

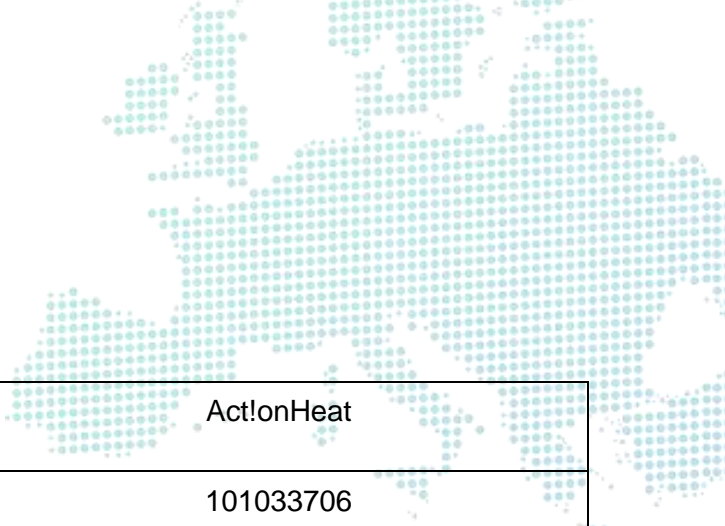


Strategic H&C planning success factors

From heating and cooling strategies to action: how public authorities can strategically plan the decarbonisation of the heating and cooling sector and initiate impactful projects



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Author(s)	Ali Aydemir, Markus Fritz, Anna Billerbeck (all Franhofer ISI)
Contributor(s)	Jurga Tallat-Kelpsaite, Marcus Hummel, Martin Holley, Giulia Conforto
Reviewer(s)	Martin Holley, Centre for Sustainable Energy

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Executive summary

The planning of municipalities is of great importance, as it determines today how we can live sustainably in them in the future. Heating and cooling (H&C) is an important issue in this context, as it accounts for about half of the total energy demand in Europe, with about 70 % still dependent on fossil fuels (for 2015). Achieving climate neutrality in 2050 therefore requires a rapid and significant change in the H&C sector. In this respect, strategic H&C planning has proven to be an effective tool to develop measures at the local level and to drive decarbonisation of the H&C sector faster and more efficiently. This report aims to explore success factors for strategic H&C planning which will guide the project's advisory services. Furthermore, the findings of this paper can help stakeholders identify and overcome obstacles in advance and so develop successful H&C plans. Policymakers can use the results to develop measures for cities that underpin successful strategic H&C planning.

However, in most countries, strategic H&C planning is still in its infancy. Moreover, it requires extensive know-how, resources and experience. So far, it is unclear which elements lead to strong H&C plans, i.e. plans that result in concrete actions to decarbonise H&C. We therefore explore this question in this report. To this end, we conducted a meta-study of 36 planning documents (Figure 1), interviewed 15 experts and carried out a survey on the topic of H&C planning (Figure 2).



Figure 1: Map of municipalities for which documents were reviewed

Key results of the survey on particularly important and challenging elements of H&C planning are shown in Figure 2. It can be seen that the points relating to a common vision of the stakeholders, availability of data and personnel are seen as particularly difficult and important. In addition, communication between stakeholders is seen as particularly important and challenging.

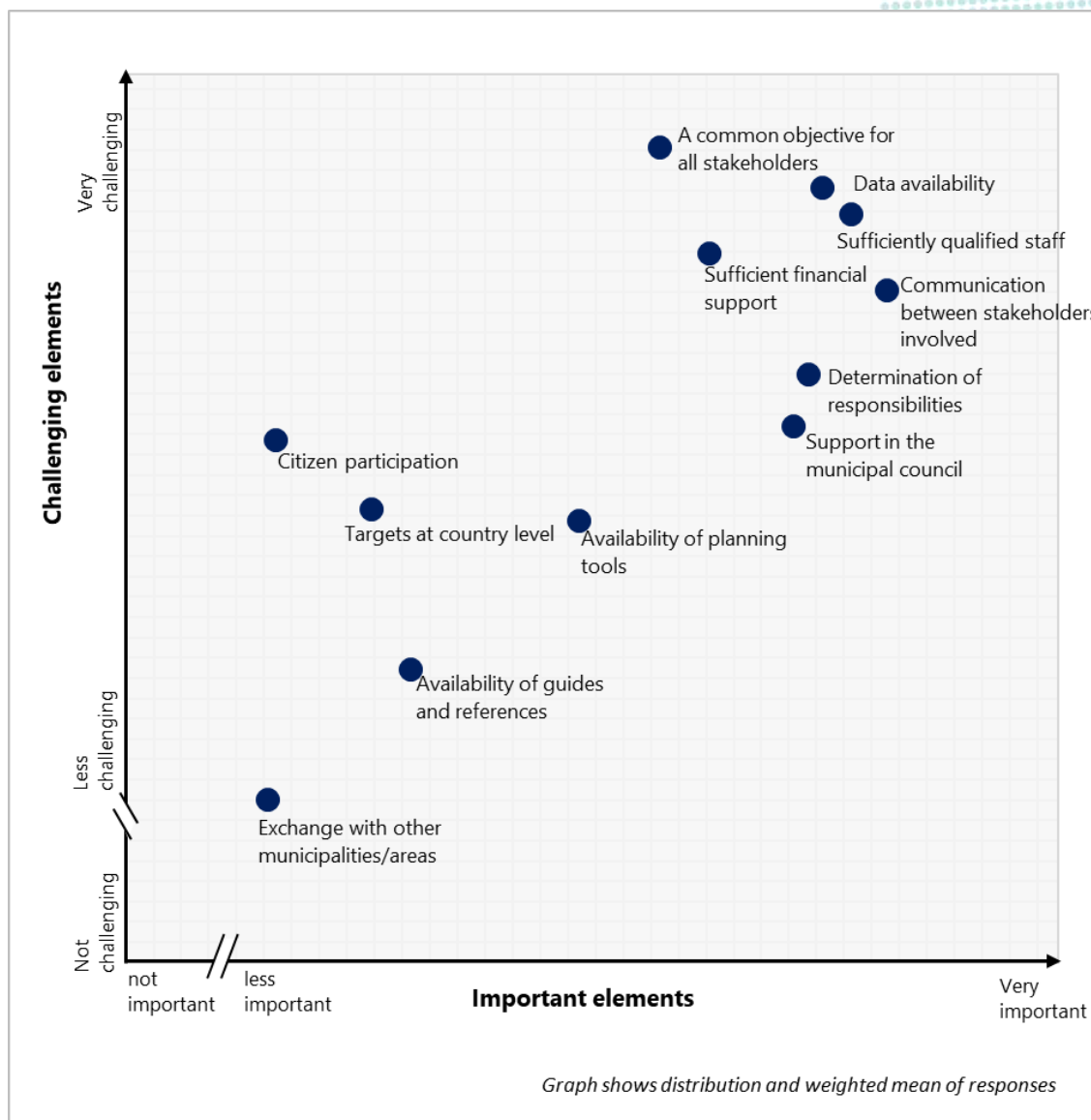


Figure 2: Key results from the survey on key success elements for H&C planning (n=349)

Putting the results of the survey, the meta-study and the interviews in context with each other, the following key findings emerge, which provide indications on success factors for strong H&C plans.

Commitment, goals and vision

From the interviews it turned out that the commitment of decision-makers is a precondition for the emergence of strong H&C plans. In this context, it is therefore also important to define together with decision-makers and other stakeholders what the goals of H&C planning are. In the survey conducted, CO₂ neutrality is seen as the main objective of strategic H&C plans. This is followed by security of supply and the implementation of concrete measures. However, all objectives were rated quite highly, i.e. respondents considered all objectives important.

Communication

It was clear from the interviews that communication of the planning process, both within municipalities and in collaboration with external stakeholders, is a challenge to be overcome for strong H&C plans. This is reflected in the survey, where good communication was rated as one of the

two most important success factors. On the other hand, having a common vision was rated as particularly challenging. We therefore conclude that successful H&C planning needs (professional) moderation to develop a common vision between all stakeholders and to help with communication.

Coordination

The interviews suggest that coordination and structures are important success factors for H&C planning. In the survey, sufficient staffing is also rated as particularly challenging. More staff, but also better internal structures and interlocking within existing municipal tasks, e.g. with spatial planning, could be solutions here. In addition, the provision of planning tools that reduce the workload could be helpful.

Contents

The meta-study revealed that the contents of the plans are quite similar. For example, there are sections on renewable potentials in all the plans. However, the way in which the content is presented differs in some cases. In addition, there are aspects that are not standard and not always included, such as the consideration of social aspects in some plans. In the survey, renewable potentials and targets, as well as measures for implementation, were rated as the most important contents. The focus of the plans is therefore more on the implementation of measures and target setting. Thus, the content does not have to be inflexible, but should be structured in a way that it supports the target set.

Data

A very central challenge emerged from the interviews seemed to be data-related aspects, which have to do with issues such as data procurement and data protection. Furthermore, the survey rated the availability and accessibility of data as an important success factor. At the same time, it seems to be a big challenge to get the data needed. In Austria and the Netherlands, initial data for H&C plans is collected or estimated by a central authority and made available for the municipalities, while currently in Germany, each municipality is solely responsible for obtaining the data. Hence, the approaches in Austria and the Netherlands are very different from the H&C planning process in Germany. Thus, the issue of data provision seems to be a point of controversy. In view of the fact that data availability was rated as highly challenging in the online survey, the approaches from Austria and the Netherlands and their transferability to other countries should be investigated further in future research.

Finally

Even though there are obstacles we need to overcome, the respondents see H&C planning as an effective and suitable instrument to tackle climate change in municipalities, which is a very good starting point. For the long-term success of H&C planning, it is essential that all relevant actors are involved from the beginning and that the plan is anchored and applied in the municipal structures. It is important that all stakeholders jointly support and implement the goal of CO₂ neutrality, which should be facilitated and promoted by adopting a long-term perspective and ensuring sufficient clarity. In this context, it is important that the focus of H&C planning is not on the creation of a single plan, but on the entire process of achieving a climate-neutral H&C supply. The plan should lead to rapid implementation with concrete policy measures.

1 Introduction

The planning of municipalities is highly important, as this decides today how we can live sustainably in them in the future. Heating and cooling (H&C) is therefore an important topic as it accounts for about half of Europe's total energy demand, with about 70 % still dependent on fossil fuels. For 2012, the European Commission (2016) indicates 75%, Heat Roadmap Europe (2017) indicates 66% for 2015, but this does not include fossil fuel consumption for district heating. Achieving climate neutrality in 2050, therefore, requires a rapid and significant change in the H&C sector.

Due to the local nature of H&C, action needs to be taken at the local level and with the involvement of a wide range of local stakeholders. In this respect, strategic H&C planning has proven to be an effective tool to develop measures locally and to drive the decarbonisation of the H&C sector faster and more efficiently (Chittum and Østergaard 2014).

Strategic H&C planning may be described as a tool for municipalities to manage their H&C supply in the medium to long term. It has been compulsory in Denmark since 1979. Its origin probably goes back to the oil crises of 1973 and 1979, which hit Denmark hard. In response, a legal framework was created with planning tools such as strategic H&C planning (Chittum and Østergaard 2014). One consequence of strategic H&C planning in Denmark might have been that the share of households supplied with district heating has increased. With a share of 45 % of district heating in residential heat supply, Denmark is today the country with the second-highest share in the EU after Sweden (50%). Furthermore, it can be observed that in Europe many countries with high proportions of district heating also use comparably high proportions of renewable energy for heat supply (cf. Figure below). Strategic H&C planning and district heating are therefore seen as instruments to achieve climate targets in the heating and cooling sector.

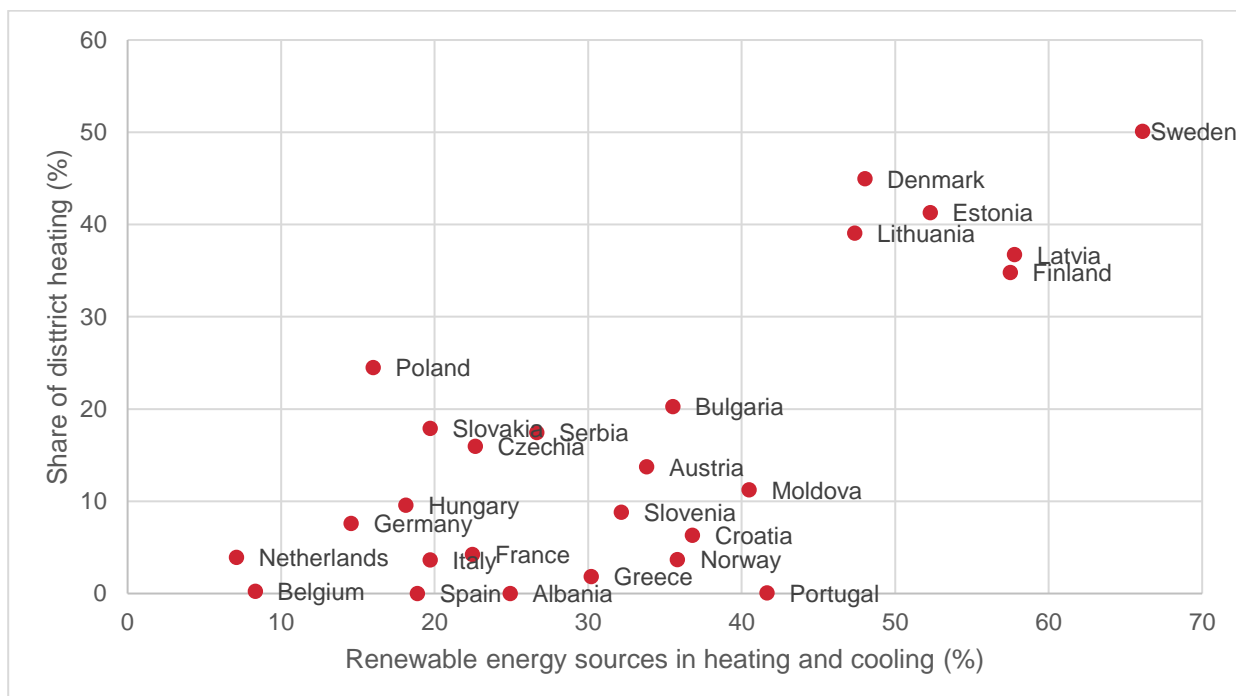


Figure 3: District heating and RES for heating (own calculations based on eurostat NRG_BAL)

In the last decade, strong efforts have been made to disseminate the use of strategic H&C planning within the EU. An active driver in this area has been the Horizon 2020 funding programme, under which numerous projects have been developed in this context, e.g. (progRESheat¹). Other examples are the Planheat², HOTMAPS³ and THERMOS⁴ projects, in which open source tools for the technical implementation of strategic H&C planning have been developed. In addition, there are projects specifically targeting district heating that have close links to strategic H&C planning (e.g. KeepWarm⁵).

The relevance of strategic H&C planning is also acknowledged by the European Commission, in the 2021 proposal for the revision of the Energy Efficiency Directive (EED). Here the following is proposed: “Member States shall encourage regional and local authorities to prepare local heating and cooling plans at least in municipalities having a total population higher than 50.000” (EU Commission 2021).

However, in most countries strategic H&C planning is still in its infancy. Moreover, strategic H&C planning requires extensive know-how, resources and experience, and it is so far unclear which elements lead to strong H&C plans, i.e. plans that result in concrete actions to decarbonise H&C. Thus, we explore this question in this report .

2 Literature

Looking at existing literature, there are only a few scientific contributions so far. Often H&C planning is not analysed separately but in the wider context of energy planning. Nilsson and Mårtensson (2003), for example, analysed 12 municipal energy plans that attempted to control and develop local energy systems in southern Sweden. They show that the plans varied regarding the planning process, content, and level of ambition. They also show that the plans follow, in general, national energy policies, i.e. reduction of oil use, improved energy efficiency, and increased use of renewable energy. Similarly, a more recent paper from Weinand (2020), also analyses municipal energy system plans. In this study, 1235 articles were collected and systemically examined using the R-tool bibliometrix. The study shows that China is the most important contributor with 225 articles, followed by the USA and Germany. District heating is a core topic in municipal energy system planning, as it is addressed in three of the top five most cited articles. Hence, the analysis provides a good overview of energy planning, however, only a little information on success factors and challenges for H&C planning is evident.

The strong connection between energy planning and district heating is also reflected in other studies. Chittum and Østergaard (2014), for example, investigate how energy planning in Denmark has supported the development of cost-effective district heating systems. Lessons from the Danish approach are considered for their relevance to the United States, where there is significant district heating potential which is still not part of the energy policy discussions. Likewise, Harrestrup and Svendsen (2014) also study heat planning for fossil-fuel-free district heating. Their work is based on a case study of the Copenhagen district heating area. They state that successful long-term strategies must ensure that costs are minimized and that investments in energy savings and new heating

¹ <http://www.progressheat.eu/Project.html>

² <https://planheat.eu/>

³ <https://www.hotmaps-project.eu/>

⁴ <https://www.thermos-project.eu/home/>

⁵ <https://keepwarmeurope.eu/>



capacity are optimized and carried out at the right time. Furthermore, there is a literature branch focusing on methods or tools for energy and/or H&C planning, ranging from overarching assessments of different approaches to specific methodologies or guidelines. Johannsen et al. (2021), for example, identify important specifications and critical design principles for future energy system modelling tools designed for municipal planners. Their results show that future tools for municipal planning purposes need to combine the need for systematic analyses with concrete and implementable initiatives while balancing analytical complexity with operational simplicity. In contrast, Büchele et al. (2019) present a concrete method for integrated strategic H&C planning applicable for any city or region. This method comprises the calculation of the cost-optimal combination of heat savings with either district heating or individual supply technologies for different building groups located in different areas.

Besides scientific publications, there are several guidelines which aim to support the process of H&C planning. IRENA and Aalborg University (2021) present a step-by-step approach to develop an effective H&C plan. They state that a plan should include stakeholder identification and involvement, scenario building, framework conditions, financing and business models. Also in Germany, several federal states developed guidelines (e.g. Peters et al. 2020; Energie- und Klimaschutzinitiative Schleswig-Holstein 2014; Energy Agentur NRW 2011). According to the German guidelines, strategic H&C planning should comprise an analysis of the status quo, an analysis of potentials, concept development (i.e. scenario development) and finally a transition strategy. In parallel to these steps, the involvement and participation of various stakeholders should be envisaged. Therefore, the analysis of the status quo should comprise the collection of all data relevant for H&C planning, e.g. the current H&C demand, greenhouse gas emissions, information on the building stock and information on the supply infrastructure. All data should be recorded spatially resolved as far as possible. In the analysis of potentials, both potentials in terms of energy savings and in terms of heat supply should be analysed. It should be clarified if the potentials could be harnessed by means of decentralised technologies or with the construction or expansion of a district heating network. In the next step, one (or several) scenario(s) should be developed in which the remaining heat demand is covered by an emission-free heat supply. Finally, to achieve and implement the target scenario, a transition strategy should be developed. This strategy should describe the transformation path and concrete policy measures.

The existing literature and documents show that there is some knowledge on H&C planning, but so far, there is no empirical analysis of success factors and challenges. This is the starting point of this paper, which analyses success factors and key challenges of strategic H&C plans based on empirical data collected in 2021. Our analysis is based on semi-structured interviews and an online survey with stakeholders from Germany. In this paper a description of the current status of H&C planning in Germany, followed by a short analysis of the developments in other countries (i.e. Denmark, Switzerland, Austria and the Netherlands) is presented. Based on the interviews and the survey, success factors and key challenges of strategic H&C planning are presented. The findings of this paper can help stakeholders identify and overcome obstacles in advance and so develop successful H&C plans. Policymakers can use the results to develop measures for cities that underpin successful strategic H&C planning.

3 Approach

In this report, we explore the question of what drives strong H&C plans, which in the sense of this study are such plans that generate actions and projects to decarbonise H&C. To address this question, we search for success factors and barriers through three steps.

- The first step was a meta-study to find out what H&C plans usually contain.
- The second step were interviews to prepare a survey on H&C planning and to discuss the information obtained in the meta-study.
- The third step was to conduct a survey asking what should be included in H&C plans, what are the success factors and which points are seen as particularly challenging.

4 Meta-Study

The meta-study serves to screen what information H&C plans usually contain.

4.1 Methodology

The meta-study involves a broad search for documents in the context of H&C planning and the related synthesis of information for the research question. The three basic steps of our approach are outlined below.

The first step was the creation of a factsheet template, which served to summarise the most important contents of the documents found on the following topics: Analysis of the Status Quo, Potential Analysis, Scenarios, Measures (see Appendix).

In a second step, internet research was used to search for documents related to H&C planning and to fill in the factsheets. The search focused on European countries, but no regional restrictions were made, i.e. relevant documents from municipalities outside the EU were also included. Currently, there is no universal characterisation, definition or similar for H&C plans, i.e. it is not possible to say conclusively what is and what is not an H&C plan. Therefore, the search was deliberately designed in such a way that the researchers themselves decided which documents they considered sufficiently relevant to include. Hence, we use the wording "documents related to H&C planning" instead of H&C plans.

In the third step, the completed fact sheets were reviewed and salient information was written down and summarised. Firstly, differences and similarities between the documents found were presented. Secondly, information was picked up that could be relevant with regard to the emergence of strong plans for H&C.

4.2 Data

As described in the Methods section, different H&C plans were identified on the basis of a literature research and summarised in the given fact sheets. In this section, a comprehensive presentation of the fact sheets is given, as well as a first descriptive analysis.

A total of 36 plans were identified and summarised in Fact-Sheets (see Appendix). The following figure shows the municipalities for which plans were found (2 plans each were found for London and Helsinki, which have a different geographical focus). It can be seen that plans were found for all regions of Europe (North, South, East, West and Central Europe). This ensured that the different regional aspects were included in the subsequent evaluation.



Figure 4: Map of municipalities for which documents were reviewed

The plans were classified into different categories for further analysis (see table below). It becomes apparent that in addition to the heat plans, energy plans, action plans or integrated energy plans were created. The category "Other" contains all documents or plans that could not be clearly assigned to an area.

Table 1: Categorisation of plans

Category	Number of Plans
Action plans	7
Integrated Climate Mitigation (ICM) plans	8
Energy plans	7
Heating and Cooling (H&C) plans	12
Other	2

In addition to the general category of the plans, the size of the plans also varies greatly. Some of the plans are not publicly accessible, or there is only a website with little information. Other plans are very detailed and sometimes contain over 300 pages of content. No direct correlation could be established between the type of plan and the respective category. However, it was found that the

size of the regions considered in the plans varies greatly. The largest city for which a plan was examined is Bursa in Turkey with a population of over 3 million. The smallest city for which a plan was examined is Sopela in Spain with a population of 12,947. The median population of the plans examined is approx. 200,000.

A complete overview of the evaluation of the plans can be found in the Appendix. It should be noted that a "y" means that the respective aspect could be identified in the plan. An "n" means that this aspect is certainly not included in the respective plan. Blank fields mean that no information is available or that the respective aspects could not be identified.

4.3 Results

In this section we describe the results of the meta-study. The results are divided into the subsections "Status Quo", "Potentials & Scenarios" and "Measures" according to the heat plans analysed.

4.3.1 Status Quo

The "status quo" part refers to the description of the initial situation of the energy system in the municipality. This is usually done in the documents by allocating energy consumption to energy carriers and applications (heating, lighting, etc.), which in turn is used for further analyses, e.g. to estimate greenhouse gas emissions. Here, the first differences in scope and methodological aspects become apparent, which probably also has to do with the different objectives of the documents. In the following, aspects are highlighted that particularly stood out during the review.

Data

A wide range of data is used, which can be roughly divided into three categories.

- Public and/or Open-Source data, e.g. public statistics on population figures or geographical data (e.g. on buildings from OpenstreetMap, heat density maps from hotmaps etc.).
- Data from the municipalities themselves, e.g. official data on buildings.
- Data from energy suppliers.

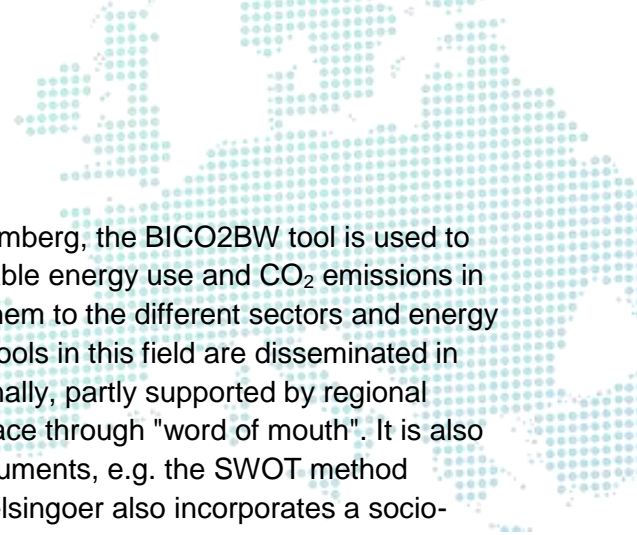
The data is then combined in different ways for different purposes, e.g. German documents used census data and building typology classifications to represent the building stock in the municipality.

Scope

The scope varies widely. For example, ICM plans map the whole energy system of the municipality, e.g. including the transport sector, while H&C plans focus only on the heating and cooling related sector, which may include several consumption sectors (e.g. tertiary sector, private households, industry). On the other hand, the data for the heating and cooling sector in energy and H&C plans are more detailed than in ICM plans. In H&C plans, estimates are made at building and neighbourhood level. It is also interesting that some documents go beyond pure energy data and also use data on social aspects, for example, in order to map the socio-economic situation in addition to the settlement structure (i.e. fuel poverty indices for Dundee or an inventory analysis on the socio-economic situation for Kremenchuk).

Instruments/methods

The tools and methods studied relate to the areas of application balances, estimation of greenhouse gas emissions, modelling of energy technologies, scenario techniques, management methods, etc. It is interesting to note that for certain purposes certain instruments are used in a geographically limited



area. For example, in the documents studied for Baden-Württemberg, the BICO2BW tool is used to determine the actual state of final energy consumption, renewable energy use and CO₂ emissions in a municipality from energy and CO₂ balances and to allocate them to the different sectors and energy carriers (Konstanz, Lörrach). This indicates that methods and tools in this field are disseminated in subject-related knowledge networks, which also develop regionally, partly supported by regional authorities. Presumably, knowledge transfer thus also takes place through "word of mouth". It is also interesting that management techniques are used in some documents, e.g. the SWOT method (Rostock). Finally, it should be emphasised that the plan for Helsingør also incorporates a socio-economic perspective into the analyses; this reflects the regulatory framework in which the issue of heat supply is embedded in Denmark. This means that the analysis methods and tools must be able to take into account the different framework conditions.

4.3.2 Potential & Scenarios

The area of potentials refers to the estimation, quantification and subsequent assessment of potentials for energy carriers from non-fossil sources for the future energy system.

In principle, similar categories are taken up in energy and heat plans: wind, solar, geothermal, wastewater, waste heat and biomass (e.g. H&C plans from the progRESsheat or hotmaps project, but also others such as Konstanz, Lörrach etc).

For data collection, standard databases, previous studies and especially potential maps are partly used (e.g. H&C plans from the progRESsheat or hotmaps project, but also others, such as Konstanz, Lörrach etc.). The availability of these potential maps varies greatly from region to region.

Tools and data sources from local providers are mentioned several times in the documents, e.g. the Energy Atlas for Baden-Württemberg and a potential tool of an energy agency for Baden-Württemberg (Konstanz, Lörrach). This again points to local or regionally related knowledge networks in expert circles.

There are differences in the level of detail of the data used. For example, the potential analyses for the city of Konstanz appear very detailed. For solar potentials, for example, "very suitable" and "unsuitable" areas are mapped. In the case of wastewater heat potentials, the location of the sewage system and the flow rate are included in the determination (Konstanz). H&C plans from the Hotmaps project, on the other hand, are based more on open source data, which do not provide such a level of detail. This may also be an important factor for the implementation of measures from H&C plans. For example, in the designation of agricultural land for solar thermal energy, it makes a difference whether the land is only theoretically available or can actually be developed for such use. Therefore, the recorded potentials probably vary between the documents from rather theoretical to actually realisable potentials.

The scenarios section refers to scenarios for projecting the energy system in the municipalities that can be found in the documents. Two scenarios are often prepared in the plans. A total of 2 scenarios could be identified in 8 of the 51 plans. These are mostly a business-as-usual (BAU) scenario and a target scenario that is to be achieved. In 7 of the 51 plans, one scenario could be identified. In 22 plans, no scenarios were created. The most scenarios were created in the Kerry County plan with a total of 17 scenarios. This shows that the scenarios are very heterogeneous. This applies to the scope of the scenarios, to the way in which the scenarios were created, and finally to the objective or level of ambition. For example, there are action plans that do not develop scenarios, but only set targets and/or measures (e.g. Budapest, Vari Voula Vouliagmeni, Tartu). In ICM plans, more diverse scenarios can be found, e.g. business-as-usual vs. mitigation or ambition scenario (Bursa, Zürich).

However, it is not always clear whether more ambitious or climate-friendly scenarios are developed through exploratory modelling or in the form of target scenarios, i.e. by back-calculating certain developments. This may also be a point of relevance for implementing measures from plans; there is, after all, a difference between whether a plan calls for a certain development or whether this has been determined by models. In both cases, the occurrence is uncertain, but in the latter case a model has been created to at least formalise the cause-effect relationships.

In the energy plans and the H&C plans, the scenarios are diverse. There are numerous scenarios that examine technical issues in terms of greenhouse gas reduction and costs, e.g. the expansion of district heating, or how district heating and refurbishment relate to each other, or even whether there are conflicting goals and whether there are optimal points from a cost perspective (e.g. H&C plans from the progRESsheat or hotmaps project). Other examples are the use of waste heat, geothermal energy, solar thermal energy and heat pumps (e.g. Rostock, Konstanz). Furthermore, some documents also examine political measures in addition to the technical aspects. The number of scenarios is comparatively high (up to approximately ten scenarios, such as for Litomerice, compared to documents with only two scenarios).

The choice of instruments used in scenario development is also interesting. In the case of the H&C plans, plans from the EU project progRESsheat should be mentioned. Here, model logics from scientific tools that were not originally built for heat planning are transferred and applied to the field of heat planning in several places, for example, the extrapolation of energy consumption with the techno-socio-economic simulation tool INVERT. In addition, energy planning tools are used that come from the utility sector (e.g. energyPRO), or new tools are developed to investigate specific issues (e.g. a tool for the trade-off between more district heating and more renovation). These and other instruments and model logics were then ultimately implemented in the Hotmaps tool. Corresponding investigations are accordingly also found in the H&C plans of the pilot municipalities from the Hotmaps project.

Given the number and variety of scenarios in some of the documents examined, the question arises: what is the appropriate number of scenarios and who are the documents aimed at? Documents aimed at citizens could appear overly-complex if too many variants and too many details are presented. For H&C plans, the question could therefore be whether documents are needed that serve more documentation purposes (with many, detailed scenarios) and others that rather summarise the municipalities results and goals for citizens.

It is also interesting to note that in some documents all key stakeholders are involved in the development of the scenarios while in others this is not clear or only happens after the plan has been prepared. In some cases, target images are developed together with the stakeholders or SWOT analyses are carried out. Therefore, another point that could play an important role for strong H&C plans is to specify at what point are stakeholders involved and how intensively?

4.3.3 Measures

Different numbers of measures are presented in the plans. In 20 plans, no concrete measures are presented. The most measures are listed in the Valencia plan with a total of 209 measures. The median is 9 measures per plan. In the review of the measures, the following points were particularly noticeable:

Level of detail: There are measures that are described in great detail, sometimes to the extent that the costs for the measure are estimated (e.g. in Strovolos). However, numerous measures are rather general (e.g. increase renovation rate) and it is not always clear how the measures will actually be operationalised.

Processes: In some documents, measures are included that aim to create processes that should last at least for a certain period of time. For example, the establishment of urban solar planning in Herten or the implementation of an energy and GHG monitoring instrument in Matosinhos.

Existing measures: Many documents refer to existing instruments and measures as starting points (Herten, Helsingoer, Geneva, Litomerice, Matosinhos, etc.).

Sphere of influence: Some measures are outside the scope of municipalities (e.g. carbon pricing in Herten) or are very far-reaching (e.g. reducing the carbon intensity of imported electricity, tackling energy poverty in the Antwerp documents). Other measures are very explicitly related to the municipality's scope for action, e.g. in the Rostock plan: areas for renewable energies are to be given priority in the new land use plan (FNP).

Feasibility studies: In some documents, measures were proposed consisting of conducting in-depth feasibility studies for identified projects (Bistrita, Dundee, Litomerice).

Energy Efficiency: In some plans that do not only refer to heating and cooling, there is often a focus on general energy efficiency measures. In some cases, "classic" energy efficiency measures such as the replacement of lighting are described in much more detail than more complicated heating and cooling measures (A Coruna, Rostock).

5 Interviews

The interviews served to prepare the survey, discuss and reflect on the results of the meta-study and thus build up overall knowledge to synthesise the information collected.

5.1 Methodology and Data

The interviews were semi-structured and lasted about one hour per interview. In addition to the general questions, the interview guide contained questions on topic blocks that arose from the meta-study: Status Quo, Analysis of Potential and Scenarios, Implementation, Financing, Open Questions. Short summaries were prepared for each interview. An overview of the interviews conducted can be found in Table 2.

Table 2: Interviews conducted

Partner	Country	Region	Municipality	Position of interviewee
e-think	Austria	-	-	Researcher in a non profit research organisation
ISI	Belgium	Flanders	-	Energy/Climate protection manager
e-think	Bulgaria		Varna	Manager/Expert in energy consulting company
eclareon	Czech Rep.		Prague	Energy and/or Climate protection manager
ISI	France	-	-	Project manager in a Network of cities
ISI	Germany 1	Baden-Württemberg	-	Energy and/or Climate protection manager
ISI	Germany 2	Baden-Württemberg	-	Energy/Climate protection manager
ISI	Germany	Baden-Württemberg	Göppingen	Manager/Expert in Public utility
ISI	Germany	Baden-Württemberg	Karlsruhe	Energy and/or Climate protection manager
eclareon	Greece		Vari Voula	Researcher in a university, H&C related
eclareon	Hungary		Budapest	Project manager/Expert in Public utility
CSE	Ireland		Dublin	Energy Systems Analyst
eclareon	Latvia		-	Member in District Heating Association
eclareon	Slovakia		Bratislava	Energy and/or Climate protection manager
CSE	UK	London	Islington	Energy Sustainability and Consultancy Manager

5.2 Results

The interview summaries are attached in the annex. In the following, some key aspects that emerged during their review are presented and supported with excerpts from the summary texts.

The role of commitment

Numerous interview summaries indicate that commitment from decision-makers is essential for the emergence of strong H&C plans. Here, political or related decision-makers are mentioned first.

- Austria: “Of great importance for the transition towards carbon neutrality in heating and cooling is the commitment from the local level administration.”
- Belgium/Flanders: “In conclusion, political engagement and stakeholder engagement are the most important drivers for successful heating and cooling planning.”
- Bulgaria: “Plejades Bulgaria ODD identify the following success factors for effective heating and cooling plans: the local authorities must be committed to the implementation of the plan.”
- Germany/Göppingen: “Finally, it is emphasised that both the political will of the city and the will and involvement of the utilities must be present in order to carry out successful heat planning.”
- Germany/Karlsruhe: “Political will is also seen as an important aspect.”
- Greece / Vari-Voula: “Critical success factors of plan are the commitment of the municipality as well as the stakeholders’ engagement.”
- UK/Islington: “The Energy Services team suggests that the key success factors of heat planning are around facilitating implementation i.e. acknowledging and, as far as possible, preparing for the reality that subsequent actions can only be implemented once early senior-level buy-in is obtained from decision-makers and suitable funding has been identified.”

The role of utilities

However, key decision-makers and implementers in H&C planning are outside the direct sphere of municipal influence. This is highlighted in numerous interview summaries and it is made clear that their involvement and thus their commitment have a significant influence on the development of strong H&C plans. The role of utilities, which can have very different relationships with the municipality, seems to be central here. They can be utilities that are partly owned by municipalities, which is quite common in Germany (so called Stadtwerke), or purely private companies that serve several municipalities/regions (see example France).

- France: “*A special feature in France is that there are virtually no local utilities. Most of heating networks are operated by 3 or 4 big companies. This means that planning currently lies primarily with these large companies,...*”
- Germany / Karlsruhe: “*The municipal utilities should also be involved in the process, but should not lead the energy master planning. [...] An imponderability in the implementation is seen in the fact that in the construction and operation of electricity and heat networks, the city is dependent on network operators, since the city itself does not operate any electricity and heat networks.*”
- Germany / Göppingen: “*There is also a waste incineration plant. However, this is operated privately, which is why an exchange regarding possible waste heat utilization has been very difficult so far*”

- Germany 1: *"It is considered positive that the municipal utilities were involved in the process, as they were able to provide good data on the one hand and are responsible for the implementation of many measures on the other hand."*
- Germany 2: *"It is noted that the cities can only steer the activities in the city to a limited extent. For many measures they depend on the support of other actors."*
- Hungary, Budapest *"Főtv's central role in Budapest's district heating system makes it influential in shaping Budapest's strategies and, by extension, it has some influence in the national objectives as well."*

The challenge of coordination and communication

In addition, coordinating and communicating the planning process both within municipalities and in collaboration with external stakeholders is a challenge to be overcome for strong H&C plans.

- Austria: *"In a first step a joint vision and mission for the short, medium and the long term should be derived. Secondly, the necessary organisational and communication structures at local level should be established. This mainly concerns the data management and the interdisciplinary decision-making structures at local level. As strategic (heat / energy) planning is a highly interdisciplinary cross-cutting issue, relevant decision making processes within cities or communities need to be adapted accordingly and cross-cutting information flow need to be ensured."*
- Belgium / Flanders: *"It is seen as a challenge that heat planning often requires other plans to be rewritten or vice versa. This means that, if possible, integrated planning with all actors should take place. If this is not the case, there is a high probability that the plan will not be implemented."*
- Greece/Varia: *"Barriers regarding the successful implementation concern the lack of communication and coordination across different levels of administration (national, regional and local), technical difficulties in obtaining reliable data and structural difficulties in public administration."*

With coordination, breaking down national or regional targets poses an additional challenge.

- Germany 2: *"The scenario thus represents a target scenario that is to be achieved through the measures mentioned in the heating plan. However, the difficulty of breaking down the national scenarios and targets to the regional level was described."*

Another important point for the emergence of strong H&C plans is the framework conditions for H&C technologies, e.g. economic (e.g. fuel prices) or regulatory (e.g. minimum technical requirements for buildings). These determine very substantially whether business cases arise for certain projects or not, and thus also whether strong H&C plans can emerge.

- Germany / Karlsruhe: *"The economic viability of the measures will play a decisive role in their implementation."*
- Greece / Vari: *"Based on pure economic terms, cost intensive renovation measures (wall insulation, double glazing, etc) in southern Greece pay off over a long period of time (>15 years)."*
- Hungary / Budapest: *Projects that it could not realise were largely due to changes in the external financial support. This may have been a government decision to withdraw support for a large projects or prices of source fuels increasing to levels that make certain investments unprofitable."*

Municipalities have little influence on macroeconomic framework conditions (e.g. fuel prices, CO₂ prices, etc.); here the scope for action lies with national and European policy.

- Germany 1: *“It was mentioned that the planning part has to be decentralized, but the framework and laws should be created centrally. It was said, for example, that a higher CO₂ price would solve many problems, as homeowners would then be more likely to take action themselves.”*

However, municipalities can certainly become active in regulatory aspects, e.g. in the context of district heating, new construction activities, etc. However, the possibilities for municipalities across the EU vary, possibly also with regard to what the legal framework allows.

- Germany / Karlsruhe: *“High standards exist for new construction, and the city can prescribe further standards for certain areas through urban development resolutions. For private areas and the existing building stock, there are no possibilities for exerting influence [...]”*
- Germany 2: *“It is said that in the area of new building it is possible to control via development plans, but especially in existing buildings there are bigger problems.”*
- Ireland / Dublin: *“For example, in planning applications for new or expanding large industrial they recommended to require waste heat reports, which allows the council to know the amount of waste heat available.”*
- UK/Islington: *“Commercial viability however is often helped by the council’s existing policy which obligates new developments to connect to heat networks where possible. This helps in commercial negotiations with potential clients and encourages transparency.”*

Of course, financial conditions also play a role here, e.g. the availability of capital, which must be ensured in order to initiate projects. Funding programmes help here.

- Germany 2: *“Regarding the concrete implementation of measures, it is mentioned that especially consulting programmes and subsidy programmes are highly effective. It is said that federal subsidies are not sufficient to achieve a climate neutral building stock. For this reason, there are various municipal subsidies that cover the difference to a better level of the minimum standard in case of a renovation.”*
- Latvia: *“In most cases, available funding is the driving factor for new project development and implementation. Rarely the reason is the expansion of urban residential areas. [...] Funds (their funding conditions) determine the eligible technologies. In the last years, the switch from fossil fuels to biomass has always been eligible for funding. Funding for the use of solar collectors is available less often.”*

Data aspects: extensive and important

A very central challenge also seems to be data-related aspects such as data procurement and data protection.

- Austria: *“Last but not least, information is crucial to any planning process. With regard to strategic energy/heat infrastructure planning, spatially explicit information about the building stock (use, age, refurbishment status, heating/cooling/electricity demand), about existing energy infrastructures such as district heating or natural gas networks, and about locally available (renewable) energy resources such as solar, (shallow) geothermal or surplus heat from industry is needed, on the one hand, to better understand current deficiencies and bottlenecks and, on the other hand, to enable concise master planning and detailed planning based on it.”*

- Bulgaria/ Plejades: *“When developing strategic energy plans for cities or regions or at national level, Plejades Bulgaria ODD find most of the time being consumed for compiling adequate input data for the analyses.”*
- Germany 1: *“With regard to data collection, it was mentioned that it was important that the municipal utilities were involved in the preparation of the heat plan. Much of the data could only be collected by the municipal utilities. [...] It is also mentioned that a common database with technologies, prices and CO2 factors should be created for the different actors.”*
- Germany 2: *“From a housing market survey, the renovation rate of the buildings could be determined and included in the modeling. It was noted here, however, that the sample for the survey for individual neighborhoods was very small in places and therefore detailed data was not available. However, data protection poses special hurdles for the city, as it is not allowed to publish the existing data in detail. Reference is made to the chimney sweep data that may be available in the future, which should capture detailed data on heat generators. Finally, it was noted that good data availability is essential for the creation of a good heat plan. [...]. Furthermore, data acquisition is seen as a big obstacle and a good data basis is seen as essential for a good heat plan.”*
- Ireland / Dublin: *The interviewed “believe that successful heating and cooling plans are created by having good spatial data available (data can be more accessible in map form showing areas suitable for district heating and other areas suitable for individual heat pumps). The lack of data availability can be seen as a barrier, as well as the knowledge on how to find, access (NDA’s/license contracts), and apply it.”*
- Greece/Vari: *“Data availability has always been one of the issues the researchers are confronted with.”*

Software tools are a way to mitigate data-related issues, guide essential planning steps for strong H&C plans and support initial feasibility studies for projects.

- Belgium / Flanders: *“Currently, a tool is being developed to support heat planning and will be supplemented with a heat guide. In it, definitions are to be developed, a workflow for heat planning is to be provided and the heat demand map is to be used in practice.”*
- Ireland / Dublin: *“They use tools to carry out spatial energy demand analysis, such as QGIS for mapping and Tableau and GeoPandas. Maps ideally need to be open source and publicly available. There is a need for tools to be relatable for stakeholders who may not be trained in the subject matter. For example, engaging business owners and citizens.”*
- UK / London: *“The Energy Services team undertakes a significant amount of project planning and development work in-house and has used the THERMOS tool for pre-feasibility work on heat networks.”*

6 Survey

In addition to the meta-study and interviews, a Europe-wide survey on the topic of H&C planning was conducted. In this survey, the opinion of the participants on different aspects of H&C planning was asked in order to get a comprehensive overview of current needs. The questionnaire was sent to more than 4500 persons and 349 of them answered.

6.1 Methodology

The survey method was chosen in order to obtain a comprehensive overview of the needs and challenges of municipal H&C planning in the individual member states. The method of conducting the survey was divided into the following three steps:

1. Conception of the questionnaire based on the meta study and first interviews
2. Publication of the questionnaire and distribution to participants
3. Evaluation of the results

In the first step, the questionnaire was designed. This was done on the basis of the results of the meta study and the previous experiences of the project team. The questionnaire is divided into 5 areas, which are shown in the following figure. For most of the questions, a pre-selection of answer options was provided in order to obtain a comparability of the answers. The pre-selection of the answer options was made within the project team based on the meta study and previous experiences. The Likert scale method was used to assess the participants' opinions on individual aspects. On a scale of 1 to 5, participants could indicate how much they agree with a point or how little they agree with it. This scale was used for the questions about the objectives, the contents, the success factors and the challenges.

Table 3: Thematic blocks and content of questions in the survey

Block	Topic	Content of questions
1	General data	Questions on <ul style="list-style-type: none"> • Postal code • Job/Workplace • Obligation for H&C planning • Connection to/ involvement in H&C planning • Responsibilities for H&C planning
2	Objectives, contents and operational points	Assessment of / opinion on <ul style="list-style-type: none"> • Objectives of H&C plans • Content of H&C plans • Involved parties/ actors in H&C planning • Time allocation for H&C plans
3	Important elements	Assessment of important elements/ aspects of H&C planning
4	Challenging elements	Assessment of challenging elements/ aspects of H&C planning
5	Evaluation	Assessment of suitability and effectiveness of H&C plans

In a second step, the questionnaire was implemented in the Questback EFS Survey software. The use of an online questionnaire makes it much easier for potential participants to answer. The questionnaire was distributed via the social media channels of the project team, public distribution lists, but also by direct mail letters. Here, the contact list of the Covenant of Mayors should be mentioned in particular. The questionnaire was online for the period from 10/4/2021 to 11/5/2021 and it took an average of 8 minutes to complete. In the third and last step, the questionnaire was evaluated.

6.2 Data

In total, results are available from 349 completed questionnaires. It should be noted that 241 of the responses came from a parallel project in Germany. Here, the identical questions were asked in German. Since there is currently an obligation for municipal heating planning in the region of Baden-Württemberg in Germany, the response from this region is significantly more pronounced. However, all results were evaluated separately for Germany and the rest of Europe and no significant differences were found. For this reason, the results are evaluated together and the results are presented below.

The following table shows the participants from the individual countries. It is clear that responses were received from all regions of Europe and that the responses therefore provide a good data basis for further work.

Table 4: Number of respondents in the survey from the individual countries

Country	Number	Country	Number
Albania	1	Hungary	5
Austria	9	Ireland	1
Belarus	1	Italy	7
Belgium	6	Latvia	1
Bosnia and Herzegovina	3	Lithuania	3
Bulgaria	3	Macedonia	1
Croatia	9	Moldavia	3
Cyprus	2	Norway	1
Czech Republic	5	Portugal	3
Denmark	3	Romania	2
Estonia	3	Serbia	1
Finland	2	Slovakia	1
France	1	Slovenia	1
Georgia	1	Spain	6
Germany	244 (241 from a specific German survey from a parallel project)	Sweden	3
Greece	3	Ukraine	8
Note: 6 respondents did not state a country			

Regarding the workplace, there are significantly more answers from the area of municipalities and city administrations (Figure 5). This is mainly due to the fact that through the selection of participants (Covenant of Mayors contact list, own contacts...) many municipalities and city administrations were requested. Furthermore, municipalities themselves are also primarily responsible for local heating and cooling planning, but can delegate it to appropriate agencies. The second most frequent respondents to the survey were consulting firms and research institutes. These responses are also very important, as they provide information about the problems and challenges that exist in the actual preparation and implementation of the plans.

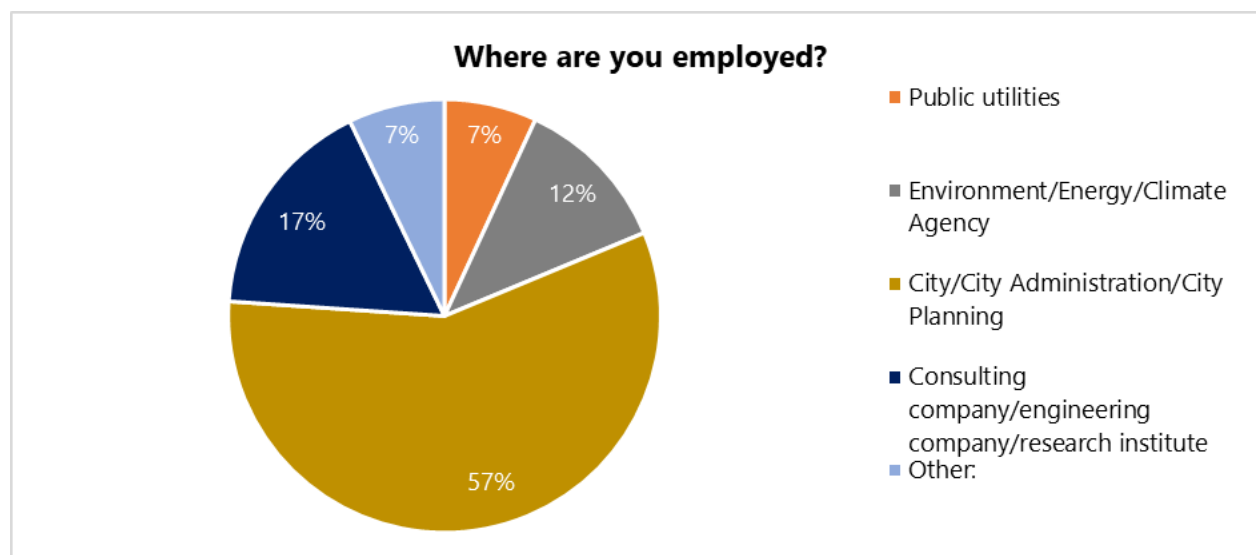


Figure 5: Workplace of respondents in the survey

Overall, the data is quite complete. Only 3 of the 349 participants did not complete the questionnaire. A complete data set is available from each of the remaining participants.

6.3 Results

In this section, the results of the survey are presented according to the structure shown in Table 3. In the first part, the objectives, content and time allocation for H&C planning are presented. The second part shows the results of the question about the important elements in H&C planning. The third part includes the evaluation of the question about the challenging elements of heat planning. Finally, in the last part, the important and challenging elements are considered together and possible implications for successful heat planning are shown.

6.3.1 Objectives, content and time allocation for H&C planning

The second thematic block of the survey dealt with the objectives, content and operational items of the H&C planning. For the objectives and contents for each question, a pre-selection of items was made. Participants could rate how much they agreed or disagreed on a scale between 0 and 5, with 5 being the strongest agreement and 0 the strongest disagreement (Likert-type scale).

The questions and results are presented below in several figures, which are presented uniformly with regard to the Likert-type scaled questions. The number in the blue circle indicates in each case the mean value of the answers given. The areas marked in light blue describe the number of answers that were rated 4 or 5. In Figure 6, for example, the item "security of supply" was rated four a total of 84 times.

Objectives

Figure 6 shows the results in relation to the H&C planning objectives. It shows that although all targets are ranked quite high with a weighted average above the medium value of the scale, achieving CO₂ neutrality is the most important target. This is followed by security of supply and the implementation of concrete measures.

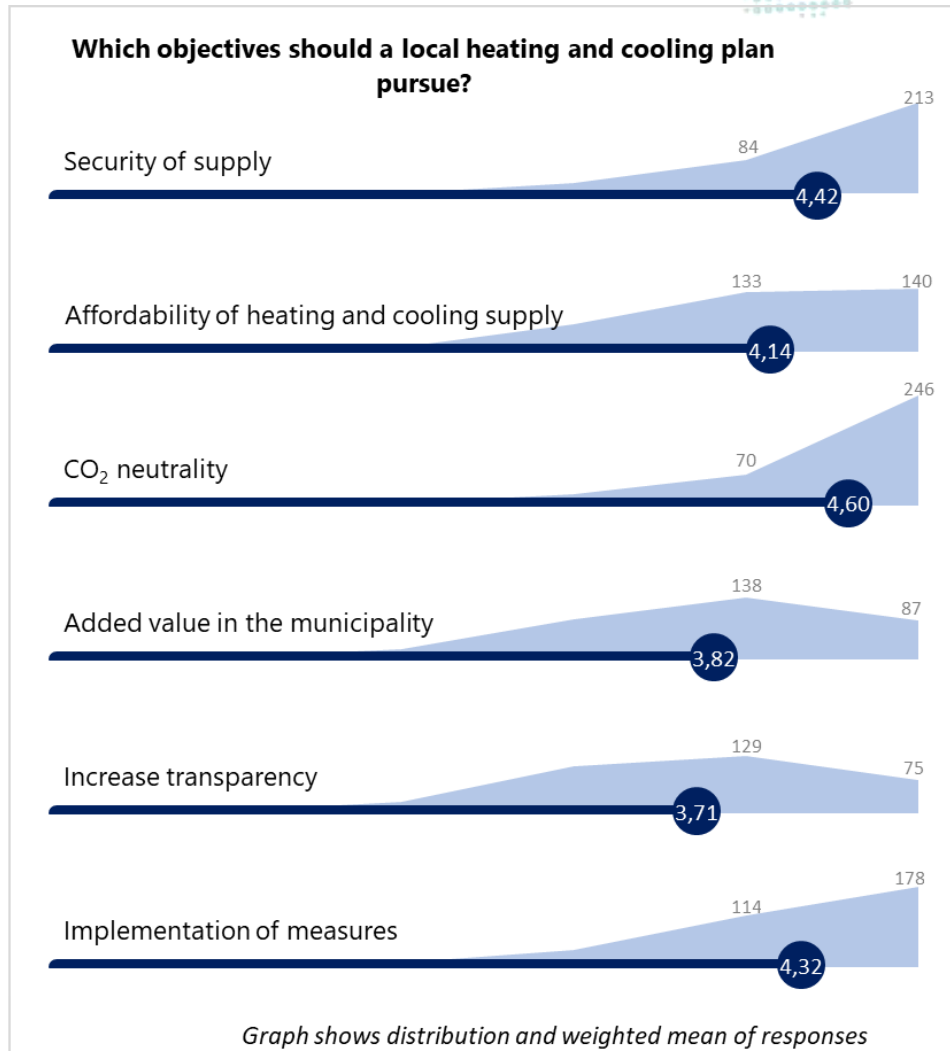


Figure 6: Results for the question on objectives

Content

Figure 7 shows the results in relation to what good H&C planning should contain. All listed topics of H&C plans received a high level of approval, although renewable potentials, targets as well as measures for implementation were rated the highest overall.

The results on objectives and content (cf. Figure 6 and Figure 7) indicate that the respondents have a common consensus on this topic.

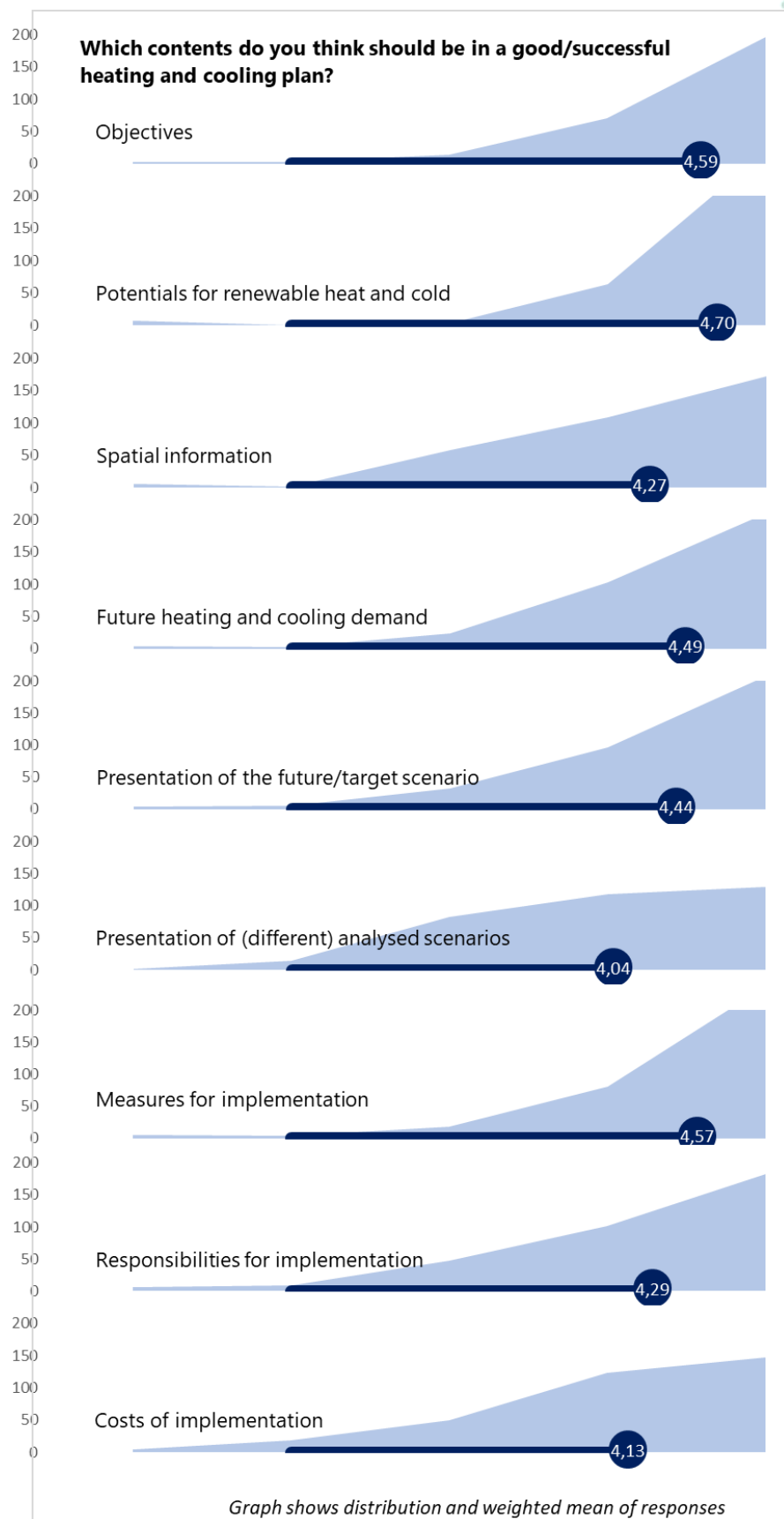


Figure 7: Results for the question on what H&C plans should contain

Time allocation for H&C planning

The first question in the questionnaire addressed the time that should be allocated for the preparation of a heating and cooling plan. Here, the majority of respondents (70 %) stated that a period of between 1 and 2 years should be given for the planning (c.f. Figure 8).

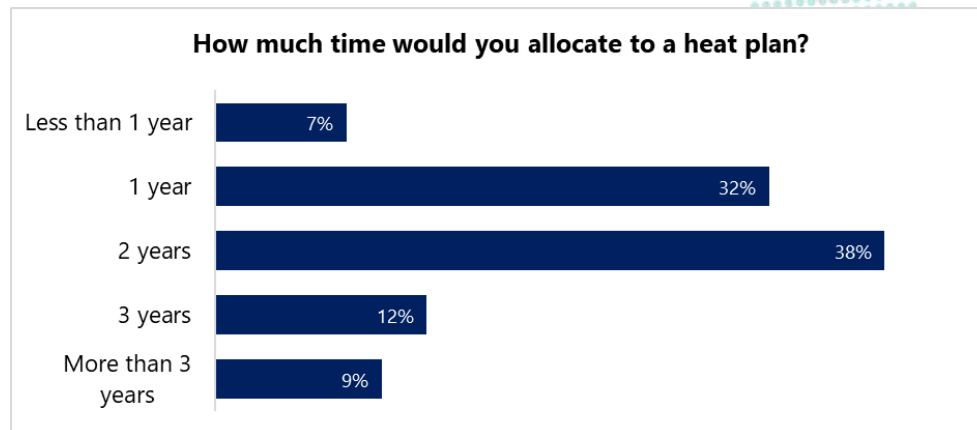


Figure 8: Results for the question on required time

6.3.2 Important and challenging elements

In the fourth part of the survey, the respondents were asked to indicate how challenging and how important they consider individual aspects of heat planning. For this purpose, the Likert scale (5 = full agreement; 0 = no agreement) was also used, and in 2 separate questions respondents were asked how challenging and how important they think the respective aspects are. The assessment of different important elements of strategic H&C planning is presented in Figure 9. All factors were rated as generally important. None of the factors received a rating of less than 2.5 (average).

Heat planning involves a variety of stakeholders with different ideas and priorities. For this reason, communication is considered the most important element of H&C planning. More than half of the respondents (64 %) consider communication very important, and about one-third (30 %) consider it important. This is also consistent with some stakeholders' perception of heat plans as a communication tool, which was a finding from the interviews.

Availability of data was rated as the second most important element by respondents. In this regard, 91 % of respondents rated data availability as very important (61 %) or important (30 %). Data on energy demand and the potentials for renewable energies form the basis for energy and heat planning. It is important to find an appropriate level of data quality. If too much work is put into data acquisition and data preparation, there may be too little time left for other things. If too little time is invested, the results of the heat planning may not be meaningful enough and thus cannot lead to any meaningful measures.

The third most important element is the definition of responsibilities. Here, 91 % of respondents rated this element as very important (56 %) or important (35 %). The definition of responsibilities is important because many different actors are involved in heat planning, as described above.

Other important elements are sufficient qualified personnel and financial resources as well as the commitment and support of the city administration. In contrast, citizen participation and exchange with other municipalities are perceived as less important in comparison, although the distribution is more differentiated. Other important elements mentioned by participants in an open question are monitoring, clear methodology, sufficient experience of contractors, presentation of conflicting goals, and specific elements such as templates for data and requests to energy companies or consumers.

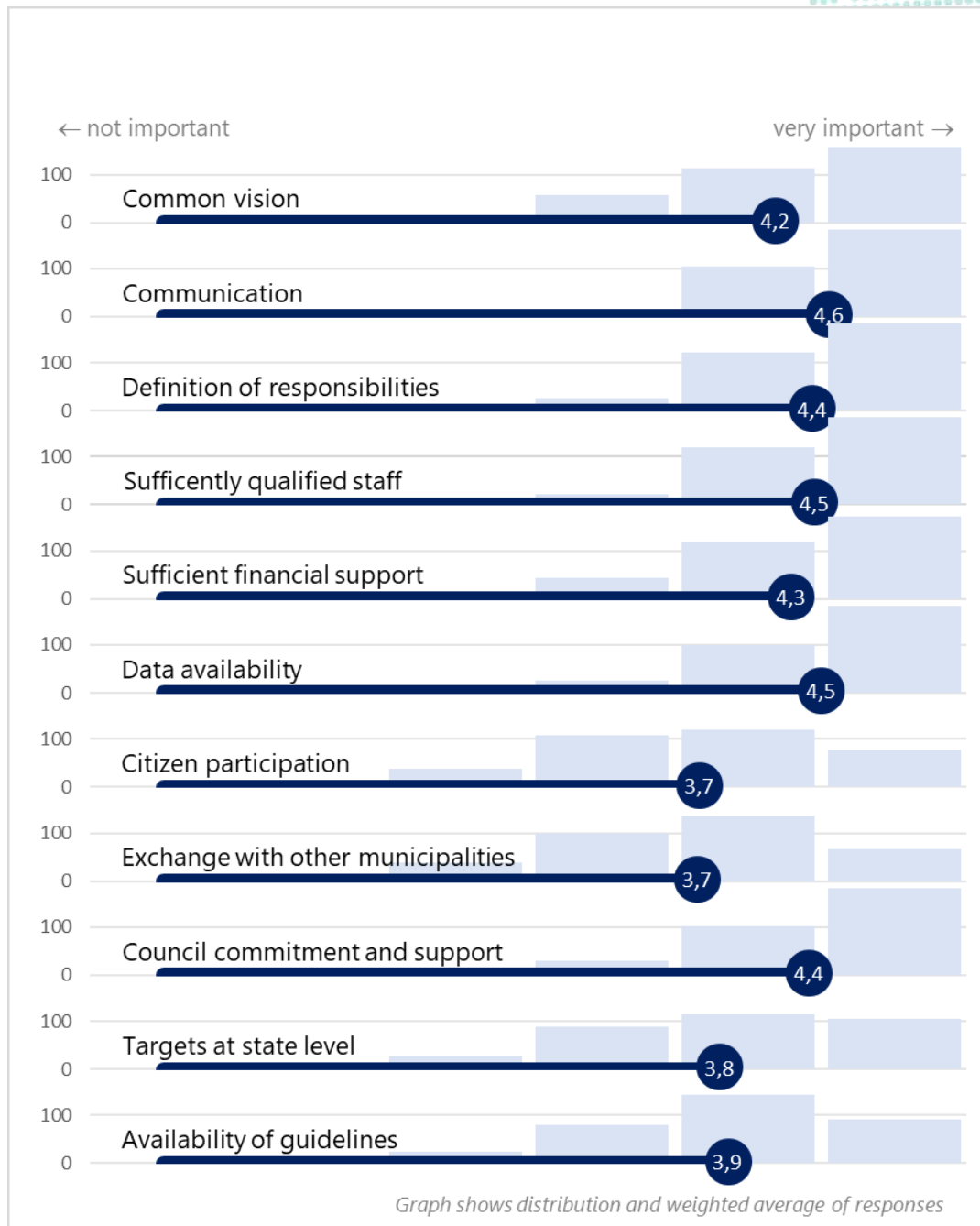


Figure 9 Assessment of important elements for H&C planning

The assessment of the respondents' answers on the challenging elements of strategic H&C planning is presented in **Error! Reference source not found.** As with the important elements, all challenging elements were rated above the mean value. This shows that all presented elements are generally rated as challenging. But compared to the evaluation of the important elements, the differences in the evaluation of the challenging elements are greater.

As mentioned before, many stakeholders are involved in the process of heat planning. For this reason, it is often difficult to create a common target picture and a common vision for all actors, as the interests can be very different. This is also shown by the results of the survey. The shared vision is ranked as the most challenging element by respondents, with 38 % rating this as very difficult and 36% as difficult. For this reason, the recommendation can be made that a moderated process for developing a shared vision is of great importance.

The second most challenging element is the element of sufficiently qualified staff. Overall, 72 % rated this element as very challenging (37 %) or challenging (35 %). Starting points for solving this problem can be more staff, but also better structures and interlocking within existing municipal tasks. In addition, the provision of planning tools that reduce effort can be helpful.

Exchange with other municipalities, the availability of guidelines, targets at state level and citizen participation are perceived as less challenging in comparison, but all of these factors are still above the mean Likert scale score of 2.5. Other challenges described in an open-ended question include staying on schedule and minimizing delays, as well as privacy and data security requirements.

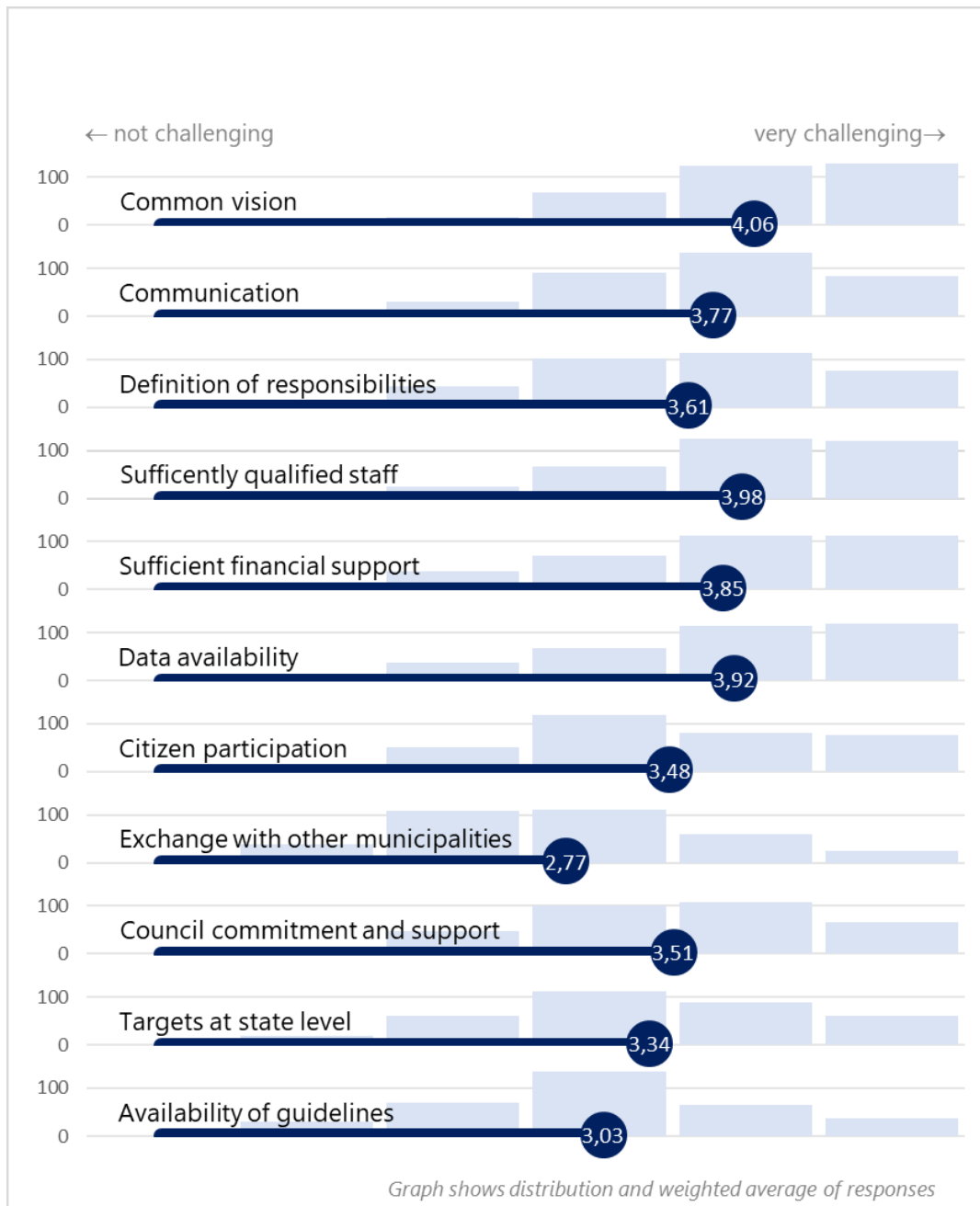


Figure 10: Assessment of challenging elements of H&C planning

Figure 11 shows the results of the questions about the important and challenging elements as a matrix. The higher a point is, the more challenging the aspect is rated and the further to the right a point is, the more important the aspect is rated.

The respondents rated communication in heat planning as comparatively important and challenging. After all, a large number of actors with different ideas and priorities are involved in heat planning. It is not uncommon for the municipality itself, the energy supplier, the building authority, a planning office and other actors to be involved. It is therefore important that these actors are in regular exchange during the process and that the heat plan is also perceived and developed as a communication tool.

The availability of data is seen as another important element. Data on heat demand and potentials for renewable energies are the basis for successful heat planning. It should be emphasized that heat planning is an upstream process that precedes technical feasibility studies and specialized planning. The question of data quality is therefore essentially about finding the appropriate measure that is sufficient to initiate target-related measures.

As mentioned before, many actors are involved in the process of heat planning. For this reason, it is often difficult to design a common target picture of all actors, since the interests can be different. Therefore, a moderated process to develop a common target picture in the context of heat planning seems to be of great importance.

Furthermore, the availability of sufficient personnel is perceived as a comparatively big challenge. Starting points to solve this problem can be more personnel, but also better structures and interlocking within existing municipal tasks (e.g. interlocking with spatial planning). In addition, the provision of planning tools that reduce the effort required can be helpful. The availability of planning tools was neither considered particularly challenging nor particularly important by the respondents.

Overall, the respondents consider H&C planning to be an effective and suitable instrument, which are initially positive starting conditions. The participants in the survey see CO₂ neutrality as the main goal of H&C planning. This is followed by security of supply and implementation of specific measures. However, respondents considered all presented goals important. Regarding the content of the H&C plans, the potential for renewable energy, the targets, and the measures for implementation were rated as very important. In addition, respondents rated good communication and availability of data as the most important elements. Different stakeholders are involved in H&C planning, which highlights the importance of good communication and the challenge of having a common vision. For this reason, successful H&C planning should have (professional) moderation to develop a shared vision among all stakeholders and to support communication. To address the challenge of sufficient staffing, more staff, but also better internal structures and dovetailing with existing municipal tasks, e.g., spatial planning, could be considered. In addition, the provision of planning tools that reduce effort could be helpful. All of these measures could be advanced with comprehensive financial support programs.

The next steps are to motivate municipalities to carry out heat planning in a committed and goal-oriented manner. To this end, heat planning should be embedded in a regulatory framework that gives municipalities room for maneuver to translate the planning into measures and concrete projects. It is therefore important that the focus of heat planning is not on the creation of a single plan, but on the entire process of achieving a climate-neutral heat supply.

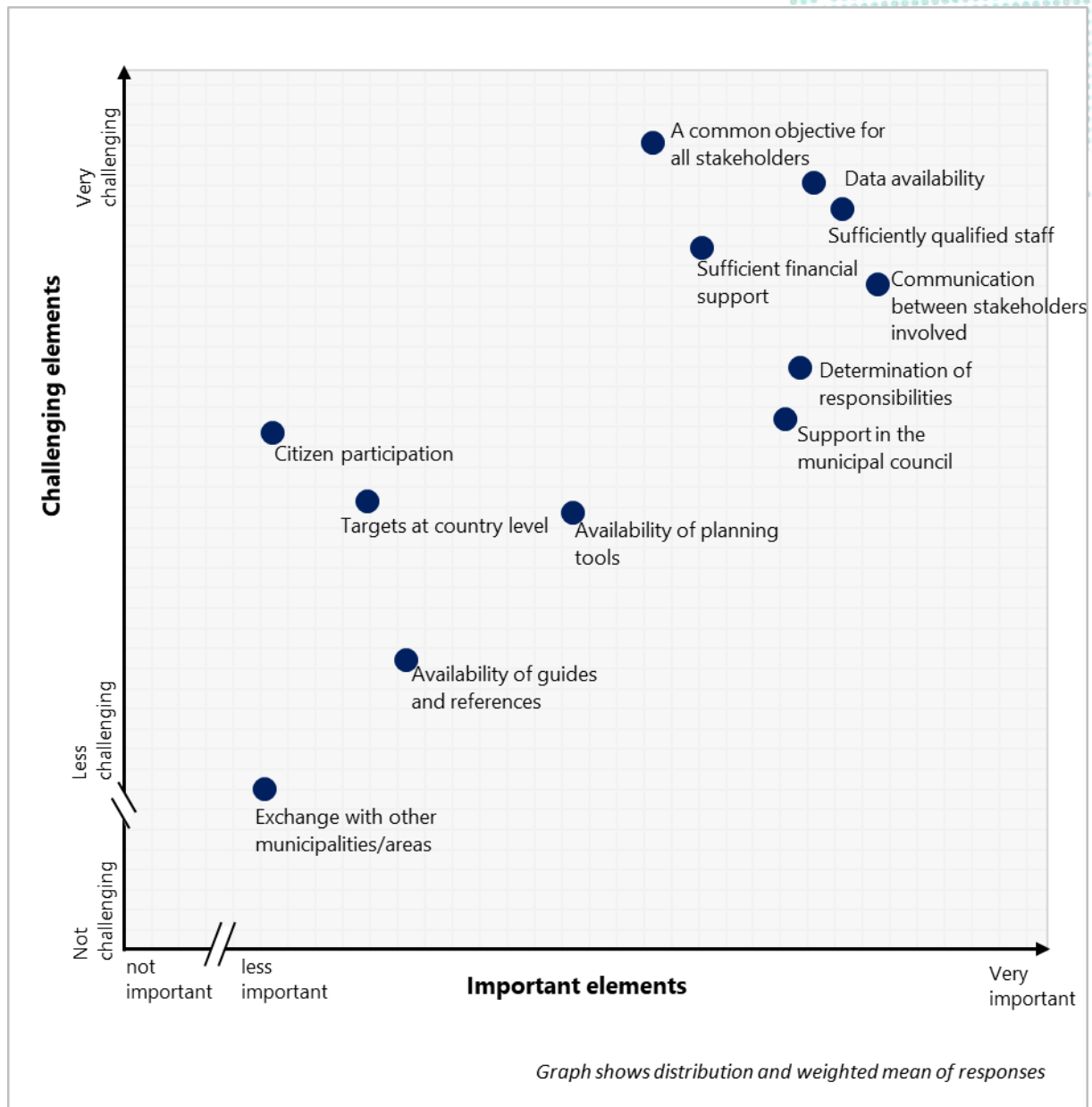


Figure 11: Important and challenging elements of H&C planning

7 References

- Büchele, Richard; Kranzl, Lukas; Hummel, Marcus (2019): Integrated strategic heating and cooling planning on regional level for the case of Brasov. In *Energy* 171, pp. 475–484. DOI: 10.1016/j.energy.2019.01.030.
- Chittum, Anna; Østergaard, Poul Alberg (2014): How Danish communal heat planning empowers municipalities and benefits individual consumers. In *Energy Policy* 74, pp. 465–474. DOI: 10.1016/j.enpol.2014.08.001.
- Energie- und Klimaschutzinitiative Schleswig-Holstein (Ed.) (2014): Die kommunale Wärmeplanung. Ministerium für Energiewende, Landwirtschaft, Umwelt und ländliche Räume.
- Energy Agentur NRW (Ed.) (2011): 100 Klimaschutzsiedlungen in Nordrhein-Westfalen. Planungsleitfaden.
- EU Commission (2016): An EU Strategy on Heating and Cooling. Available online at <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0051&from=en>
- EU Commission (2021): Directive of the European Parliament and of the Council on energy efficiency (recast). Available online at <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021PC0558&from=EN>.
- Harrestrup, M.; Svendsen, S. (2014): Heat planning for fossil-fuel-free district heating areas with extensive end-use heat savings: A case study of the Copenhagen district heating area in Denmark. In *Energy Policy* 68, pp. 294–305. DOI: 10.1016/j.enpol.2014.01.031.
- Heat Roadmap Europe (Ed.) (2017): Heating And Cooling Energy Demands. HEATING AND COOLING - facts and figures. Available online at https://heatroadmap.eu/wp-content/uploads/2019/03/Brochure_Heating-and-Cooling_web.pdf.
- Johannsen, Rasmus Magni; Østergaard, Poul Alberg; Maya-Drysdale, David; Krog Elmegaard Mouritsen, Louise (2021): Designing Tools for Energy System Scenario Making in Municipal Energy Planning. In *Energies* 14 (5), p. 1442. DOI: 10.3390/en14051442.
- IRENA and Aalborg University (2021): Integrating low-temperature renewables in district energy systems: Guidelines for policy makers, International Renewable Energy Agency, Aalborg University, Abu Dhabi, Copenhagen. Available online at https://irena.org/-/media/Files/IRENA/Agency/Publication/2021/March/IRENA_District_Energy_Systems_2021.pdf
- Joshi, Ankur; Kale, Saket; Chandel, Satish; Pal, D. (2015): Likert Scale: Explored and Explained. In *BJAST* 7 (4), pp. 396–403. DOI: 10.9734/BJAST/2015/14975.
- Köhler, Benjamin; Bürger, Veit; Weidinger, Roman; Doderer, Hannes; Schäfer-Stradowsky, Simon; Tänzler, Dennis (2021): Strategische kommunale Wärmeplanung. Ariadne.
- Mathiesen, Brian Vad; Bertelsen, Nis (2020): Developing an effective strategic heating/cooling plan: What key success factors? IRENA WEBINAR. April 20th 2020. Aalborg University - Sustainable Energy Planning Research group. Webinar, 2020.
- Nilsson, J. Stenlund; Mårtensson, A. (2003): Municipal energy-planning and development of local energy-systems. In *Applied Energy* 76 (1-3), pp. 179–187. DOI: 10.1016/S0306-2619(03)00062-X.

Peters, Max; Steidle, Thomas; Böhnisch, helmut (2020): Leitfaden Kommunale Wärmeplanung. Edited by Ministeriums für Umwelt, Klima und Energiewirtschaft Baden-Württemberg. KEA Klimaschutz- und Energieagentur Baden-Württemberg GmbH.

Rehbogen, Alexander (2019): Räumliche Energieplanung für die Wärmewende. SIR Salzburger Institut für Raumordnung und Wohnen. Karlsruhe, 9/30/2019.

Weinand, Jann Michael (2020): Reviewing Municipal Energy System Planning in a Bibliometric Analysis: Evolution of the Research Field between 1991 and 2019. In Energies 13 (6), p. 1367. DOI: 10.3390/en13061367.

Appendix

Find the full appendix here: https://actionheat.eu/sites/default/files/media/files/D2.1-Appendix_final_uploaded.pdf

About Act!onHeat

Heating and cooling (H&C) accounts for about half of Europe's total energy needs with 75% still dependent on fossil fuels. Thus, rapid and significant change is needed to reach the EU 2050 goals. Due to the local nature of H&C systems, action has to be taken at local level involving a variety of stakeholders. This has been recognised in recent years and activities have been started like developing best practice policies and open source analysis tools. However, (efficient) H&C planning and project development are still not commonplace in most European municipalities.

Act!onHeat will enable and accelerate local Heating & Cooling transitions by:

- identifying success factors of effective energy plans, turning them into practical workflows;
- developing individual and group support activities to guide municipalities, local planners and stakeholder in applying these workflows;
- facilitating finance and the design of effective heat & cooling projects and policy frameworks



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