payback periods are seen as a problem by the interviewees because house owners only plan 2-3 years in advance. The new government has an agreement to develop a subsidy measure for this. Another municipal incentive for retrofitting measures is that citizens can borrow thermal cameras from the energy centre of a local construction company. Air photos are available on the internet so that neighbours can compare themselves. There are several information services available for private households from organisations such as the Danish Energy Agency, Knowledge Centre for Energy Saving in Buildings, Energy Service and the Helsingør Energy Centre. The municipality has organised information meetings and distributed leaflets. Additionally Denmark actively promotes energy savings in buildings by providing funds for respective campaigns. Consumers are expected to change their heat supply from individual gas- and oil-fired boilers to district heating. Alternatively, in areas where district heating is unavailable, the intention is that they use heat pumps, potentially combined with individual solar heating, or biomass-based heating. In addressing citizens and small businesses, real estate agencies might play an important role. Efforts should be focused at new property owners, according to the interviewed experts, because at the time of moving into the premises their owners are considering building refurbishment and renewing energy installations. This is the time where energy efficiency measures are best considered and financed. Therefore, the real estate agents are important stakeholders in the municipality's communication with the target group.
Energy Suppliers	There are two providers of district heating operating within the municipality of Helsingør: Forsyning Helsingør and, to a lesser degree, Hornbæk Fjernvarme. Both of them are largely involved in the process of improving and expanding Helsingør's district heating network in order to phase out gas and oil-fired boilers in buildings (households and businesses) and therefore fulfil requirements of the heat supply act. Moreover, energy companies are obliged to realise energy savings in enterprises and households by offering subsidies or consultancy, for example. Forsyning Helsingør is especially engaged in changing its heat production from fossil fuels to renewable energy. The local natural gas provider has started a law suit against Forsyning Helsingør, claiming that their planned expansion of district heating into a natural gas supplied area is not feasible from a socio-economic perspective (which has become a main rule for recent

	projects). In addition the interviewees point out that district heat providers in Denmark are non-profit organizations and therefore it is difficult to invest in DC because there is an issue with existing district heating consumers (should renovation of the grid be put on the consumer?). Moreover, the central administration demands regional providers of district heating to establish a system that allows the measurement of the return temperature of hot water supplied by their systems in order to decrease losses. The municipality is just a co-owner of the energy supplier (very uncommon in Denmark), however, they have the authority to approve / disapprove a project according to certain guidelines. Despite that the municipal energy supplier has been working independent in the last years. The district heating system is not part of the municipality administration but is 100 % owned by an independent energy supplier (subsidiary company, shareholder). The independent district heating supplier is about to be merged into the Helsingør energy supplier. Recently, producers and traders of wood pellets agreed on the requirements for certifying their fuels sustainable. Such certification has been a precondition for the utilities to import and use biomass fuels. Energy Service Companies (ESCOs) have been supported and contracted by the municipality to increase renewable energy supply and renovation in all municipal buildings. The fee is calculated from the baseline to the saving.
Finance corporations and insurance companies	-no information-
Local professionals (planners / designers / installers / craftsmen / chimney sweeps)	There is an initiative from the municipality for capacity building for local craftsmen with regard to renewable energies, energy efficiency and climate protection. Content of the education are technical, financial and labelling issues.
Energy agencies and energy advisors	In Denmark the administration of energy issues and its actions are carried out by the Danish Energy Agency, which is part of the ministry for Climate and Energy. The agency is responsible for the registration of all installations of electricity and heating generations. During the course of the energy policy agreement of 2008, a “Knowledge centre for Energy Savings in Buildings” was established. The centre opened in 2009 and its objective is to provide information, know-how and advice in the field of energy savings for buildings. It is accessible to the public. The reason for its establishment lies in the fact that the bulk of the energy

	is used in buildings and the existing building stock offers a large potential for energy savings. The Energy Service (in Danish: Energitjenesten) was established in 2005 as an independent energy consultancy service run by citizen-based organisations. The Energy Service is present through ten local / regional offices and is able to run activities throughout Denmark. The aim is to promote behaviours and decisions that save energy and change energy use to renewable energy sources - not only at home, but also at the workplace and within transport. The Energy Service is a project under the organisation of Sustainable Energy (in Danish: Vedvarende Energi). Sustainable Energy is a national Danish NGO with 2,000 members. It publishes a magazine 4 times a year, runs campaigns and projects, and is active on the Danish political scene concerning energy (Energitjenesten, 2015). The Helsingør Energy Centre was founded in 2014 by local craft businesses with financial support from the municipality, aimed at offering advice and guidance to local citizens and small businesses. School classes have also visited, gathering inspiration. The centre intends to convey general technical knowledge (e.g., about the functioning of a heat pump) and also provides training activities (see Holländer et al. 2016).
Action groups (citizens, NGOs)	The non-profit association “Gate 21” is a partnership between local authorities, private companies and research institutions, working together for a sustainable society and green business development in Helsingør. It supports the partners in the development, financing and management of projects in the areas of public-private innovation in construction, urban planning, transport, energy and resources.
Media	-no information-
Research and development institutes	-no information-

3.4 Germany: Herten

Herten is, regarding landscape and climate characteristics, very typical for Germany. The municipality of Herten is located in the Ruhr area in the West of Germany at an elevation of 75 m above sea level and has around 60 000 inhabitants. It is characterised by its history as a former coal mining city, while nowadays the tertiary sector is the most important. The characteristic buildings are the former dwellings of the miners. One special issue in the whole region around Herten is the pit water and mine gas. The land use is divided into areas of settlement, industry, mixed use, public use, recycling of former mining areas and free areas. The free areas cover the largest proportion of the land, followed by areas for settlement. Social housing and home for the elderly play a big role in Herten. The municipality's activities towards a sustainable energy use include the participation in the Covenant of Mayors, the local climate protection plan and the so called energy lab Ruhr ("Energielabor Ruhr").

In terms of loads and energy demand, Herten represents a German average and is not outstanding in any way. The local utility company in Herten is privatised, but is property of the city (see fact sheets status-quo of energy demand, Büchele et al. 2016b). The heat for the district heating network in Herten is currently provided mainly by coal fired combined heat and power plants. The heat supply via individual decentralized heating systems, such as boilers, is mainly based on fossil fuels. 20 % of the final energy consumption in Herten is met by district heating. The share of biomass on renewable energy for heat is in Herten not as high as in Germany in favour of a higher share of heat pumps and solar thermal heat.

In the following, barriers, drivers and stakeholders in Herten have been identified by conducting a survey with 25 respondents (please be aware that this survey is not representative) and expert interviews with experts from:

- Herten Municipality (City administrative for energy and innovation, Climate Manager and Technical Environment Protection)
- Jung-Stadtkonzepte (responsible for the waste incineration plant)

Additionally, inputs from pre-interviews with local partners, discussions at Policy Group Meetings, the Cross-Municipality Workshop and project meetings were taken into account.

3.4.1 Relevant technologies and barriers in Herten

The most important renewable and sustainable energy technologies in Herten are:

- excess heat from the local waste incineration plant
- excess heat usage from industry
- extension of the existing district heating grid
- solar thermal energy on deconstruction areas (former mining areas)
- heat pumps as individual installations

Excess heat is a big topic in Herten especially **excess heat from the local waste incineration plant**. Currently just a very small share of excess heat is used for neighbouring industries. It is, however, planned to use the whole potential and feed it into the district heating grid. Barriers to the use of excess heat from waste incineration plants for district heating mainly relate to contract arrangements between the waste incineration plant owner, the municipal energy supplier and the two big energy suppliers in the region for its use. Currently, the municipal energy supplier has a contract with the waste incineration plant but it might not utilise all the excess heat that will be made available. Another barrier is the regulation policy regarding waste and recycling. It is unclear whether there will be enough waste available in the future. **Excess heat usage from industry** is not really seen by the experts as a potential source of energy because very few production sites exist in Herten, but they also state that it is worth a closer look. The survey participants seemed to be very sceptical against excess heat from industry. Potentials exist in commercial areas near to residential areas. The region has a tradition of the so called collective economy ("Verbundwirtschaft"). This means that industrial sites and small companies are very much interconnected. This collective economy should be used for an inter-sectoral cooperation between industrial areas and residential districts rather than intra-sectoral collectives. According to the interviewees a barrier to this could be the central procurement policy of big players. These might not be particularly interested in local solutions with relatively small purchase quantity. Therefore, the municipality has to find an interested medium-sized producing company located near to the local grid. This requires huge effort and independent research.

The heat for the **district heating** network in Herten is currently primarily provided by coal fired combined heat and power plants. One target of the municipality is to use waste incineration for district heating and thus make district heating 100 % renewable. Interviewees stated that district heating has a long tradition in Herten and should be connected to more households. It should be promoted by integrating it into the energy plans and the urban management. As a principle, all public buildings should be connected to the district heating grid as soon as possible. Convincing households to use district heating is important, according to the interviewees. Participants of the survey rate district heating as environmentally friendly, reliable and simple to handle. One barrier could be the notion of being dependent on one locally available district heating supplier, while the gas supplier can currently be easily changed (this is partly confirmed by the survey). Some consumers even want to produce their own heat with a heat pump or pellet boiler. However, these perceptions are not widespread because the municipality is the owner of the district heating grid and consumers have high confidence in the municipal energy supplier (which was confirmed by 13 out of 25 survey participants). Other users are glad that they do not have to maintain their gas-fired boiler or their chimney. A compulsory connection to district heating is not an option. The interviewed experts say that modernisation of the district heating grid must be considered and it needs to be constructed for appropriate temperatures.

District heating, in general, goes together with **combined heat and power** within the region. A heating station without electricity production is unknown within the region. Low electricity prices, however, makes combined heat and power plants less competitive as has been discussed in the project meeting.

Experts consider that a mix of **solar thermal energy** and excess heat from the waste incineration plant is the most reasonable solution for Herten. According to the interviewees, investment must be made in the renovation of the grid and its construction for appropriate temperature levels. This could be a financial barrier if it is not economically efficient. In Herten there is already a pilot

district with solar thermal plants. In addition, solar energy potential could be sited on deconstruction areas of former mines. According to the interviewees, barriers could be regulations that hinder the construction of deep basements on redevelopment sites. One specification for a solar thermal plant would also be the possibility of expanding it. One expert sees the integration of solar thermal heat into the grid as a particular challenge. For individual installations, few house owners and low purchasing power might be a problem. Another barrier is the knowledge and awareness gap of trade and repair businesses; according to the experts interviewed, solar thermal installations are more efficient and have a more attractive price than photovoltaic and could be used for supplemental water heating. In addition, most house owners are only beginning to be aware about funding for photovoltaic installations. The competitive situation of (grid connected) solar thermal installations and photovoltaic, combined with storages, also becomes clear in the master plan for Herten; the solar thermal potential is rated low while the photovoltaic potential is rated quite high in comparison with other renewable energies. Work is needed to convince investors regarding the benefits of solar thermal installations, for example as part of the Climate Weeks in Herten, together with manufacturers, as one expert suggested. Some subsidies for solar thermal heating are already available through a cooperation of the local energy supplier and a (supra-)regional heat supplier.

The experts see a potential for **heat pumps** as individual installations in Herten. Heat pumps are especially recommended in areas without a connection to natural gas or district heating. In the long term it might be even more economic to use heat pumps instead of new grids where there is low demand in energy efficient buildings, as the interviewees clarified. This holds true for new buildings due to the Energy Saving Ordinance (EnEV). In existing buildings heat pumps are only efficient in combination with under-floor heating and low temperature requirements. Either high additional investment or high energy costs are required because of inefficiency and this is therefore a financial barrier. Additionally, there is no standard solution for (existing) buildings to install heat pumps. The topic is part of campaigns of the municipality and the manufacturers in Herten.

The **geothermal potential** is rated low by the experts. There is a special situation, however, in which pit water from past mining activities has to be permanently pumped; it is released in nearby rivers to prevent flooding of the area. This water has temperatures of up to 20 °C and principally it can be used for large heat pumps as an energy source for the district heating grid. However, technical requirements might be high and cost intensive due to the contamination of the pit water. Nevertheless, a demonstration project exists in a nearby city. In Herten the mine gas first has to run dry. A new commercial area on the old coal mine area has been developed that could be supplied by this geothermal source, as well suggested by the interviewees. Additional drillings for geothermal heat are not possible at the moment because there are two remaining active mines in the region.

A **biogas** plant was operated in the city region, fuelled with organic waste producing electricity, but this plant closed two years ago. Experiences with the central biogas plant in Herten showed acceptance problems (there were complaints about the smell wrongly assumed to be caused by the plant). In place of the previous biogas plant a bigger, more commercial plant was built in the neighbouring region which uses different types of waste. Individual biogas installations are used for local heating concepts in two districts in Herten. The potential of waste water is currently being investigated.

The potential **biomass** resources from forestry or agriculture in the region are low and uneconomic. There is very little waste wood and wood is too valuable as a resource, as one interviewee points out. As there is insufficient wood from the region, the import of wood might be necessary which is not really sustainable. Additionally, the process involves combustion which is connected to emissions and air pollution. The experts indicate that acceptance problems would also arise with a biomass plant.

Regarding other renewable technologies, photovoltaic and wind energy are relevant in Herten in connection with the Hydrogen Competence Centre. There is a big wind generator, which is currently being upgraded, and some smaller wind energy installations. However acceptance issues, associated with the landscape, are a big problem. There is no potential for hydropower in Herten.

The hospital in Herten requires **cooling**. It is already equipped with an adsorption chiller so that a small proportion of the cooling capacity might be provided by heat coming from the district heating network. This measure would increase the district heating utilisation in the summer and thus lift the overall efficiency of the district heating network. As a municipal representative said, there is a complete concept for the hospital already available but not yet implemented. The barrier is the location of the hospital outside the central grid. This solution could also be used for other buildings requiring cooling, such as warehouses, supermarkets, retirement homes etc.. The local sausage industry currently covers its huge cooling demand autonomously.

Insulation is not such a big topic in Herten although there are many old buildings (>80 % of the buildings were built before the first Heat Insulation Ordinance in 1977). In the survey 15 out of 25 respondents agree that investments in energy efficiency of buildings in Herten are urgently needed. Substantial investment is necessary but this is almost impossible for the buildings which house low income families. There are also many rented apartments, so the investor-user-problem is a barrier in the residential sector.

3.4.2 Drivers in Herten

The following section presents an overview of the drivers that were identified in the interviews. The drivers are described in more detail in Chassein et al. 2017.

Status quo of actions in the municipality to (further) promote renewable energy

- The municipality has an ambitious climate protection concept which it uses as a planning base of the municipal process of change including a long term climate protection plan covering the period until 2050.
- Heat for the district heating system shall be generated totally by the waste incineration plant.
- The “Alley of change” has been built. This is a bicycle lane with information panels regarding renewable energies and other energy related topics in the region.
- There is a close cooperation between the municipality and the utility company (as a subsidy of the municipality); also between energy supply and city development.
- There is a cooperation between the local utility company and the (supra-)regional heat supplier.

- The concession for the district heating network is owned by the municipal utility company.
- The municipality has the philosophy of being an example and investing in the grid is regarded to be more cost-efficient than funding individual insulation measures etc.
- A competition for households regarding climate protection is organised regularly.
- There is one district (solar area “Sonne+”) which is supplied by 100 % renewable energies from the municipal energy supplier.
- The Energy Park “Ewald” is located close to the city where innovative technologies can be tested.
- The region has a tradition of the so called collective economy (“Verbundwirtschaft”). This means that industries and companies are very much interconnected.
- There is virtual energy storage, combining different renewable energy sources / combined heat and power generators and demand side management (DSM), in connection with hydrogen production and fuel cells.
- Subsidies for renovation based on relative CO_2 emission reduction are available.
- Some subsidies for solar thermal heating are available through a cooperation of the local utility and a (supra-)regional heat supplier.
- A campaign for manufacturers promoting heat pumps has been conducted.

Planned measures to (further) promote renewable energy

- Districts are developed (“Hertener Siedlungen”) together with the utility company with emphasis on district heating (there are lower standards regarding insulation if district heating is used, and therefore lower rents).
- Another district “Westerhold-Bertlich” is planned to run on a 50 % reduced energy demand.
- Campaigns such as information events for house owners, together with banks, are planned.
- Development of an integrated heating concept for the city centre.

Recommendation for policy measures to (further) promote renewable energy

- The potential to reduce the temperature level of the grid has to be identified and appropriate measures have to be developed.
- The current climate concepts (2020 and 2020+) excluded cooling, which could play a crucial role in the future considering the aging population. One concrete issue would be, if the district heating system can also be used as a district cooling system to supply public buildings and retirement homes.
- Complementary case studies regarding load transfer could be performed in the context of the project “Stadt als Speicher” (City as Storage).
- Identification of political instruments which increase the number of renovations, the identification of buildings with high potential for energetic improvement etc..

3.4.3 Stakeholder analysis Herten

Tab. 11: Detailed description of stakeholders in Herten

Stakeholder	Description
National and regional authorities	There are several policy measures to support energy efficiency and renewable heating and cooling on national and regional level (see Holländer et al. 2016).
Local authorities	The philosophy of the municipality of Herten is to be ambitious in stepping up to targets that can be reached on its own and offer low-threshold solutions for citizens and (medium-sized) companies. A few local politicians remain sceptical of these plans regarding the energy system in Herten. Furthermore it is difficult to persuade them otherwise, despite the very good international reputation of Herten. Regarding the city development, Herten integrates comprehensive heating supply systems (inclusive district heating) in plans for new city districts. This raises the profile of the topic in the minds of local politicians and it is then possible to offer subsidies. A big challenge for the municipality of Herten is to get citizens involved in energy topics. The new “Alley of change” - which is a bicycle lane with information panels regarding renewable energies and other energy related topics in the region – is an initial attempt to reach citizens with energy information. The local utility company and the waste incineration plant are subsidiaries of the municipality of Herten. This is why they have a strong influence on strategies of the municipality and vice versa. The public administration is involved as it provides the information campaigns and actively applies for funding projects. This is also with regard to heating and cooling (e.g. within the project “Energy Laboratory for Germany" or the information campaign “Mitmachstadt”). In Germany there is a funding of an office for energy and climate protection management available for municipalities. Such an office was established in Herten.
Businesses	The city of Herten is about to develop a climate protection action plan for commercial areas. Especially relevant topics are photovoltaic cells for large roof tops, for example of logistic companies, small combined heat and power plants, and small geothermal plants. These energy sources could be combined with storage capacity for wind energy electrolysis and hydrogen. The Ewald district (“energy park”) has a very high potential for renewable solutions within one energy system but there are very different load profiles (evening revenue, manufacturers etc.). It is also unclear whether the area will be managed by

	one stakeholder or several stakeholders. The existence of several decision makers could be a barrier for comprehensive investments. Despite that, companies are important for the economy of the region and they benefit from a good network with the citizens. The biggest players in Herten, which offer most of the work places, are public companies such as the waste incineration plant (AGR), two hospitals, and a sausage factory owned by Nestlé. Companies with enhanced motivation to invest in efficient energy usually come from the public sector such as, for example, heating technology providers. Others, like hotels / catering, are motivated by a “green image”. For most companies energy related topics are low on the agenda, and energy efficiency is only improved in regular renovation cycles. In comparison to the residential sector, the energy demand of small and medium-sized companies in Herten is negligible. The municipality plans to encourage companies with a campaign for renewable energies.
Households	In Herten, households are the biggest consumer of energy. There is a large proportion of old buildings (>80 %) built before German thermal insulation ordinance standards became mandatory. Even if house owners can decide how to invest in their buildings they cannot decide about the energy system available. Campaigns such as information events for house owners, together with banks, are planned. In general the public is not particularly concerned with energy related topics although many information services (e.g. the campaign “Mitmachstadt”) and projects are available. Motivation usually comes from people already interested in energy topics. The best way to interest people is through positive experiences communicated by word of mouth; but this takes time. Insulation is not a particularly big topic in Herten although there are many old buildings. Energy modernisation of heating technologies and energy renovation of housing will be supported financially until 2020. The investor-user-problem could be a barrier in the residential sector because there are many rented apartments in Herten. The population of the city is diminishing but the number of households is constant because many people live alone in their houses / flats. There is also a large proportion of low-income households in Herten which will probably not invest in modern and more environmental friendly heating technologies in the future, as they lack capital for up-front investment. Housing companies play a big role in Herten, especially for districts and single houses. The speed of energy modernisation within the building stock can be

	increased by housing agencies through their investment decisions. There are two big housing companies in the city with low-income households as their target groups, and low rental prices. Social housing is funded in Germany, so the housing agencies focus on low rental prices, and let properties to people receiving social welfare having heating costs paid by the municipality. The consequence is that neither the housing agencies nor the householders have a reason to invest in energy efficient solutions. One other housing company works together with the local utility company, promoting district heating and photovoltaic cells and invests in quality (e.g. barrier-free design). There are no housing companies owned by the municipality in Herten.
Energy Suppliers	The energy supplier in Herten is connected with the municipality, especially in its climate responsibilities. As it is a subsidiary company of the municipality, the municipal energy supplier is involved in the process to increase environmentally friendly heating and is guided by the climate concept of Herten. It can decrease its CO_2-emissions for the district heating-network by switching to other fuels and / or alternative supply technologies. It is the task of the energy supplier to approach consumers. The energy supplier has a contract with the waste incineration plant to use surplus heat and it is also planned to use excess heat. If excess heat is used, however, the electricity supply will diminish slightly and the contract will have to be renegotiated. Regarding district heating in Germany a grid concession is required. The energy supplier has the concession in Herten and no one else can use the district heating grid (e.g. to feed in surplus heat from an individual biomass plant). Large energy suppliers in the region however, deliver heat for the municipal energy supplier of Herten.
Finance corporations and insurance companies	In Herten there is good cooperation between the municipality and the local bank (e.g. energy roof contracting). Financial institutions are part of information events about district developments, especially for investments needing retrospective funding. In addition, banks usually invest in their own real estate and so care about energy efficiency.
Local professionals (planners / designers / installers / craftsmen / chimney sweeps)	-no information-
Energy agencies and energy advisors	Energy advisors or district managers are just small players in the energy system of Herten e.g. with regard to advice events. Local energy consultants provide the know-how for energy modernisation within special

	projects (such as "Energy Laboratory for Germany") and on a daily business basis. A lot of measures are conducted by the regional energy agency “EnergieAgentur NRW”.
Action groups (citizens, NGOs)	-no information-
Media	Support of several media organisations is an important driver for energy related projects in Herten. For example, best practice examples of citizens and their renovation projects are presented in a city magazine. In addition, there is a mobile application provided for users to inform themselves about energy related topics in the region. Recently, there was even a supra-regional report about projects in Herten.
Research and development institutes	In Herten the cooperation between the city and several regional research institutes (universities and others) provides profound evaluation of (pilot) projects.

3.5 Portugal: Matosinhos

Matosinhos is a city in the northern part of Portugal, situated right by the Atlantic Coast. The municipality has around 175 000 inhabitants, a number that has been slowly declining since 2011. The unemployment rate tends to be slightly higher than Portugal's average (11 % in 2014). Historically, Matosinhos was heavily industrialized but, more recently, its economy shifted towards one of services. Still, some relevant industrial and logistics infrastructures are there located (including a large cruise-ship terminal and a large petrochemical refinery). The municipality of Matosinhos has been active in developing actions towards sustainability such as the participation in the Covenant of Mayors, a Sustainable Energy Action Plan (SEAP) and, more recently, the participation in the Pact of Mayors.

As in all other case studies biomass has the highest share of renewable energy for heating in Portugal with 96 % followed by heat pumps (3,5 %) and geothermal heat (0,08 %). There are two energy distribution networks, one for natural gas and the other for electricity. The energy is commercialized by a number of private companies but the networks are managed as public interest infrastructures and managed by a different set of private companies (just one in the case of the electricity network). There are no district heating and cooling facilities in the Matosinhos region. Generally, district heating is not used in Portugal, with the exception of one district heating and cooling network in Lisbon and a couple other very small installations across the country. Thus, heating systems in Matosinhos are almost exclusively individual and tend to consist primarily of fireplaces (more typical in older buildings and rural areas), and boilers or furnaces running on natural gas, bottled gas (butane or propane) or heating diesel.

In the following, barriers, drivers and stakeholders in Matosinhos have been identified by conducting a survey with 14 installers and designers (please be aware that this survey is not representative) an expert interview with:

- Porto Energy Agency (Technical Director)

Additionally, inputs from pre-interviews with local partners, discussions at Policy Group Meetings, the Cross-Municipality Workshop and project meetings were taken into account.

3.5.1 Relevant technologies and barriers in Matosinhos

The most important renewable and sustainable energy technologies in Matosinhos are:

- industrial excess heat
- solar thermal energy
- heat pumps
- additional: high renovation potential of buildings

The potential for **industrial excess heat** could be substantial, according to the experts, but this still needs to be assessed and confirmed. Depicted by one interviewee in the industry, there are many examples of excess heat recovery in Portugal, mainly since 1980, with a number of those distributing that heat to a client (generally on a one-to-one relationship). These generally appear due to the companies' own initiatives and do not generally directly involve the public authorities. Despite that, these were often triggered by public financial support / incentives programs. A main barrier for the use of excess heat comes from the perceived risks of assuming long-term commitments between companies. There are two big challenges for promoting excess heat usage: financial terms (for instance, business models, funding arrangements, etc.) and identifying sites where a small number of entities could cooperate and share heat and cold resources and convince them to collaborate. In some cases there might be a potential for using industrial excess heat in proximity to large services buildings, but in spite of that, no actual heat networks exist. The National Energy Agency (ADENE) is actually doing a study on this, identifying relevant sites, similar to the one identified in the progRESsHEAT project and the experiences from the project may help understand the applicability of solutions in those sites. There is an area in Matosinhos where some potential heat (and cold) suppliers and consumers are in close proximity. Further barriers named by the experts could be the temperature level of supply and demand not matching or the quality of excess heat being insufficient. Additionally many private companies will not easily cooperate with each other. Usually the available funding at national level for renewable energy sources (wind, solar thermal, excess heat) is not actively used; often companies don't apply for the funds. This may be because managers may not prioritize the investment in replacement heating/cooling systems. The Galp oil refinery should be a good heat producer, but it is not always easy to convince such a large, national company to cooperate with the municipality. It supports the country as a whole and is not relevant at a local level. Besides the company doesn't need subsidy; if they want to invest they have their own finances. Another barrier is the services sector that is characterised by offices that are spread out across the city. For the residential sector, the demand density is too low to give it priority.

Solar energy potential is generally high in Portugal although more significantly in the south than in the northern part where Matosinhos is located (but still much higher than, for instance, in Germany or Denmark). The topic is, however, being explored more and more even though the growth rate has been lower than it could, according to one interviewee. A funding program was launched for the upgrading of old thermal solar panel systems in social and non-profit institutions but less than 2 % of the budget was actually applied for – probably because most of the existing installations are relatively new. In general, investment in solar thermal installations is driven by natural market dimensions, according to one expert. The survey with 14 installers and designers confirmed this notion as solar thermal systems are offered by most of them and seen as a relevant technology for the future. In an urban context, such as the one for Matosinhos, solar thermal is probably already more relevant than biomass and certainly much higher than heat pumps. One expert depicts the barriers: solar thermal systems are still viewed as being fairly expensive by most families. Additionally, some of the financial support that was in place some time ago, even though it was not large, has been cut. Respondents of the survey, however, see this technology as economic feasible. Designers and system installers may also still lack the required knowledge or best-practice involved in using low-enthalpy systems that can better integrate solar thermal. This is expected to follow the natural path of technology introduction and information diffusion within the society. In this area, there is still the need for a committed public campaign that still did not happen in Portugal. People may also not be fully aware of the potential

of the technology. Moreover building thermal regulations have been trying to impose the installation of solar thermal systems in new constructions, but some loopholes have defeated this up to recently. Thermal solar panels are technically harder to install in existing buildings than in new ones. This is even more expressive in multi-family buildings, which is the case for a large number of buildings in Matosinhos. Furthermore, since the rate of new construction in Portugal has been very low for the past 2 decades, the uptake of solar thermal has been slower than it could be otherwise. Management and use of a central solar system feeding multiple apartments in a multi-family is also seen as problematic in Portugal due to cultural aspects (e.g. several people still do not regularly pay the condominium fees they should). Larger scale solar thermal projects are sometimes seen in the industrial sector, where companies can leverage solar thermal (particularly using more advanced vacuum tube technology that can give high enough enthalpy to integrate solar in the industrial processes. Additionally, the fact that there is no heat distribution network in Matosinhos makes it difficult to implement large-scale solar thermal plants. From this perspective, solar thermal would first be restricted by the barriers affecting the investment in district heating technologies.

Matosinhos' temperate climate make it particularly suited to using **heat pumps** since the temperature differentials will be significantly lower than most other places in the rest of Europe, according to one interviewee. Heat pumps (or similar systems) are widely used in commercial buildings already. In the residential sector this technology is still fairly rare, but its share is increasing rapidly. In addition within the survey sample air heat pumps are the most offered technology (by 12 out of 14 companies) and it is rated as a well-developed technology by 11 out of 14 companies. In addition many people still think of air-conditioning units as being just for cooling even though most systems also function as heat-pumps for heating.

There are no **district heating and cooling** facilities in the Matosinhos region. Portugal is in a significantly different position from Europe in regards to the use of thermal energy distribution networks. The main reasons for this are the mild climate and the culture of frugality, which result in generally much lower heating and cooling needs than elsewhere in Europe. In practice, there is only one fairly large district heating and cooling network in Lisbon (ClimaEspaço) and a couple of other very small networks. The twenty years experience from Lisbon shows that big clients use it consistently, but the demand by the residential clients was much lower than initially anticipated. Due to the low density of thermal energy demand in the Portuguese residential sector and long payback times for new district heating and cooling infrastructure, it is not considered a cost effective target for district heating/cooling networks. This will only be made worse as the building stock improves. Moreover demand profiles for cooling in services buildings may be unfavourable to district heating and cooling, e.g. very low thermal demand during the night (when offices and malls are closed) and very high during the day (when they're operating), which complicates the economics of running the thermal generation if there is not enough storage. One expert points out that private house owners in Portugal traditionally prefer decentralized heating systems. These are reasons why there is no effective support for the installation of thermal networks in Portugal. In addition current Portuguese regulation does not promote the use of thermal networks and even the transposition to the Portuguese law of the Energy Efficiency Directive (EED) is weak in addressing the potential role of district heating and cooling in the Portuguese reality. For service buildings operating all day around (e.g. hotels or hospitals) district heating and cooling may be particularly interesting because the sizing and operation of the network can be more easily optimized. The first step in this direction is already being taken by the National Energy Agency

and it is identifying locations where a small number of highly relevant heat/cold users can come together and be connected by a small network. After that has been put in place, there is a potential for expanding the network gradually. Mixing some residential buildings may also help fill-in some of the night-time low demand from some services buildings profiles. A benefit of district heating and cooling networks is the possibility to use mixed (renewable) energy sources which can be introduced gradually or adjusted over time as market conditions and availability change.

There are a small number of **cogeneration** facilities in the industry and large services buildings, generating both electricity (that is injected into the national grid) and heat for own use. There were also some incentives for co-generation facilities, mainly in terms of beneficial tariffs, but these have been recently stopped. Combined heat and power is now even less attractive than it was before from a financial perspective (particularly for new investments). Still, as one expert stated, most co-generation facilities do not use renewable fuels (e.g. biomass), instead opting more for natural gas or oil.

Biomass potential is small under the current conditions. Matosinhos municipality is surrounded by the sea on one side and dense urban development on the other so there is almost no rural or forest areas where biomass production could occur; the closest potential biomass sources are quite removed from the area (at least 15 to 20 km away), potentially limiting their use without a restructured commercial and logistical network of production and distribution of biomass in the region. Respondents of the survey see an advantage of biomass in stable prices. Some time ago, a financing program promoting the use of biomass in the industry saw very poor reception. There were very few applications to the program the interviewee assumed, because many were already using it. In other, more rural, areas, biomass (pellets) boiler probably have a higher potential than solar thermal installations, mainly due to cultural aspects, generally older buildings and residents, and better access to the resource. Generally speaking, the interviewee stated that biomass is probably losing share to other heating technologies in the residential sector, particularly natural gas boilers. One additional, but still important, reason for the lower use of firewood in the residential sector is related to a significant uptake of high efficiency fireplaces with heat recovery, which effectively provide higher amounts of heat while using less biomass.

There is no data of **geothermal** potential around Matosinhos. However, given the geography of the region, this is expected to be very low (around 12 km of sea-coast).

Biogas production is currently done from urban waste by the main company collecting waste (LIPOR) from a number of municipalities, including Matosinhos, but the facility is based in another municipality (Maia). It does have a cogeneration facility but heat seems to be used on its own facilities. There is very little information about the details.

Regarding other renewable technologies, the potential does not exist for hydro energy (no rivers) and wind is not really suitable as the whole area is urbanised. Maybe there is some potential for offshore wind, according to one expert, but there is no national framework to promoting it. Small windmills for individual solutions would probably be too noisy to be tolerated; rooftop photovoltaic may be more acceptable but initial costs and feed in tariffs make it no longer as beneficial as it was a few years ago when clear incentives were in place.

Regarding **cooling**, residential buildings generally present negligible needs, mostly due to the favourable climatic conditions in Portugal (the warm temperatures are coupled with low relative

humidity levels), as well as the traditional use of shading in windows. Services buildings, however, tend to have significantly higher demand for cold, due to their sizes and activities.

From the heating perspective, according to the experts, the best thing that can be done is to look at the **renovation potential** of buildings. Public buildings, in common with other buildings, are very old and most do not have adequate insulation. Since the 90s there have been some renovation projects (double-glazing etc.), but there is still much to do. 12 out of 14 participants of the survey agree that investment in energy refurbishment of buildings is very important. The main barrier according to the experts is that people are not aware of the benefit of energy efficient measures.

3.5.2 Drivers in Matosinhos

The following section presents an overview of the drivers that were identified in the interviews. The drivers are described in more detail in Chassein et al. 2017.

Status quo of actions in the municipality to (further) promote renewable energy

- There is a policy measure which promotes the use of fireplace heat recovery systems (to replace the traditional open fireplaces) and as of 2013, its execution was very positive. This actually reduced the share of renewable energy for heating in the residential sector due to lower amounts of firewood being used to meet the heat demand.
- In addition, an advisory team on energy efficiency measures develops projects within the municipality. The projects implemented by this team mainly focus on municipality-owned buildings.
- A funding program was launched for the upgrading of old thermal solar panel systems in social and non-profit institutions but less than 2 % of the budget was actually applied for.
- There are (weak) construction regulations imposing the installation of solar thermal systems in new constructions.
- A new information campaign was implemented in Portugal in October 2016. This entails a set of 10 mini-guidelines going through the 10 Solutions for Energy Efficiency (wall insulation, roof insulation, efficient windows, solar protections (shading), ventilation systems, solar thermal systems, heat recovery fireplaces and salamanders, water heaters and boilers, residential air conditioning, solar photovoltaic systems).

Planned measures to (further) promote renewable energy

- A study is now being conducted by the National Energy Agency (ADENE) that will map all the potential suppliers and clients of heat and cold in Portugal. This will hopefully help identify opportunities for implementing energy efficiency measures. It is fairly easy to identify sites where a small number of entities could cooperate and share heat and cold resources, be it in Matosinhos or elsewhere in Portugal.

Recommendation for policy measures to (further) promote renewable energy

- A mechanism should exist for excess heat usage where the public authorities give backup and long-term security to the projects, e.g. by ensuring that if the original promoter goes out of business, thermal networks can still be operated normally. One way could be for the infrastructures to be owned (even if not managed) by public authorities.
- Measures should be taken to bring the temperature level down and train professionals to explore low-temperature solutions.
- Construction rules (in particular for thermal insulation) should be more stringent in Portugal.

3.5.3 Stakeholder analysis Matosinhos

Tab. 12: Detailed description of stakeholders in Matosinhos

Stakeholder	Description
National and regional authorities	The management of Portugal's energy supply is quite centralised (see also Holländer et al. 2016). Yet, there are some regionally organised activities basically oriented towards the European Funds which find full application in the Northern Region. In such a context, regional administrative bodies as well as municipalities have a limited role in regards to the basic energy infrastructures such as the diversification between electricity and gas. Some of the available funding and national policy priorities changed with the recent economic crisis and change of government, which had clear impacts on the continued development of renewable energy (particularly for electricity production). Still, the investment that was put in place was already quite substantial and the results can be seen in the sporadic periods when 100 % of the national electricity production comes from renewable.
Local authorities	Political targets are agreed mostly at municipal rather than regional level, for example within the European mayor partnership agreement (Covenant of Mayors). The municipality, however, has almost no impact on the production of the largest vectors, like electricity, road fuels, natural gas, etc. which are all produced, managed and distributed nationally. The most relevant political decisions are made at the national level. The energy supply sector is regulated by a public national entity, but ultimately run by private companies in a liberalized market. There could (or should) be a local strategy and policy for renewable heat and cold, but it would involve changes in how the urban space is planned and how projects are thought.

	In Matosinhos there are three important authorities: the municipal government of Matosinhos, Junta de Freguesia (local parishes or boroughs) and the public transport operators (public / private mix). Most buildings in Portugal (and Matosinhos) have been built around 20 to 40 years ago, at a time when adequate insulation was still not a common practice and regulations were less stringent. There is some renovation of the building stock, but this process is naturally slow and much remains to be done. An advisory team on energy efficiency measures develops projects within the municipality. The projects implemented by this team mainly focus on municipality-owned buildings. Public authorities generally have no role in the promotion of solutions involving multiple private entities.
Businesses	The city of Matosinhos is characterised by a large commercial area with some big players; a harbour and few office buildings are spread across the city. There is no single business centre with a high density of heat demand. There was one factory for wood products, which had its own equipment producing high temperature heat (combined heat and power), but this has been very recently closed. Yet, close by, there is a new large development including several office and services buildings. Furthermore, a logistics centre has been recently built and several other large malls and stores are located all within a radius compatible with a thermal energy distribution network. All in all there is a large potential to optimize the heat and cold production and distribution within this cluster. A big issue elsewhere in the municipality is the (lack of) proximity of potential producers and customers of heat. There are information campaigns promoting thermal and photovoltaic solar panels addressing industrial sector.
Households	The residential sector in Matosinhos naturally has a very low energy demand for heating and cooling, mainly due to the mild weather all year-round. Even though it can become very warm in Portugal, the climate also tends to be dry and, thus, the comfort conditions in households can be managed without the use of air conditioning. For instance, there is a culture of shading windows with blinds, which helps to prevent the rooms from getting too warm. Hence, generally speaking, in the residential sector, there is no need for cooling. In winter there are few really cold days and heating demand is fairly low, which is also helped by a culture of frugality that frequently prioritizes using more clothing layers than installing and running large heating systems.

	The climate conditions and culture create a large potential for buildings with nearly zero needs for extra heating or cooling. Therefore, the main challenge may not be increasing the use of renewable energy, but rather to facilitate energy savings and promoting energy sufficiency in the building stock. In general, the culture and common practice in the country has led to a system based more on direct individual ownership and little shared responsibility or dependency. The municipality could provide incentives for renovation but past experiences from subsidies at the national level show that people did not make use of that funding, as one interviewee stated. There were some funds supporting energy efficient renovation (double-glazing etc.), but only a few people applied for them. Many people might not even have been aware of it. The newest building regulations oblige people to properly insulate new buildings, but the rate of new construction in Portugal has been very low for the past two decades (not only due to the financial restrictions but also due to an apparent excess of residential buildings in the country). The municipality can encourage people to use less energy; another expert stated that the issue of acclimatisation and heating in Portugal is, unfortunately, focused mainly on the equipment and less on the potential of the building envelope which should clearly be the first option in temperate climates. There are information campaigns promoting thermal and photovoltaic solar panels addressing residential sector.
Energy Suppliers	Utility companies in Matosinhos are the water utility (public / private mix), the waste management company LIPOR, and electric and natural gas utilities.
Finance corporations and insurance companies	-no information-
Local professionals (planners / designers / installers / craftsmen / chimney sweeps)	Designers and system installers may still lack the required knowledge, experience or best-practice involved in using low-enthalpy systems that can better integrate renewable resources such as solar thermal installations. This is expected to follow the natural path of technology introduction and information diffusion within the society. An interviewee said that in this area, there is still the need for a committed public campaign that still did not happen in Portugal. From an individual use perspective, most of the systems in Portugal still explore high-temperature solutions, for instance for domestic hot water and ambient heating 80°C is considered the standard temperature. However, low-temperature solutions are

	becoming more common in the market offering, particularly due to their better compatibility with some of the renewable technical options such as solar thermal or heat pumps technologies or even, possibly, excess heat.
Energy agencies and energy advisors	Key stakeholders in activities regarding to energy related issues in Portugal are the Energy Agencies including, ADENE (Agência para a Energia) that operates at a national level and AdEPorto (Agência de Energia do Porto) that operates at the local level. Matosinhos is part of the latter. The majority of the local agency's actions focus on retrofitting solutions but also some on divulging and informing the public about energy saving measures. Measures within the city, with the main involvement of the Energy Agency, mainly concern information campaigns promoting thermal and photovoltaic solar panels. They address the buildings and industrial sectors. Recently, ADENE has been conducting a study on identifying relevant sites for heat networks in Portugal, by identifying potential industrial sites with excess heat in close proximity with companies or buildings with potential for using that heat.
Action groups (citizens, NGOs)	INEGI is a Porto-based non-profit private institution. It is recognised as being of public utility, which aims to bridge the university – industry gap. INEGI is focused on applied research and development, innovation and technology transfer activities for the industry.
Media	-no information-
Research and development institutes	The region around Matosinhos hosts some of the most renowned Portuguese Universities.

3.6 Romania: Brașov

Brașov is a historical city located in the Central part of Romania with around 274 491 inhabitants (2014). It is surrounded by mountains and forests at an elevation above sea level of 625 m. Brașov is located practically in the middle of the country being one of the most important cities in the country. After closing the large industrial facilities located within the city and removing the heavy industry from the city to the periphery and neighbouring towns, Brașov became one of the main touristic cities in Romania, with a growing trend and an increasing number of tourists, from the country and from abroad. The tourism infrastructure, the services sector and the new housing construction are the highest developing segments, within the last years. The industry developed in the areas outside the city, as well having an important dynamics in the recent years. Brașov's General Urban Plan prohibits the development of heavy industry within the city, allowing the residential areas expansion and boosting the tourism and leisure infrastructure, shops and SME's businesses.

The city's activities concerning the sustainable use of energy include, for example, membership of the Covenant of Mayors (as one of the first cities), the local Energy Management Agency (ABMEE) and intelligent energy projects and awareness-raising campaigns. As a tourist city, with a natural reservation, sustainability could become a trademark of Brașov.

Part of the energy supply in Brașov is private, the rest as well as transport and distribution is public. The main energy plants supplying Brașov are the following: Four sites with each supplied by a gas fired combined heat and power combustion engines operated by Bepco, and furthermore a number of small heat-only boilers (district thermal units) situated in different parts of the network. District heat is supplied from the private company Bepco. In order to provide and sustain the continuity of the district heating system, the municipality has started a public service in charge of the DH, namely the Local Public Service for District Heating (SPLT). The small municipality-owned energy supplier Tetkron (6 % private) was closed in autumn 2016. Fuel used for district heating in Brașov is natural gas. District heating is available for most households but the system is old and at the same time the number of consumers is declining (about 9 % of households are connected to the district heating grid). Brașov suffers of high losses within the district heating system. What is noticeable is the lack of an approach to develop a modern and efficient district heating system to serve the newly residential premises and businesses. The new buildings, regardless of their destination, are heated individually/per building, generally with natural gas.

In the following, barriers, drivers and stakeholders in Brașov have been identified by conducting a survey with 110 private households and energy manager of public buildings as well as through expert interviews with:

- Technical Director of Tetkron (former DH company)
- Technical Director of Bepco (combined heat and power company)
- Environment Department of Comprest (Waste company)
- Deputy Mayor of Brașov Municipality

Additionally, inputs from pre-interviews with local partners, discussions at Policy Group Meetings, the Cross-Municipality Workshop and project meetings were taken into account.

3.6.1 Relevant technologies and barriers in Brașov

The most important renewable and sustainable energy technologies in Brașov are:

- rehabilitation of the district heating system (distribution networks and boiler stations)
- combined heat and power (CHP)
- solar thermal energy
- use of organic waste as biogas
- heat pumps

The **district heating** network in Brașov is a serious problem in the city. Instead of extending the district heating grid to new connections and new areas, the district heating supplier is struggling with fast decreasing numbers of connected buildings. Barriers against district heating are various, according to the interviewees: 1) (Infra)structural barriers are created by substantial losses in the heating distribution system, which is oversized for the current level of consumers who find it easy to install individual boilers. An expert described it as follows: “The old infrastructure is oversized, inefficient, syncopated, with poorly used routes that generate losses. It works poorly in Brașov.” 63 % of the survey respondents agreed that the current district heating infrastructure is bad. Besides infrastructure problems reasons for this resentment are the high costs of district heating and the inflexible heating source (see additional information below). 2) Financial restrictions of district heating suppliers to invest in the transport and distribution networks. They continue to search for financing sources in order to adapt the system to the actual functioning parameters. An expert sees the lack of a national legislation that would limit the obligations on certain territorial areas for the use of a unitary system as a reason that no major financing decision is made. At the moment, there are no legal restrictions for choosing a heating system: individually, for a multi-storey building or at district level etc.. The district heating company claims that there is a need for adequate legislation in order to promote it. They need to ensure that the financial funds necessary for the rehabilitation of related distribution networks and boiler stations, transport networks, high efficiency cogeneration sources and thermal stations are available from the local budget. 3) Perception barriers because of lack of trust in the district heating system and very serious reservations regarding the old system that was also used in the communist period. The decision makers are unaware of the environmental impact of individual boilers. Additionally, district heating is not yet “green” but fuelled by natural gas. In Romania there are just a few cities that use district heating and they face problems similar to Brașov[6]. In 1989, there was the revolution in Romania with big impacts on the infrastructure.

Additional information about the energy system in Brașov (information from ABMEE):

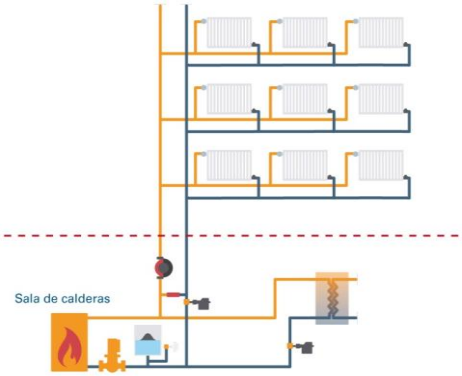
If households use individual boilers in Brașov they have more influence on the temperature level and control over consumption. People consume as much as they can afford. Within the district heating network, however, the consumer doesn't have heat until the heating season starts, even if the outside temperature is low, because of losses and very old equipment, so people are not satisfied. With gas supply, customers only pay for what they consume, while with district heating they also pay for the losses. Citizens prefer to be independent and to produce

[6] All major cities in Romania had DH before 1990. Today there are few large cities in Romania that still have DH systems. These cities have ongoing programs of retrofitting: Bucharest, Ploiesti, Iasi, Timisoara, Buzau.

their heat on their own, whenever they need it, using boilers in their apartments. Many of the connected households are low-income households; 90 % of public buildings are supplied by their own boilers while just 10 % are connected to the district heating grid. The district heating system was designed and produced in the 80s to supply heat for 80 000 apartments (currently approx. 10 000 apartments), as well as to provide industrial steam for the tractors and bearings industries (no longer in existence). Now the production source has been replaced by a production source of high efficiency cogeneration (private investment). Even though sections of the heat transport network have been reconfigured and modernised since 2010, there have been problems with the heating supply since 2015. Tetkron Company did not pay the heat which led to Bepco's inability to pay the natural gas, so the heating was cut off (information provided by Bepco). As a consequence, consumers' confidence in the heating system suffered, leading to distrust. Despite this, the energy suppliers and the municipality claim that district heating should be promoted as it is the correct solution for large urban populations. The question for the city is how to convince the people to return to the centralised district heating system. The current government wants to stick with the system, but there will be local elections in June 2016.

There is another challenge in Brașov: There are many old buildings (before 1990) in which the energy supply system is vertical which means that they are connected to a column heating circuit (Fig. 7). In this type of distribution, installing individual metering system may be more complicated, given that the radiators are vertically join between the different floors of the building. In this case the consumption is assigned by using an individual metering system (allocators). The energy supply systems in new buildings (after 1990) are horizontal (ring heating circuit, see Fig. 7) or individual boiler so that everybody just pays for their own consumption. In this case, consumption is assigned by using a simple metering system. The most usual installation system is column heating circuit, given that the majority of communities have this type of distribution. The government is not allowed, however, to invest money in private property in order to change the old vertical systems into horizontal systems, and lacks an alternative strategy; subsidies for changing the system might be unfair on those who would not benefit, according to one interviewee. The energy suppliers have carried out some pilot studies for horizontal system financed by the companies, and there was a good acceptance.

The new buildings of Brașov (>1990) are connected on a ring heating circuit:



The old buildings of Brașov (<1990) are connected on a column heating circuit:

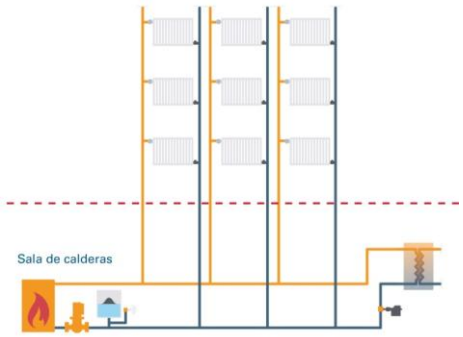


Fig. 7: Energy Supply System in the residential sector in Brașov
Source: http://www.gasnaturaldistribucion.com

Cogeneration is used for the centralized heating system, but as interviewees pointed out, the system does not cover the total existing potential. In 2008 the environmental ministry ordered the closing of the former plant because of high emissions (fuelled by coal) and inefficient working. A private investor built four new combined heat and power plants in different areas within the Brașov region, running with gas boilers, and they can also be used as a backup for peak loads. This was a measure to switch from coal to gas. All interviewees agreed that the new high efficiency cogeneration production source works well. It is a good example in Brașov and as such well accepted. The combined heat and power company reported three challenges related to combined heat and power: 1) Heat demand is not continuous because of the summer-winter relationship which is 1:10; there are 5 months of winter (October-April) with a high load, 4 months with a semi-base load and 3 months of summer with only hot water demand. Daily money for electricity keeps an energy supplier in business. 2) One authority is fixing the price for combined heat and power, while another authority is regulating the price for the distribution grid. 3) The biggest challenge is to provide just the right amount of heat that is needed at each moment. The company has also succeeded in bringing down the price using combined heat and power to one third of the previous price. Combined heat and power is not yet utilised as a decentralised installation in individual buildings because, as experts say: 1) a very high initial investment is needed; 2) cogeneration sources are unknown for individual users; this is confirmed by the survey; 3) the feed-in tariff is not regulated; 4) new buildings / residential areas are designed to function with boilers; 5) it needs permanent monitoring and it is a source of noise pollution.

Potential for **solar thermal heating** in Brașov is high according to analysis undertaken to identify the potential for the use of solar energy in the city. The interviewed experts stated that financial barriers (high initial investment and a long payback time), a lack of education of manufacturers and a lack of continuity of solar energy for 365 days, imposing the necessity of an alternative source for heating, may hinder the use of the technology, both at central and individual plants. Only individual solar thermal installations for isolated users at a long distance from the heating transport network should be promoted, according to the interviewees. Drivers could be subsidies, reduced pollution and adequate technology availability. Asked about future heating sources in Brașov, most survey participants (73 %) stated that solar thermal energy should be used.

Even though **biogas** has several positive aspects, through reduced pollution and “ECO image boost”, there are several barriers highlighted by the interviewees. First of all, the initial costs are very high and the feed-in tariff is not regulated for small individual installations. Secondly, there is a lack of technical assistance and know-how, and the continuity of secondary resource and a continuous function cannot be ensured since there is no gas deposit produced. Additionally, given its technical complexity, it would require permanent monitoring. This is why, according to one expert, large scale biogas plants are only suitable for locations isolated from the heat transport network. However, not all agree; the contrary could be the case because heat could be fed into the grid without extra costs for a network. The use of organic waste as biogas for heating and / or electricity production is another option to make energy supply in Brașov renewable. The municipality currently has a contract with a private waste company to collect garbage. This is transported and sorted in a nearby city with an incineration plant, but, as indicated by the interviewees, it could be used locally. One barrier could be the legislative incoherence regarding the selective waste collection. Another interviewee stated that waste might not be a solution because of very decent replication. Many people are afraid of district heating produced using waste. Additional initial investment is high and it is unclear whether there is sufficient waste

necessary for the production of heat. Therefore it could be used if there were enough financial resources and more details regarding the technology and legislation. Barriers could be overcome through informing actions.

In other cities, ground water **heat pumps** are used for individual supply. According to the interviewed experts however, this is not a solution for Brașov because of the surface area required. Drilling has to be very deep to get the temperature needed. Barriers could be the very high initial investment and that an agreement certificate is needed for deep wells from the National Agency for Mineral Resource. Air heat pumps could be a solution.

The interviewed experts agreed on the fact that biomass and biogas have a big potential for making energy supply renewable within a radius of 30 km around Brașov. This was identified in the Stratego-Project. Regarding **biomass** the potential of wood that can be used for heating purposes is limited. This region, even though richly forested, is part of a protected natural area, where rules are very strict about standing timber. A new solid waste dumping facility, as well as an incineration plant, had already been considered, but their viability connected to the district heating grid was questioned by interviewees given the declining number of clients connected to the district heating. In some buildings biomass boilers are already used, usually in houses that are not connected to the gas network but according to the interviewees they are very expensive. Barriers are mainly financial, because of high initial investment and a long payback time (one expert talked about more than 12 years). Other barriers that were named by the interviewees are more structural. Usually, central biomass plants are built at a safe distance from cities to avoid local air pollution. Additionally, there would be a constant need for biomass supply and the interviewees consider that an unreliable source of raw materials to supply such a large scale biomass plant would be a problem. The interviewees stress that biomass is only a solution if it is not imported, which may be possible in the case of small / medium scale plants. Informing actions, studies and promotion can help to push biomass usage in Brașov.

Other renewable heating technologies such as geothermal energy and excess heat cannot be used efficiently in Brașov, according to the interviewees. This is also true for electricity generating technologies such as wind engines and hydropower. Only photovoltaic has potential. The 4 % target of energy to be generated from renewable energy sources in all sectors in Brașov by 2020 is for photovoltaic. The use of photovoltaic, however, is limited by the level of solar exposure and the unstable legal framework for Green Certificates.

There is no significant potential for district **cooling**. One expert argues that there are no high buildings, no skyscrapers and of course there is no distribution network. Another interviewee stated that there is a potential, as long as heating is produced, but no solution has been promoted to ensure the cooling of the produced heat. He sees this as a task for a national strategy.

Another serious problem in Brașov is the building state (60 % of survey respondents agreed to that). Many buildings (especially buildings that are connected to the district heating system) are not insulated. Parts of the block, or individual flats, have been refurbished, but others need urgent retrofitting. Thus there is a substantial **potential to renovate**. The municipality has a budget to retrofit the envelope of public buildings under authority of the city council (kindergarten, high schools and hospitals). Experts say, however, that in addition to European funding, public-private partnerships should be accessed, taking the relatively high costs into consideration.

3.6.2 Drivers in Brașov

The following section presents an overview of the drivers that were identified in the interviews. The drivers are described in more detail in Chassein et al. 2017.

Status quo of actions in the municipality to (further) promote renewable energy

- The high efficiency cogeneration production with private investment works well.
- The municipality is the owner of the heating network.
- In 2016 some ongoing investment in the district heating grid were finalised and some changes are visible.
- In 2010 the previous company (CET Brașov) that owned the old coal and gas cogeneration plant invested in the infrastructure (40 % of the pipes are new). When pipes are renovated, smaller sizes are used supposed to supply households.
- Annual meetings of all stakeholders related to energy are held in Brașov.
- There was a marketing campaign for benefits of district heating based on metered savings.
- There is an energy responsible in each public building.
- Monitoring and evaluation of public buildings is available.
- Energy action plans play an important role in the company strategy of the cogeneration provider Bepco.

Planned measures to (further) promote district heating

- In order to gain consumers and to have a well performing future district heating system investments in the district heating grid and heating supply in general (horizontal branching and individual metering) are planned.
- Plans to improve the perception of the system by setting educational programmes for schools.

Recommendation for policy measures to (further) promote renewable energy

- There is a great need for the development and implementation of a clear strategy and a master plan with the vision for heating systems to be streamlined in Brașov. This needs to consider the existing secondary energy resources, the current and forecasted heat demand, the citizens' cultural paradigm, as well as the environment and financial efficiency impact.
- Barriers regarding district heating (e.g. lack of trust of consumers) can be overcome through a long term commitment of the local authorities, informing actions, coherence in implementation policies, continuity, and investment in the transport and distribution infrastructure.
- A national legislation that would limit the obligations on certain territorial areas for the use of a unitary system is needed.
- Financial funds for the rehabilitation of related distribution networks and boiler stations, transport networks, high efficiency cogeneration sources and thermal stations are necessary from the local budget.
- Regulation for feed-in tariff of cogeneration is needed.
- Informing actions, studies and promotion can help to push the use of renewable energy.

3.6.3 Stakeholder analysis Brașov

Tab. 13: Detailed description of stakeholders in Brașov

Stakeholder	Description
National and regional authorities	In Romania regional authorities do not have regional legislative power. The national policy is developed by the state institutions and implemented by local authorities. Local authorities can, however, also develop local policies as long as they comply with the national legislation.
Local authorities	The main public stakeholders are the Municipality of Brașov (forms the executive structure) and the Brașov City Council with Public Administration (political decision maker). In Brașov political actors are very inspired to change the energy system and retrieve the trust of people in the system. The lack of a national legislation that would limit the obligations on certain territorial areas for the use of a unitary system means that no major financing decision has been made. There are elections in spring 2016 in Brașov. The forest plays a big role in Brașov providing a lot of waste wood mass owned by the local community and “the forest compensates for much of the emissions” as one interviewee indicates. Brașov is obliged to have energy efficiency programmes and to appoint an Urban Energy Manager.
Businesses	-no information-
Households	The population of Brașov is very concerned about environmental issues. There are also serious problems for households as follows: 1) The usual system of energy provision is vertical. 2) Low confidence in the district heating system because of heating was cut off in the past and the district heating system suffers from losses; less than 10 % of the total number of apartments in Brașov is connected to the district heating system. Many district heating connected households are low-income households. There is a high proportion of multi-family houses and most flats are owned by residents (92 %), so the investor-user dilemma is less important. Old people usually stay in their houses for their whole lifetime, while young people want to be independent. There are many very old houses from the 19th century in the old part of the city that require innovative thermal insulation solutions. These houses need urgent retrofitting. About 20 % of the buildings are new with high technical norms.

Energy Suppliers	District heat in Brașov is supplied from the private company Bepco. The infrastructure is mainly under the authority of the Local Council. Bepco reports that: “We cannot influence the decision making processes, but we can make well-argued technical and economical propositions. Energy action plans play an important role in the company strategy.” Other utilities in Brașov are: natural gas supplier, water supplier, waste management companies, electricity suppliers.
Finance corporations and insurance companies	-no information-
Local professionals (planners / designers / installers / craftsmen / chimney sweeps)	-no information-
Energy agencies and energy advisors	Energy agencies in Brașov provide information about energy related topics and developed many projects in the field of energy efficiency (for example many public buildings were retrofitted by the local authority and many block of flats through governmental or private funds). Unfortunately, citizens are not much interested in obtaining and using this information.
Action groups (citizens, NGOs)	-no information-
Media	-no information-
Research and development institutes	-no information-

3.7 Overview of the barriers, drivers and stakeholders in the case studies

The following tables gives an overview of the barriers, drivers and stakeholders identified for the most important technologies within the case studies. The ranking of the “most important” technologies is based on the assessment of the potential of technologies arising from the interviews. In addition, a technology is evaluated as important for a case study if concrete steps have already been undertaken to promote the technology. District heating is referred in the tables as DH, combined heat and power as CHP and photovoltaic as PV.

Tab. 14: Overview of the barriers and drivers for the most important technologies and relevant stakeholders in Ansfelden

Austria: Ansfelden		
Barriers	**Drivers**	**Stakeholders**
biomass (fed DH): • low gas price • people are not eager to change energy sources • investment costs for changing the heating system • municipality does not own the entire DH network	**biomass (fed DH):** • high on the priority list • awareness raising activities • old fossil oil-/gas fired boilers will need to be replaced soon • municipality is proud of its “own” biomass DH system • municipality owns part of the DH network	• public administration • municipality • pulp and paper industry • small businesses and large shopping centres • owners/tenants, especially of old buildings (1960s / 1970s) • district heat supplier & district heat and gas supplier • heating and cooling installers • local building developers • OÖ Energiesparverband • Energy Commissioner of Upper Austria • media channels
excess heat: • reluctance to sign a long-term contract • back-up solutions needed	**excess heat:** • large amount of excess heat • interest by the district heating supplier to use excess heat	
heat pumps: • potential might not be high enough for large municipal projects	**heat pumps:** • favourable natural conditions • subsidies for the installation of heat pumps	

Tab. 15: Overview of the barriers and drivers for the most important technologies and relevant stakeholders in Litoměřice

Czech Republic: Litoměřice		
Barriers	**Drivers**	**Stakeholders**
geothermal heat: • significant investment requirements • cheap heat prices of current heat suppliers • restrictions of utilisation	**geothermal heat:** • subsidised drilling • awareness and information campaign • good communication	• public administration • Municipal Energy Savings Fund • service and commerce companies • company that is responsible for the installation of heat pumps and individual solutions • households • private providers of district heating: Energie Holding and Helia Pro • installers and craftsmen • non-governmental organisations
district heating: • historical reasons • DH from coal combustion is much cheaper • no guaranteed purchase price of electricity • fixed costs of the DH system	**district heating:** • expansion to city centre	
solar thermal heating • high investment costs • low prices of DH • spatial planning • fogs and overcast sky	**solar thermal heating** • public campaigns	

Tab. 16: Overview of the barriers and drivers for the most important technologies and relevant stakeholders in Helsingør

Denmark: Helsingør		
Barriers	**Drivers**	**Stakeholders**
district heating: • owner structure of the system • non-profit regulation • high investment costs • dependence on single system • not much expansion potential • unfavourable tax regime • renovation measures	**district heating:** • high supply security • feasibility studies • municipal measures • comprehensive coverage • easy to combine different supply options	• ministry for Climate and Energy • public administration • Climate Secretary • Energy Service Companies • owners / tenants of office buildings • house owners • private households • Helsingør Energy Centre • real estate agencies • providers of DH: Forsyning Helsingør, Hornbæk Fjernvarme • producers / traders of wood pellets • local craftsmen • organisation of Sustainable Energy • school classes • NGO “Gate 21”
biomass (fed CHP): • low gas prices • limited local biomass resources (=> import) • subsidy will be removed • stop of taxation reform • space requirements • need of manual work	**biomass (fed CHP):** • no taxation of biomass • sufficient supply from the world market • competitive technology	
heat pumps: • tax regime • might be risky • legislation • high investment costs • uncertainty issues	**heat pumps:** • good way for feeding DH systems • switching from gas boilers to heat pumps is very feasible	

Tab. 17: Overview of the barriers and drivers for the most important technologies and relevant stakeholders in Herten

Germany: Herten		
Barriers	**Drivers**	**Stakeholders**
excess heat: • contract agreements • regulation policy • central procurement policy	**excess heat:** • collective economy (“Verbundwirtschaft”)	• public administration • municipality • main employers: waste incineration plant, two hospitals and a sausage factory • households: biggest energy consumers; many low-income households • housing companies • municipal energy supplier • local bank • media organisations • regional research institutes
district heating / CHP: • dependence on DH supplier • low electricity prices	**district heating / CHP:** • long tradition • close cooperation between the municipality and the utility company • no maintenance of gas-fired boilers / chimneys necessary • development of districts	
solar thermal energy: • investments in the renovation / construction of the grid • regulations for redevelopments sites • low purchasing power • knowledge and awareness gap • potential is rated low	**solar thermal energy:** • space: deconstruction areas of former mines • more efficient than PV • more attractive price than PV • subsidies • pilot district with solar thermal plants	

Tab. 18: Overview of the barriers and drivers for the most important technologies and relevant stakeholders in Matosinhos

Portugal: Matosinhos		
Barriers	**Drivers**	**Stakeholders**
(industrial) excess heat: • fear of long-term commitments • temperature levels of supply and demand do not match • insufficient quality • companies do not want to cooperate with each other • lack of awareness about RES H/C technologies and funding • spatial structure of service sector	**(industrial) excess heat:** • proximity of supplier and user • Galp oil refinery	• municipal government • Junta de Freguesia (local parishes or boroughs) • public transport operators (public / private mix) • owners / tenants of very old buildings • large commercial area, few office buildings • factory for wood products • private Galp oil refinery • utility companies: water, waste management, electricity • energy agencies • INEGI: Porto-based non-profit private association • universities
solar thermal energy: • systems are still viewed as being fairly expensive • financial support has been cut • lack of knowledge or best-practice of installers and designers • no heat distribution network • difficult installation of panels in existing buildings • high temperature level	**solar thermal energy:** • funding program • construction regulations • information campaigns	
heat pumps: • awareness and knowledge gaps in the residential sector • lack of knowledge or best-practice of installers and designers • high temperature levels	**heat pumps:** • widely used in commercial buildings already	

Tab. 19: Overview of the barriers and drivers for the most important technologies and relevant stakeholders in Brașov

Romania: Brașov		
Barriers	**Drivers**	**Stakeholders**
district heating: • losses in distribution system • underperforming distribution infrastructure, not adapted to the actual consumption demand • lack of national legislation • insufficient investment in transport and distribution networks • insufficient number of consumers connected to the district heating system • lack of trust in the DH system • unawareness of environmental impact of individual boilers	**district heating:** • investment in DH grid • municipality owns the heating network • elections in spring 2016 • marketing campaign • objectives for the future	• municipality • Brașov City Council • households; high proportion of multi-family houses • Bepco: private DH company • other suppliers of natural gas, water, waste management, electricity • energy agencies
cogeneration (CHP): • heat demand is not continuous • different pricing authorities • high initial investment • lack of information • feed-in tariff not regulated • need of permanent monitoring • noise pollution	**cogeneration (CHP):** • 2010: investments in infrastructure • high efficiency CHP with private investment works well • energy action plans	
solar thermal heating: • financial barriers (high initial investment and a long payback time) • a lack of education of manufacturers • a lack of continuity of solar energy for 365 days	**solar thermal heating:** • sufficient potential available • reduced pollution • adequate technology availability • support of the solar thermal heating by from survey participants (private households)	

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Attachments

Attachment 1: Interview guideline for pre-interviews

Interview Guide for telephone interview progRESsHEAT

Interviewer (IREES): ..... Interview partner/Case Study: .....

Date: ..... Phone number: .....

Dear interview partner,

We are addressing the WP 3.2 „Barriers and drivers" for Matosinhos on the basis of Report 3.1 „Description of targets and policy systems in place on the different levels" and the PGM-minutes.

Apart from this interview, we would like to have three further interviews that you should conduct with persons in Matosinhos that we identify together.

We have six areas for the questions:

- Ongoing activities
- Energy supply and grids
- Buildings
- Industry/tertiary
- Other issues

Ongoing activities

There has been a workshop with companies and policy maker. What has been talked about in the workshop?

What was the result of discussion? What are the priorities?

What other activities are going on related to the progRESsHEAT project?

Energy Supply and grids

Report 3.1: There is no specific target on heating/cooling in .... Do you think this is a problem for the diffusion of renewable energies in ...? / There is a specific target in ... Do you think this is can be achieved? [*Prompts: long-term motivation? no monitoring without targets? Acceptance of measures?]*

Report 3.1: Do you see a potential for DH in ...? What would be the energy source? How could the city proceed hereby?

What temperature levels are interesting for Matosinhos?

If you think of the energy suppliers in your city: How many energy suppliers are there? Who is the owner of the utilities (private/public)? What is their "core business"? Do "green tariffs" exist? Do they promote energy saving measures? What potential influence on energy supply has the city?

How important is energy autarchy for the municipality?

Buildings

How long do people usually live in their houses? What is the ownership structure like?

How would you rate the buildings in ...? *[prompts: How to increase the insulation rate? Advisors necessary?]*

What about the public buildings? Are they insulated or use renewable energy? Are there barriers, which ones? *[prompts: Solar thermal installations on public buildings? DH used for Public Buildings? Perhaps interview with a representative of the city?]*

Is there a conflict between DH and insulation in Portugal? *[prompt: If the DH is renewable, there is no need for retrofitting /insulation for environmentally triggered reasons?*

What about office buildings/Buildings in the tertiary/industrial sector? What about the potential to insulate or use renewable energy? *[prompt: Partially doubled, see section concerning industry/tertiary]*

Industry/tertiary sector

How big is the potential for industrial excess heat? *[prompt: Temperature levels, integration into the DH grid, or possibilities for small grid within a district (with other companies)?]*

Which other measures are planned or are possible to get the heat supply renewable or to save energy*? [prompt: Energy efficiency networks, Demand side management etc.]*

What about cooling? *[prompt: No topic? Big topic? PA2 area with freeze and cooled storage?]*

Other issues

There is an information campaign by the government. How does it look like? Is this action enough in your eyes?

What do you expect from the progRESsHEAT project for the local economy?

Migration topics, employment, behaviour, attitudes, demographic development, emission of pollutants => important for H&C?

Other barriers and drivers?

Attachment 2: Interview guideline for expert interviews with local stakeholders

WP3

Interview guideline expert interviews

[Case Study]

Prepared by:

Edith Holländer, Annette Roser, Edelgard Gruber, - IREES

Expert interviews

In order to identify barriers and drivers for renewable energy-based and energy efficient heating and cooling

Interview-Partners: Experts to be asked representing relevant institutions concerning barriers and drivers. This will be defined in the pre-interviews with the local partners.

Definitely:

- local or regional government, municipal administration (persons responsible for energy, environment, urban planning or the project itself resp.)
- energy supply companies (at least one of them)
- local energy agencies (if any)

If further or more detailed information is needed, e.g. about acceptance by target groups:

- industrial associations or chambers of commerce
- housing companies
- homeowners associations
- consultants (consumer organisation, consumer advice centre, consulting engineers associations)
- environmental groups, e.g. organisation for nature conservation
- research institutes, e.g. authors of local energy concepts

Method: in-depth interviews by phone or face-to-face

General instructions

- The interview will be conducted in the national language of each country
- The interviewer should first read all questions and decide which expert is the most suitable to answer them.
- We need every interview **as soon as** it is completed! This is necessary for optimization of the analysis process.
- The lists and "prompts" should assist the interviewer to get an answer from the interviewee. The list should be available throughout the interview to assist the interviewer.
- Of course it is possible to skip a question for example if the answer is already given or not necessary anymore. If the interviewee jumps to another question by himself please go back later.
- Please write down answers as detailed as possible and insist on details if the answer is too general.
    - For example. Interview partner tells you that "There are several concerns from the households against district heating" => Ask which concerns exactly. Ask how these concerns are expressed. Ask why these concerns are a barrier to implement DH. Ask how this barrier could be overcome. Ask if there are other barriers for example of other stakeholders.

Interview

Interviewer	
Date	
City/Region of person interviewed	
Organisation/Function of person interviewed	
Comment	

START	
Introduction of Interviewer	*[Name]*
Presentation of Project	*Our project "progRESsHEAT" aims at an increased use of renewable energy exemplified by six local case studies in EU-Countries. Among others we ask decision makers on the regional and local level about the degree of use of renewable and barriers or drivers for fostering such technologies.* *Our project concentrates on heating and cooling:* • *space heating* • *hot water* • *process heat in industry* • *air conditioning* • *process cooling in industry*
Important	*All interviews are evaluated anonymised.*

General Questions	
Topic	***Questions and prompts (if applicable)***
Energy Supply Conditions	*Do you focus more on renewable energies more on general retrofit of heating systems (DH, substitution of oil or coal by gas) or more on energy saving measures (e.g. energy efficiency insulation) in your work?* *(Choose one answer)* O *renewable energies* O *general retrofit of heating systems* O *energy saving measures* *Do you consider it as a problem that there is no local target for renewable energies in ...?* *From your point of view, what works in particular good regarding the (renewable/sustainable) heat supply in ...? What works bad?* *Have there been recent changes in heating (and cooling) energy supply in ...? If yes: What changed? How did consumers react on changes?*

Main Topic: RENEWABLE HEATING AND COOLING	
Topic	***Questions and prompts (if applicable)***
Technology specific Barriers	***There are several possibilities to make heating and cooling supply renewable. We want to go systematically through the possibilities. Please tell us for every technology for which a technical potential is available why it is not utilized yet. If you can not say anything about the potential <u>and</u> the barriers we will skip the technology and go to the next one.*** *(Interviewer: If the interview partner can't say anything about potential nevertheless ask him about barriers)*
Solar Thermal (Hot topic in Matosinhos)	*Technical potential (i.e. potential that cannot be addressed by policies) of solar thermal heating depends strongly on solar irradiation and feasible roof tops. We regard the potential to be existing in .... Do you agree?* *<u>Just if potential exists:</u>* *Why do you see a potential for solar thermal heating and how big is it in comparison with other renewable energies?* *In your opinion: Why is solar thermal heating as **individual** installation (for example in private/commercial/public buildings) not utilized yet?* ☐ financial reasons ..... ☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons ..... *(Interviewer: always ask for details! => Why is it a barrier? How can it be overcome? Description of the barriers can be found in the attached barrier list)* *In your opinion: Why is solar thermal heating as **large scale plant** (grid connected) not utilized yet?* ☐ financial reasons ..... ☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons ..... *Have some of existing barriers on solar thermal been overcome, yet? If Yes: How?*

	In your opinion: Do you think the use of solar thermal plants (individual/centralized) should be pushed? If Yes: How could the barriers been overcome? What are the most important drivers, i.e. factors with positive impact on the market penetration of solar thermal plants? *[Description of the drivers can be found in the attached driver list]*
Biomass (Hot topic in Ansfelden, Helsingør, Herten)	*Technical potential of biomass depends strongly on available (solid and dry) forest or agricultural resources in the region. We regard the potential to be not existing in .... Do you agree?* *<u>Just if potential exists:</u>* *Why do you see a potential for biomass and how big is it in comparison with other renewable energies?* *In your opinion: Why is biomass heating as individual installation (for example in private/commercial/public buildings) not utilized yet?* ☐ financial reasons ..... ☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons ..... *In your opinion: Why is biomass heating as large/central plant not utilized yet?* ☐ financial reasons ..... ☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons ..... *Have some of existing barriers regarding biomass been overcome, yet? If Yes: How?* *In your opinion: Do you think the use of biomass plants (individual/centralized) should be pushed? If Yes: How could the barriers been overcome? What are the most important drivers, i.e. factors with positive impact on the market penetration of biomass?*

Biogas (direct use via CHP *and* feed in natural gas network) (Hot topic in Helsingør)	*Technical potential of biogas depends strongly on available (wet) recourses as organic waste, agricultural products or waste water. We regard the potential to be existing in .... Do you agree?* *<u>Just if potential exists:</u>* *Why do you see a potential for biogas and how big is it in comparison with other renewable energies?* *In your opinion: Why is biogas heating as individual installation (for example in agriculture, food industry) not utilized yet?* ☐ financial reasons ..... ☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons ..... *In your opinion: Why is biogas heating as large/central plant not utilized yet?* ☐ financial reasons ..... ☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons ..... *Have some of existing barriers on biogas been overcome, yet? If Yes: How?* *In your opinion: Do you think the use of biogas plants (individual/centralized) should be pushed? If Yes: How could the barriers been overcome? What are the most important drivers, i.e. factors with positive impact on the market penetration of biogas?*
Waste (Hot topic in Herten)	*Is organic waste used for energy production yet?* O *yes* O *no* *<u>If Yes:</u>* *How exactly is it used?* *Is there more potential to be utilized for heating/cooling? If yes: What are the barriers? (For example regulations, distance from energy users)* *Have existing barriers on organic waste been overcome, yet? If Yes: How?*

	<u>If No:</u> *Is waste recycled? If yes: How exactly?* *In your opinion: Do you think the use of organic waste for heating and/or electricity production should be pushed? If Yes: How could the barriers been overcome? What are the most important drivers, i.e. factors with positive impact on the market penetration of waste utilization for heating?*
Deep Geothermal Energy (Hot topic in Litoměřice, Herten)	*Technical potential of deep geothermal energy depends strongly on available geographic conditions. We regard the potential to be existing in .... Do you agree?* *<u>Just if potential exists:</u>* *Why do you see a potential for deep geothermal energy and how big is it in comparison with other renewable energies?* *In your opinion: Why is deep geothermal energy heating as central plant not utilized yet?* ☐ financial reasons ..... ☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons ..... *Have some of existing barriers been overcome, yet? If Yes: How?* *In your opinion: Do you think the use of geothermal plants (centralized) should be pushed? If Yes: How could the barriers been overcome? What are the most important drivers, i.e. factors with positive impact on the market penetration of deep geothermal energy?*
Heat Pumps (Helsingør Tax regime might play a big role)	*Technical potential of heat pumps depends strongly on differences in temperature levels or space. We regard the potential to be existing in .... Do you agree?* *<u>Just if potential exists:</u>* *Why do you see a potential for heat pumps and how big is it in comparison with other renewable energies?* *For individual heat pumps there is a potential everywhere. In your opinion: Why are heat pumps as individual installation (for example in private/commercial/public buildings) not utilized yet?* ☐ financial reasons .....

	☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons ..... *In your opinion: Why are heat pumps as central plant not utilized yet?* ☐ financial reasons ..... ☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons ..... *Have some of existing barriers on heat pumps been overcome, yet? If Yes: How?* *In your opinion: Do you think the use of heat pumps (individual/centralized) should be pushed? If Yes: How could the barriers been overcome? What are the most important drivers, i.e. factors with positive impact on the market penetration of heat pumps?*
District Heating and Cooling / Combined Heat and Power (CHP) (Ansfelden: see specific question v3)	*Technical potential of district heating always exists.* *In your opinion: Why is district heating potential not utilized yet?* ☐ financial reasons ..... ☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons ..... *CHP as individual installation within buildings are possible everywhere. In your opinion: Why is CHP as decentralized installation not utilized yet?* ☐ financial reasons ..... ☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons .....

	District Heating is just "green" if it is fed by renewable energies. Is there potential to increase share of renewable used for district heating? If Yes: How? *Have some of existing barriers on district heating been overcome, yet? If Yes: How?* *In your opinion: Do you think the use of district heating (centralized) should be pushed? If Yes: How could the barriers been overcome? What are the most important drivers, i.e. factors with positive impact on the market penetration of DH combined with CHP?* *Do you see any potential to use district* **cooling** *in ...? Why (not)? If yes: Why is the potential not utilized yet?* *In your opinion: Do you think the use of district* **cooling** *(centralized) should be pushed? If Yes: How could the barriers been overcome?*
Excess Heat (Hot topic in Ansfelden, Matosinhos) (Helsingør: Tax regime might play a big role)	*Technical potential of excess heat depends strongly on available industrial sites. We regard the potential to be not existing in .... Do you agree?* *<u>Just if potential exists:</u>* *Why do you see a potential for excess heat and how big is it in comparison with other renewable energies?* *In your opinion: Why is excess heat potential not utilized yet?* ☐ financial reasons ..... ☐ awareness/ knowledge reasons ..... ☐ regulative reasons ..... ☐ other reasons ..... *Have some of existing barriers on excess heat been overcome, yet? If Yes: How?* *In your opinion: Do you think the use of excess heat should be pushed? If Yes: How could the barriers been overcome? What are the most important drivers, i.e. factors with positive impact on the market penetration of excess heat?*
Other Technologies (***Herten: May the focus of the city on hydrogen lead to less relevance for renewable heating?***)	*Renewable Energies for electricity production may be relevant for heating purposes as well. Do you think the following energies are relevant in ...? If Yes: Why the potential is not utilized yet?* *Photovoltaic* ☐no ☐yes Barrier:..... *Local Wind Energy* ☐no ☐yes Barrier:..... *Small Hydropower* ☐no ☐yes Barrier:.....

	Have some of existing barriers been overcome, yet? *If Yes: How?* *In your opinion: Do you think the use of one of these renewable energies should be pushed? If Yes: How could the barriers been overcome? What are the most important drivers, i.e. factors with positive impact on the market penetration of these technologies?*
Energy Saving (Hot topic in Herten)	*Energy saving aspects have to be considered together with renewable energies even if there is no direct dependency of each other.* *Which share of public buildings in ... has already been insulated?* *Which share of public buildings in ... does already use renewable energies?* *How would you rate the condition of most of the buildings in ...?* *How would you rate the condition of most of the heating systems in ...?* *What can be done to renovate the buildings or heating systems? Do you see any barriers? How could the barriers been overcome? What are the most important drivers, i.e. factors with positive impact on the market penetration of energy saving investments and behaviour?*
Your Role	*To what extent do energy action plans (or similar directives) play a role for your work?* *To what extent can you influence decision making processes regarding heating system by yourself?*

Main Topic: STAKEHOLDERS	
Topic	***Questions and prompts (if applicable)***
Stakeholders in the Energy Transition Process	*How would you describe your own role and motivation in the transition process?* *Which of the following stakeholders for the stronger diffusion of renewable energy for heating and cooling supply in ...? We want to go systematically through the list (see next pages). (Description of the stakeholders can be found in the attached stakeholders list. Ask all questions for each relevant stakeholder)* ***Description**: How can you describe this stakeholder? What do you think of if you think of this stakeholder?* ***Role**: What is the stakeholder's role? How is the stakeholder linked with other stakeholders?* ***Motivation**: What is the stakeholder's motivation to use or promote renewable energy? Is the stakeholder maybe an opponent to RES?* ***Power**: Which power or means of impact does the stakeholder have? What restrictions do they face in their processes?* ***Specific Technology**: Is this stakeholder especially relevant for certain technologies?*

	Description	***Role***	***Motivation***	***Power***	***Specific Technology***	***Com-ment***
Example housing agency	Large private company, posses xy number of flats	Manage ment of flats	might have interest in a "green image".	investment decisions (own finances).	Especially relevant for individual installations within houses.	
Authorities						
regional/national						
local						
Final energy consumers						
industrial actors						
commercial actors						
Final energy consumers						
households						
housing agencies						
agriculture						
Energy Suppliers						
energy supplier (natural gas)						
energy supplier (DH)						
energy supplies (other)						
Technology Suppliers						
producer of technologies/techn ology providers						
local professionals						
Others						
banks						
energy agencies						
Non-profit ass.						
R&D institutes						
media						
...						

Closing Questions	
Topic	***Questions and prompts (if applicable)***
Framework Conditions	*Do energy agencies in ... or similar institutions offer advice for renewable energies and/or energy saving potential? If yes: How does this look like? How do people accept/use it?* *Can you imagine positive employment effect for any of the technologies?*
Transferability of Case Study	*Is it a special situation in ... or is it transferable to other regions in the country?*

Thank you very much for your support!

Attachment 3: List of codes for qualitative analysis with Atlas.ti

Barriers
Barrier: financial-economic
Barrier: institutional-structural
Barrier: perceptual-behavioural
Barrier: technical
No Potential
Risk

Buildings
Housing Structure
Public Buildings
Renovation Potential
Retrofitted Buildings

Case Study
Case Study: AT Ansfelden
Case Study: CZ Litoměřice
Case Study: DK Helsingør
Case Study: GE Herten
Case Study: PT Matosinhos
Case Study: RO Brașov
Transferability of Case Study

Drivers
Best Practice Example
Chance
Driver: financial-economic
Driver: institutional-structural
Driver: perceptual-behavioural
Potential

Energy System
Energy Autarchy
Energy Demand
Energy Price
Energy Savings
Energy Supply
Plans and targets
Temperature Level
Transport/Mobility

Renewable Energies
Biogas
Biomass
Combined Heat and Power (CHP)
Cooling
District Heating (DH)
DH: grid extension
DH: more connections
Geothermal Energy
Heat Pumps
Hydropower
Photovoltaic
Solar Thermal Heating
Waste
Waste Heat
Wind Energy
general RES

Stakeholders
Stakeholder: Companies
Stakeholder: End User
Stakeholder: Energy Agencies
Stakeholder: Energy Provider
Stakeholder: Financial Institutions
Stakeholder: households/house owner
Stakeholder: installer/manufacturer/planer
Stakeholder: Media
Stakeholder: Municipality
Stakeholder: NGOs
Stakeholder: other
Stakeholder: real estate companies
Stakeholder: regional/national authorities
Stakeholder: research and development
Stakeholder: technology producer

Attachment 4: Survey results

The survey results for all case studies and surveys are delivered as extra documents.