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D1.2 - Report on end-users' current status, practices and needs in H&C plans

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PU	Public	**X**

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List of abbreviations / Nomenclature

Abbreviation	Definition
CAPEX	Capital Expenditure
CO_2	Carbon Dioxide
DEA	Dynamic Energy Atlas
DHC	District Heating and Cooling
DHW	Domestic hot water
ESCO	Energy Service Company
GIS	Geographic Information System
GJ	Gigajoule
GUI	Graphical User Interface
H&C	Heating and Cooling
IRR	Internal Rate of Return
KPI	Key Performance Indicator
kWh	Kilowatt-hour
NO_x	Nitrogen oxides
NPV	Net Present Value
OPEX	Operational Expenditure
OS	Operating System
PM	Particulate Matter
RES	Renewable energy share
SEAP	Sustainable Energy Action Plan
SO_x	Sulphur oxides

Introduction

This document represents deliverable “D1.2 Report on end-users' current status, practices and needs in H&C plans”, developed under the responsibility of TUD in the framework of Task 1.1 “Definition of end users’ requirements through a participatory approach”. The deliverable has been implemented collaboratively by the partners directly involved in WP1, namely TUD, VITO, ARTELYS, UNIZAG FSB, TECNALIA, ANTWERP, NOA, ML and VLG.

To perfectly match the software functionalities to cities’ needs and wishes, a bottom-up approach was adopted, trying to involve cities as much as possible in the process of definition of PLANHEAT tool specifications. Following a bottom-up approach, public authorities (cities and regions) have been directly interrogated about their specific needs for mapping and planning H&C at local level through questionnaires, online surveys, webinar and a dedicated face-to-face event in Delft.
The different phases of this involvement of local authorities are presented here.

The objective of this activity is first to investigate current practices for H&C mapping and planning in terms of already existing methodologies and tools currently used by public bodies to identify needs and deficiencies which may be improved according to public bodies wishes and needs.
Then, the identified end-users’ desiderata have been translated into technical specifications for the PLANHEAT integrated tool in terms of functionalities and interface, and will be integrated in the following D.1.3 “Report on the Modules Specifications”.
The results of this translation process will be presented to municipalities in a dedicated workshop, which will be held during the PLANHEAT Launching Event in the framework of the “3rd European Congress of Local Governments” (taking place in Krakow, Poland, on 27-28 March 2017), in order to collect feedback for potential further refinement.

In the next chapters, the following aspects are presented:

- The methodology adopted to collect relevant inputs for the present deliverable (Chapter 1);
- How the methodology has been implemented (Chapter 2);
- Analysis of the main outcomes from the questionnaires and translation in technical requirements for the tool (Chapter 3);
- Conclusions (Chapter 4).

1 Methodology

Relevant input for this deliverable has been collected by a complete participatory approach, which took place from M2 to M4 of the project.

The collection of relevant input from European cities has been performed through a simple questionnaire (which will be described in Chapter 3 of this document), where cities are directly asked to provide knowledge and information about mapping and planning H&C at local level, current practices and wishes.

This questionnaire has been circulated by email and through telephone interviews by all the PLANHEAT partners (also thanks to the support of EHP) to several cities all over Europe and it has been possible to collect inputs from Velika Gorica, Antwerp and Lecce and 23 additional cities from 10 European countries (Belgium, Bosnia and Herzegovina, Croatia, Greece, Italy, Latvia, Macedonia, the Netherlands, Poland and Spain) providing to the PLANHEAT project a comprehensive overall vision of the European situation in terms of redaction of sustainable H&C plans and presenting different climate and urban energy efficiency scenarios.

A physical workshop has been specifically organized in Delft by TUD on the 14th of December in order to maximize validation cities' participation, to stimulate the dialogue and communication among them and with the PLANHEAT technical staff, to interrogate them on the needs for future mapping and planning of low carbon scenarios for heating and cooling as well as to present the preliminary results obtained from the questionnaires' collection. In this event the VITO Dynamic Energy Atlas has been presented as an example of the potential of mapping tools for the redaction of sustainable heating and cooling urban plans.

In order to facilitate the processing of survey results, this questionnaire has been translated by VLG and DAPP in an online form (Fig. 1 - https://docs.google.com/forms/d/e/1FAIpQLScFMul9cTOjHY-ujlqTqyZFxIDpgeuIQMBhfedbN1NkyUClg/viewform) promoted both through the PLANHEAT website (www.planheat.eu) and through LINKEDIN.

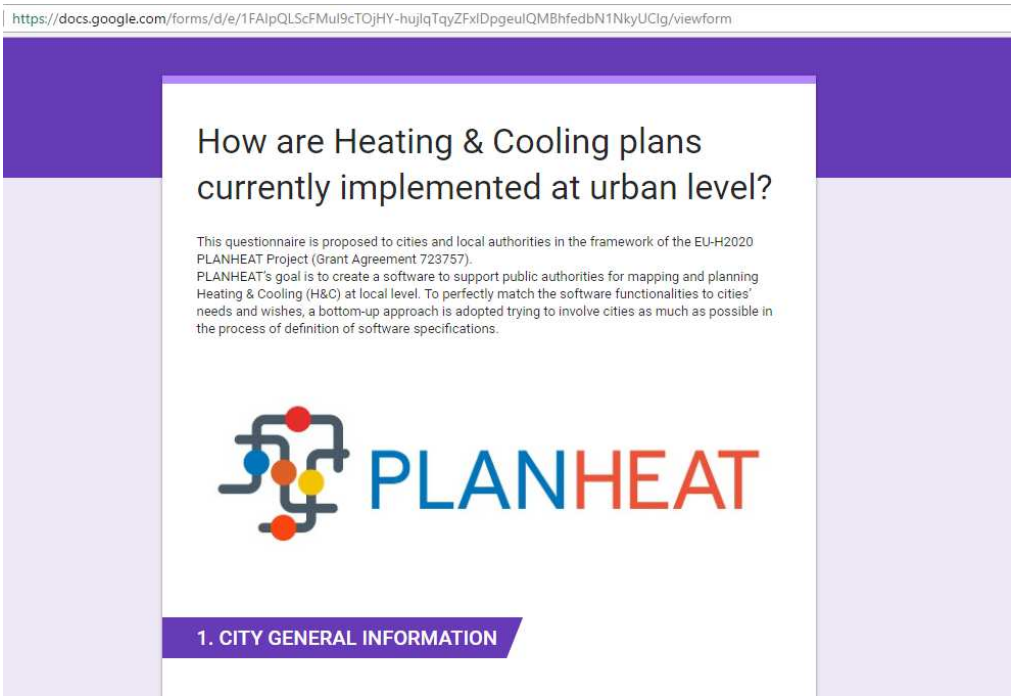

Fig.1 – PLANHEAT On-line Questionnaire

The questionnaire and the online survey have been promoted during a Cities Oriented Webinar organized in the framework of the CELSIUS Project named "CELSIUS Talk: Heating and cooling strategy development", held on the 25th of January 2017, where the PLANHEAT project has been disseminated, focusing on the important role of EU cities in this preliminary tool requirements specification phase. Attendees from the cities of Chemnitz (DE), Gdynia (PL), Uppsala (FI), Gothenburg (SE), Ljubljana (SI), Copenhagen (DK), Genova (IT), Oslo (NO) were contacted at the end of the webinar, in order to collect their input as well.

The webinar has been also the venue for an introduction of the project to, and interaction with EU-funded sister projects such as CELSIUS and progRESsHEAT.

Fig.2 – CELSIUS Talk: Heating and Cooling strategy development (Courtesy of CELSIUS Project)

It is important to underline that the collection of Cities' input for the shaping of tailored specifications of the PLANHEAT tool will go on until M6, and further questionnaires and inputs will be collected during the PLANHEAT Launching event at the European Congress of Local Governance in Krakow. This is thanks to the presence of a dedicated promotional stand and a dedicated workshop, where representatives from local authorities all over Europe will be able to interact with the PLANHEAT technical team.

Being based on a participatory approach, these events have helped in the process of building a common understanding of project's technical activities, and facilitated the development of agreed strategies and formulation of specific solutions to solve technical issues.

In coordination with the other partners involved in this task, DAPP set up the template of the questionnaire and the plan for interviews, also according to the D.1.1 "Executive Action Plan". Technical partners collected information from the cities of their network (mainly from their own countries) and finally TUD and DAPP translated these into technical requirements for the tool.
In addition to this, bi-weekly conference calls have been organized to discuss technical activities related to WP1 and WP3, including further analysis of workshops and questionnaires' outcomes. The combination of all these types of input is presented in this document.

2 Methodology Implementation

2.1 PLANHEAT questionnaire on urban heating & cooling plans

The questionnaire that was distributed to local authorities and municipalities, has been divided into three sections (i.e. quantification of H&C demand, quantification of current and potential H&C supply sources and planning and estimation of new H&C scenarios), plus an introductive part dedicated to cities' general information. For each section, information on needs and wishes, current practices in terms of used tools and methodologies and their strengths and deficiencies are requested (Fig.3).
The questionnaire is a mix of "open answer" and multiple choice questions, in order to guide the end users through the document and provide the most detailed information about the current and future situation of its municipality, concerning sustainable urban heating and cooling plans.

The text of the Questionnaire is attached as an appendix at the end of this deliverable.

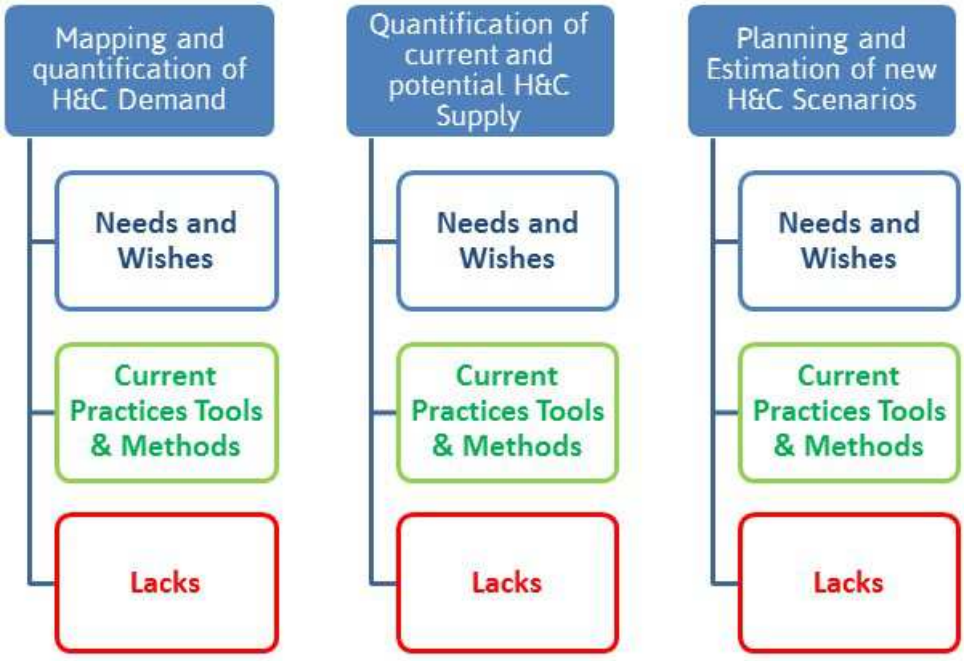

Fig.3 - Questionnaire's fields of investigations

2.1.1 Preliminary Section: City general information

In this section, generic information from the city is requested (Name, Country, Number of Inhabitants…) in order to geographically frame the input and to facilitate eventual clustering activities in terms of city size, climate, EU geographic region and number of inhabitants.
Furthermore a specific question about city peculiarities is proposed in order to identify potential waste heat sources (i.e. industrial suburb, underground etc.) or geographical and environmental

features (i.e., local presence of forestry, lake, forestry, cultural or environmental heritage constraints, etc.).

At the end of this section, local authorities are queried about their current state of sustainable urban planning, both in the framework of the SEAP, and concerning specific strategies towards the decarbonisation of heating and cooling systems.

2.1.2 Section 1: Quantification and mapping of H&C demand

One of the aims of the PLANHEAT mapping module is to map and quantify H&C demand using data that is easily available to public authorities, such as land use and cadastral maps, demographic information, typology of building and construction age, etc…
This mapping activity could be performed both at district and city level.

In this framework, it is important to understand what the needs and wishes of local authorities are, identifying how they are currently performing this kind of activity (methodologies and tools). This is necessary in order to set up the PLANHEAT mapping module in a shape and form that can easily be integrated into current practice, but fulfils cities' needs and wishes, and addresses the deficiencies of current methodologies.

2.1.3 Section 2: Quantification of H&C supply

The other aim of the PLANHEAT mapping module is to map and quantify potential supply from renewable sources (solar energy, biomass and geothermal energy), from unconventional energy sources available at urban level (such as sewage, water bodies, underground ventilation shaft, data centres, shopping malls, etc...) and from industrial excess heat.
This mapping activity could be performed both at district and city level.

The supply of heating and cooling is analysed with a similar approach in both the current baseline situation and the foreseen and desired situation.

In this framework it is important to understand which sources are currently used to supply heating and cooling systems at the urban level, and which are the main installed H&C infrastructures (DH/C Networks, Gas Networks, CHP plants, decentralized boilers….).
As mentioned previously, it is important to understand what the needs and the wishes of local authorities are, as well as to identify how they are currently performing these kinds of activities (methodologies and tools) in order to set up the PLANHEAT mapping module in a shape and form that can be easily integrated into current practice, but that can fulfil cities' needs and wishes, and addresses the deficiencies of current methodologies.

2.1.4 Section 3: Planning and estimation of new H&C scenarios

In the last part of the questionnaire, representatives from local authorities are interrogated about their needs and wishes concerning the planning and simulation of heating and cooling systems for their cities in terms of scale (district/building/city), identification of desired energy sources, description of the outputs and for which purposes the simulation analysis are performed (economical and environmental, other specific requirements such as DHN extension, revamping of heating generation units….)

It is worth emphasising that the evaluation KPI panel will be customized according to inputs collected by additional cities in Task 3.4.

2.2 Validation Cities Workshop

On the 14th of December 2016, a physical workshop in Delft was organized by TUD in the presence of all WP1 partners (physically or via conference call). This event was an opportunity for a first evaluation of the results of the questionnaire campaign, to present the questionnaire to validation cities, to discuss the preliminary results from the public authorities survey and for a direct interaction between technical partners and the PLANHEAT validation cities, also in order to refine the questionnaire before its online implementation (January 2017).

In this framework, VITO presented the Dynamic Energy Atlas, a mapping tool built in-house by the Flemish institute, that will be the initial input for the PLANHEAT mapping module. The presentation included a live demonstration of the DEA for Flanders, showcasing the current energy sources that the tool covers and presenting different ways to analyse supply potentials.

Afterwards, the new energy source potentials to be implemented and mapped by the tool were discussed among the WP1 partners. the City of Antwerp emphasised the importance of following city input for this issue, in order to map really targeted energy sources that could be easily exploitable by the city (i.e. industrial waste heat in case of Antwerp).

2.3 Joint webinar CELSIUS-PLANHEAT-PROGRESSHEAT projects

On the 25th of January, PLANHEAT participated in a joint webinar with the progRESsHEAT and CELSIUS projects in order to promote PLANHEAT research activities within the CELSIUS cities network.

CELSIUS is a running European project, funded under the Smart Cities & Communities call (2011). The project aims at developing, optimizing and promoting efficient decentralized heating and cooling systems in cities, thus consistently contributing to the reduction of CO_2 emissions and of primary energy consumption. The project involves five different cities: Gothenburg, Cologne, Genoa, London and Rotterdam, and includes the monitoring of 22 demonstrators (12 new and 10 already existing and operating) covering different efficient technologies, systems and practices (celsiuscity.eu).

One of the goals with CELSIUS was to recruit 50 New CELSIUS Cities and to provide them with relevant support, advice and guidance to help gain support for, establish, construct or ultimately grow district heating and cooling systems in their cities.
New CELSIUS Cities believe that intelligent district heating and cooling systems have a role to play in the evolution of the city's energy systems, and have committed to actively engage and collaborate with the CELSIUS project in pursuing the cities' heating and cooling objectives. According to this vision, CELSIUS cities could be interested in designing innovative and sustainable H&C plans for their urban contexts.

The CELSIUS offering towards New Celsius Cities consists of: workshops, demonstrators, the CELSIUS toolbox, an expert group and a series of webinars.

The CELSIUS project, as PLANHEAT supporter, invited PLANHEAT and progRESsHEAT representatives to take part in one of the aforementioned webinars and promote the ongoing research activities on planning H&C at local level within the CELSIUS cities network.

During this online meeting, CELSIUS cities had the possibility to take a closer look to the tools that are being developed by the European projects progRESsHEAT & PLANHEAT, and how they will help key decision makers in the development of their heating and cooling strategy.

DAPP introduced the PLANHEAT project concept with a focus on the PLANHEAT validation cities and a training strategy, underlining the opportunities that the PLANHEAT tool can offer to EU cities in supporting the decarbonisation of their H&C systems.

At the end of the Webinar, a short Q&A time has been introduced and the following questions were posed to the speakers:

- At what scale will the PLANHEAT tool work?
- How are cities involved in the implementation and development of the tool?
- Which advice would you give to municipalities before starting an H&C planning process at city level?

3 Analysis of the main outcomes from the questionnaires and translation in technical requirements for the PLANHEAT tool

The first section of this chapter presents the information collected through the questionnaire, whereas the second part reports the outcomes resulting from the analysis of the aforementioned information. These findings have been further elaborated and translated in technical specifications for the PLANHEAT modules and integrated tool.

3.1 General results

Findings and results from the survey are presented in the following sections, according to the structure of the questionnaire as presented in Chapter 2. Results are reported as percentage of the total number of interviewed cities, having provided a positive answer to a specific question of the questionnaire.

3.1.1 Preliminary section: City general information

Through the joint effort of WP1 partners the questionnaire has been shared among a European network of municipalities covering 9 different EU countries (Belgium, Croatia, Greece, Italy, Latvia, Macedonia, the Netherlands, Poland and Spain) and one extra-EU country (Bosnia and Herzegovina) for a total number of 26 cities and planning authorities (3 validation cities, 23 additional municipalities and other planning authorities).

Fig.3 – EU countries covered with the survey (questionnaires and interviews)

Validation cities

- Antwerp (BE)
- Velika Gorica (HR)
- Lecce (IT)

Other cities and regional authorities

- Bolzano (IT)
- Cagliari (IT)
- Genova (IT)
- Zagreb (HR)
- Regea (HR)
- Rotterdam (NL)
- Valencia (ES)
- Karpoš (MK)
- Riga (LV)

- Jastrebarsko (HR)
- Klanjec (HR)
- Osijek (HR)
- Perušić (HR)
- Karlovac (HR)
- The Hague (NL)
- TU Delft campus (NL)
- Region of Asturias (ES)
- Barakaldo (ES)
- Region of Basque Country (ES)
- Kortrijk (BE)
- Visoko (BA)
- Athens (GR)
- Starogard (PL)

Then, a round of interviews was conducted either in person or by phone/skype with a smaller number of public authorities. These followed the same structure as the questionnaires, but allowed for both more detailed background information and general systemic observations not captured in the standard questions. The following cities and authorities participated:

- Rotterdam (NL)
- The Hague (NL)
- TU Delft (NL)
- Zagreb (HR)
- Lecce (IT)
- Athens (GR)
- Antwerp (BE)

The interviewed cities cover a wide range of cases in terms of:

- Size (minimum size: 2,368 inhabitants; maximum size: 3,100,000; total inhabitants: 15,981,449)
- Climatic conditions
- Peculiarities as reported in the following table.

Municipality	**Peculiarities**
Antwerp (BE)	World port , Global top 3 petrochemical cluster, historical centre, 19th & 20th century expansion
Lecce (IT)	Availability of wind and solar energy
Velika Gorika (HR)	Alluvial plains with high level of groundwater, large groundwater reservoir near the river Sava
Cagliari (IT)	Harbour, beaches, lagoons, wetlands, prevailing trade and tertiary activities
Genova (IT)	Port, Mechanical industry, Shipbuilding
Perušić (HR)	Wood industries
Karlovac (HR)	Industrial zone "Mala Švarča"
Rotterdam (NL)	Harbour, petrochemical industry, refrigerated storage, large waste incineration plant and more
The Hague (NL)	Harbour, geothermal power plant, sea water heat pump plant
Karpos (MK)	Urban city neighbourhood
Riga (LV)	City located at the East Sea, significant biomass resources nearby (wood, straw)
Visoko (BA)	Municipality is located between Sarajevo and Zenica, it has 15 industrial zones, textile and leather industry are the most developed

Table 1: Peculiarities of the interviewed cities

The majority (65%) of the cities interviewed have developed a Sustainable Energy Action Plan (SEAP). Furthermore, 27% of them have already developed plans for future decarbonisation of H&C systems at urban level/regional level.

3.1.2 Section 1: Quantification and mapping of H&C Demand

At present, only 35% of respondents have partially or fully quantified **heat demand** (and some that have, only for municipal owned buildings) whereas only 8% of the interviewed municipalities quantifies **cooling demand**.

Needs and wishes

Heat demand
Although all respondents have interest in mapping H&C demand, they have differing needs and wishes for the reference scale (multiple choices were possible):

- 69% neighbourhood scale
- 58% building scale
- 35% other: city/municipality scale; variable scale according to the purpose (e.g. 1 ha for regional energy planning, 50mx50m for city energy planning); building block scale to avoid issues related to data confidentiality.

The remaining 12% highlights the preference to map and quantify future heat demand temperature levels.

Cooling demand
As with heat demand, needs and wishes for cooling demand are related to the possibility to estimate them at both neighbourhood (38%) and building scale (38%).

Methodologies and tools
The methodologies to quantify heat demand are based on the analysis and aggregation of fuel consumption data (e.g. natural gas). Some cases have consumption data publically available for public buildings only. Furthermore, although these methodologies provide good results for residential and commercial buildings, they are rarely suitable for the assessment of heat demand in the industry sector.
The tools included in the questionnaires are: ArcGIS, LEA, Energy databases, traditional calculation spreadsheet (e.g. excel). Further details are reported in the following tables.

Tool name	**ArcGIS (ESRI) - Antwerp**
Objective	Analysis of heat demand for feasibility studies and as a support for policy making.
Input	Heat consumption per street segment/grid segment
Output	Maps and analysis
Additional Information	• Heat consumption is projected geographically, provides a spatial overview • Provides advanced spatial analysis tools. • Compatible with most of the city's datasets. • Can be aggregated to higher scale • Broadly used and has good support • Not an open source software, compatibility with QGIS might be an issue/Demands expert knowledge/Not very suitable for modeling and simulating.

Tool name	**LEA – Delft**
Objective	Model demand of all TUD buildings
Input	Building properties, demand data

Output	Demand forecast
Additional Information	Uses common data format, can work with other tools (like Wanda)

Tool name	**Banca Dati Energia (BDE - Energy database) – Genova**
Objective	Quantifying heat demand
Input	Input data are provided by IRETI (utility for natural gas network in Genoa) and by regional geoportal for collecting georeferenced information
Output	Aggregated energy data
Additional Information	The tool is in accordance to the "open data" principle It's not possible to specify the energy final use

Tool name	**Energy control mapping which is in agreement with 2012-2015 city's regulation and country's regulation valid since 2015 - Karpos**
Objective	To quantify energy demand
Input	U-coefficient calculation for building's envelope
Output	Building's energy efficiency class and energy needs
Additional Information	It's not a standard at national level (currently missing)

Tool name	**Heat demand map of distribution grid operator - Kortrijk**
Objective	Mapping heat demand
Input	Consumption data, provided by distribution grid operator (gas consumption; electricity consumption; split in industrial / non-industrial)
Output	
Additional Information	Very static A lot of data to process to create maps; requires a lot of skills within the city administration to work with this data

Tool name	**Scada HIGH – LEIT - Visoko**
Objective	Mapping heat demand
Input	Gas flowrate and outside temperature
Output	Gas consumption (including consumption forecasting and data base)

As for **cooling demand**, methodologies based on benchmark data according to the buildings typologies are reported. ArcGIS is the only tool mentioned (by municipality of Antwerp) for analysing and modelling cooling demand.

Tool name	**ArcGIS - Antwerp**
Objective	Analysis of cooling demand for feasibility studies and as a support for policy making.
Input	Cooling consumption per street segment/grid segment
Output	Maps and analysis.
Additional Information	• Cooling consumption is projected geographically, provides a spatial overview • Provides advanced spatial analysis tools. • Compatible with most of the city's datasets.

	• Can be aggregated to higher scale • Broadly used and has good support • Not an open source software/Demands expert knowledge/Not very suitable for modeling and simulating.

Reported deficiencies

Heating demand

- A tool or module to forecast the heat demand in the upcoming decades in order to plan the gradual transformation into sustainable city is needed. A crucial input parameter is the energy performance of buildings. This is not available yet. The dataset of energy performance certificates is a starting point and could give very good estimates for a neighbourhood's current status and renovation potential;
- Detailed information about the final energy use (only estimations are possible);
- GIS-data are required;
- Additional needs are related to the possibility of boiler capacity calculation, DH distribution system and consumers location, detailed and easy-to-use catalogue of technology and prices;
- Lack of information about current tools,
- Lack of information about most of the necessary data;
- No access to gas, electricity consumption data;
- User friendliness: tools provided with ability to change grid size, adding data layers.

Cooling demand

- A tool or module to forecast the cooling demand in the upcoming decades in order to plan the gradual transformation into sustainable city. Actual, real cooling demand. The assumption of no cooling demand for residential buildings is still defendable but climate change and changing user demands might change that in the future;
- Tools for data acquisition and transmission are missing;
- Lack of information about current tools;
- Lack of methodologies to quantify cooling demand of AC units using total electricity consumptions.

3.1.3 Section 2: Quantification and mapping of H&C supply

Summary

Present day H&C supply is still fairly homogenous: non-renewable H&C supply still comes mostly from natural gas networks (73%) and CHP (power plants, 35%). Unmetered conventional sources (for example fuel oil) are also mentioned but will be difficult to quantify.

The three most well-known renewable thermal sources, biomass (58%), solar (38%) and geothermal (27%) already see significant deployment. The lesser well known sources are, as expected, not used as much yet: 12% sea/lakes/rivers and waste incinerators, 8% waste heat from industries, 4% for sewage networks, waste heat from ports and data centres.

The installed H&C facilities mentioned are:

- District Heating network (42%);
- District (Heating and) Cooling Network (15%);
- Natural Gas network (73%);
- Combined Heat and Power Plants (27%);

- Biomass generator (31%);
- Heat pumps - water/water, air/water, soil/water (12%).

H&C supply is currently quantified only by 38% of the interviewed municipalities. Specifically solar, biomass and geothermal supply sources are the sources quantified in current practices being also the most relevant and widespread.

Needs and wishes

Representatives reported various preferences for the reference scale for mapping and quantifying H&C supply:

- To quantify annual extractable potential from different resources available at local level (54%);
- To quantify annual effective potential from different resources available at local level (65%);
- To improve the reliability and level of detail of supply quantification (31%).

There is an interest to further development of existing methods for quantifying the most relevant supply sources (solar, biomass and geothermal). Furthermore, other sources like power plants, sewage network, ports, incinerators, data centres and underground networks are also considered relevant sources but are currently not quantified due to a lack of proper tools and methodologies.

Methodologies and tools

The following methodologies for quantifying H&C supply were reported:

- Based on the analysis of thermal energy sales data [kWh] provided by supply companies and split for each sector (building, industry and transport).
- Solar energy potential is calculated using solar radiation maps available online and PVGIS.
- Biomass potential is calculated using a data non-publicly available (forest coverage on local level and biomass production potential by specific forestry type)
- Geothermal energy potential is also calculated using geothermal potential maps at national level which aren't publicly available

As for the tools, the following tools and databases are mentioned:

Tool name	**ISGE (Information System for Energy Management) system https://www.isge.hr/ - Jastrebarsko**
Objective	Energy and water consumption metering
Input	Energy and water consumption, and costs
Output	Monthly/yearly energy and water consumption distribution
Additional Information	Simple, easy-to-use, GUI

Tool name	**WANDA - Delft**
Objective	Network and supply modeling
Input	Network properties, demand data
Output	Monthly/yearly energy and water consumption distribution
Additional Information	Uses common data format, can work with other tools (like LEA)

Tool name	**EXITE database - Karpos**
Objective	Monthly and yearly consumption monitoring

Input	Heating bills
Output	Consumption of energy in buildings, data comparison
Additional Information	By-hand input

Tool name	**Banca Dati Energia –database - Genova**
Objective	To estimate energy consumption and production at municipal level and geoportal
Input	Input data are provided by IRETI (utility for natural gas network in Genoa) and by regional geoportal for collecting georeferenced information
Output	Aggregated energy data
Additional Information	• The tool is in accordance to the "open data" principle • It's not possible to specify the energy final use

Tool name	**Solar PVGIS - Regea**
Objective	To estimate solar energy potential
Additional Information	• Easy to use, GIS based • Not enough precise

Reported deficiencies
On the question of what is missing in current tools and methodologies to reach their needs and wishes, respondents provided the following answers:

- The current tools and methodologies are adequate. However due to the different companies handling the quantification of each source, the result is in different format and different scale that complicates the analysis. Quantification in the future should bring results in an uniform format and should be easily updateable
- GIS based input and output, higher level of detail and reliability
- Lack of information about the potential of integrate wind turbines in the harbor
- Estimation of the potential of geothermal; waste heat from industry; data centers
- There is also a need for very good waste heat potential calculator

3.1.4 Section 3: Planning and estimation of new H&C scenarios

Summary
Most of the local authorities do not yet use any planning tools, but the interest towards planning methodologies and methods is very high. Furthermore, as only 15% of the interviewed authorities are supported by external consultants to provide the needed know-how for energy planning activities, the existence of an easy-to-use tool providing such a possibility is well received.

Needs and wishes
Respondents have voiced a significant interest in all the options supplied. The most popular ones are related to economic output and shaping local energy contracts (88%), identifying local renewable H&C potential (81%) and being guided in the creation of new scenarios (69%) mostly at district scale (69%). The 'other' category resulted in a few extra suggestions:

- Impact on current energy infrastructure and capacity (networks and distribution assets);

- the evaluation of the social benefits (job creation);
- Planning and simulation for a city centre;
- Assess the relation between the energy and social data (energy poverty);
- Estimation of the potential of unconventional energy sources (e.g. geothermal, waste heat from industries, etc.).

Methodologies and tools

Only 27% of cities answering to the questionnaire is currently using planning tools, and only 15% is supported by an external consultant. This underlines the need for user friendly tools and appropriate training modules. The most common tools used by cities are EnergyPlan, Trnsys, LEAP.

Reported deficiencies

- Other stakeholders will invariably need to be involved in the planning process. Examples are the local population, ESCOs, network operators, housing corporations, companies and so on. Several municipalities have indicated the desire to be able to calculate potential business cases. Even though they may not be the investing party, they consider themselves matchmakers and can use the output to shape policy making;
- Future heating and cooling demand relates to urban planning and is therefore also of great interest to elaborate future plans for sustainable heating and cooling. The City of Rotterdam has evaluated several approaches that may be of interest for PLANHEAT.

3.2 Technical requirements

The information collected has been analysed and translated into possible technical requirements for the PLANHEAT modules and integrated tool. The translated technical requirements have been organised in operative functionalities, input data required and output data generated, KPIs and requirements for the Graphical User Interface (GUI).

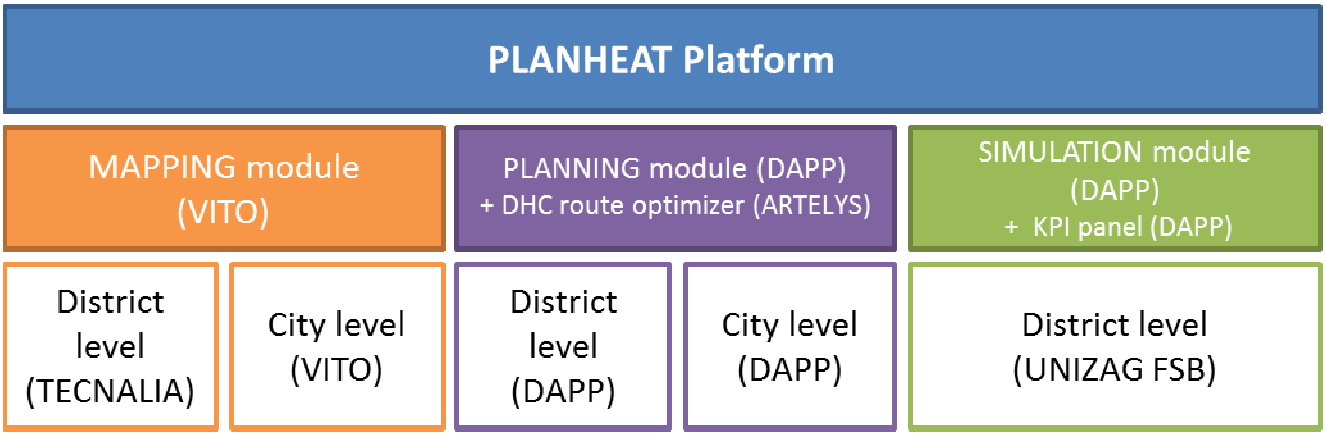

Figure 1: PLAHEAT tool – Updated concept

3.2.1 Mapping module

Analysis of survey results

From to the results of the survey shown in sections §3.1.2 and §3.1.3, the following conclusions have been extrapolated.

Methodologies to indirectly **quantify H&C demand** from energy consumptions of metered sources are used the most in common practice. For the residential sector, information from building energy labels is used as well. Relevant input data for this quantification are frequently acquired by municipalities from ESCOs, sometimes by agreement, sometimes as a legal requirement. **Tools for quantifying and mapping H&C demand** are available and used by the interviewed municipalities as well, especially with respect to the heat demand. The need for more precise and user friendly tools to be used without the support of an external consultant is reported.
Although the quantification of the cooling demand is considered a strategic aspect, less information about cooling demand related tools and methodologies is available. Cooling related consumption data is frequently hidden in electricity consumption figures. Furthermore, the possibility to estimate future H&C demand (reduced heat demand and increased cooling demand as an effect of climate change and heat waves) is mentioned as an important aspect in order to plan the gradual transformation into sustainable cities. Considering **quantification and mapping of H&C supply**, solar, biomass, geothermal, sea/lakes/rivers, waste heat from industries are indicated as the most relevant sources, followed by power plants, sewage network, ports, incinerators, data centres and underground networks. Methodologies and tools to assess and map the potential supply are available, but the need to further develop them in order to have more reliable results is highlighted.

In addition to the aforementioned general conclusions, the following detailed highlights have been deducted:

- **GIS**: In some cities renewable HC planning has not yet been integrated into GIS practices, and has been stated as an explicit wish;
- **Vector vs raster:** during the interviews, the desire for PLANHEAT's mapping module to provide output maps using statistical divisions (for example postal code area,

neighbourhood, district etc) rather than a raster, was communicated by several municipalities. These divisions are more common in their planning processes, so catering for them would therefore make PLANHEAT's output easier to integrate into their existing work routines. Care should also be taken that calculations can be traced back to the source data and the number of steps between source and product is both known and reduced to a minimum, as converting from one format to another may decrease accuracy;

- **LoD and privacy**: some respondents mention privacy concerns as a reason not to go beyond the building block in detail level. As reducing the detail level early on in calculations will also reduce the accuracy of results, one solution would be to provide output maps in a public version (for example pre-set at the neighbourhood or block aggregation level) and simultaneously have detailed output data privately available for further analysis;
- **Existing maps**: some cities have already created a number of detailed maps related to energy demand, demand reduction and residual and renewable supply, as part of their energy atlas. It may therefore be beneficial for them if the PLANHEAT planning and simulation modules include the ability to incorporate these maps (assuming they themselves are in common and/or non-proprietary formats). Care should however be taken that this data is reliable and verifiable (i.e. including the calculation methods used);
- **Data sources**: as the majority of respondents have not even quantified H&C demand yet (and all of them have indicated interest in at least one of the demand mapping options), PLANHEAT's training modules and documentation should include information on the pathways and source data that can provide these maps;
- **Uniformity of input and output**: The validation city of Antwerp states: "The quantification of potential of each H&C supply source is outsourced and each company uses its own methodology. The potential of solar energy is quantified by measuring the suitable areas of the roof to place a solar panel for all buildings in the city, whereas the biomass potential includes the sources in the proximity of the city", and "due to the different companies handling the quantification of each source, the result is in different format and different scale that complicates the analysis. Quantification in the future should bring results in an uniform format and should be easily updateable."

Technical requirements

All the collected information has been translated into possible technical requirements for the PLANHEAT mapping modules.

	Technical requirements
Operative functionalities	**Quantification and mapping of H&C demand** at variable scales (e.g., city, neighbourhood, building block, building block) avoiding data confidentiality issues **Quantification and mapping of H&C potential supply** (annual extractable and effective potentials) through reliable methods considering solar, biomass, geothermal, sea/lakes/rivers, waste heat from industries as the most relevant sources followed by power plants, sewage network, ports, incinerators, data centres and underground networks. Able to estimate future H&C demand All estimations should be easily updatable Including information about buildings energy performance to be able to assess the renovation potential

	GIS-based Able to import already existing and available maps
Input data required	Training strategy to inform about what are the relevant data Able to support multiple format Uniformity of input and output
Output data generated	Uniformity of input and output Output maps using statistical divisions (for example postal code area, neighbourhood, district, etc.) Standard data format interoperable with other tools
GUI requirements	User friendliness (to be used without the support of an expert): ability to change grid size, adding data layers, To limit manual data input

Table 2: Technical requirements for PLANHEAT mapping module

3.2.2 Planning module

Analysis of survey results

Most of the respondents are first interested in economic outputs coming from an estimation of heating and cooling new scenarios; this reflects the difficulties that energy planners have in collecting information about costs and revenues, required for an accurate definition of future plans.
From a policy development point of view, the economic and financing aspects play a fundamental and strategic role.
The identification of the potential of renewable sources is also considered important in the planning of future energy scenarios. Furthermore, more than the half of the respondents is interested in the identification and exploitation of potential from urban waste heat.
Very few respondents are supported by an external consultant, and express the need to be guided in the planning phase of this process.
The district scale is indicated as the most interesting to be investigated. Although building scale is a close second, it is also strongly dependent on the resolution of the available data and privacy requirements.
A tool able to evaluate the replacement of existing heating and cooling equipment at building level towards the realization of new district heating systems, is also considered useful by the majority of respondents.

Technical requirements

In the process of translation of the outcomes of the surveys into technical requirements, five main fields have been identified, summarised as following:

- **Boundaries and scale -** The scale considered should be related to source intensity and location. High temperature residual heat generally warrants larger investments and may therefore cross municipal borders. Examples are large industrial areas with residual heat potential exceeding the demand of the municipality they are located in, and waste incineration, where several municipalities may dispose of their waste in the same facility.

- **Existing infrastructure -** Two categories of existing infrastructure were mentioned during the interviews and in the validation city presentations. Collective heating systems in communal and office buildings can be connected cost effectively to a new DH branch, and their presence should therefore be considered in the planning module. This also applies to the presence of smaller existing DH networks (example: validation city Velika Gorica), which may become both more robust and more efficient if they are interconnected and start using multiple heat sources;
- **Network temperature** - Two considerations are important here: future energy efficiency of the connected building stock and the relation between heating and cooling demand. A lower network temperature is considered in some places, as this will both increase diversity in potentially available (renewable) sources and reduce network losses, although how low the temperature can go also depends on the replacement cost of existing (high temperature) delivery systems. If there is a balance and the buildings are efficient, it might be possible to deploy a smaller scale network that provides low temperature heat or cold depending on the season. In cities where the existing DH network has a high temperature, this appears to also be commonly used to provide DHW. Considering a network temperature below DHW levels is possible, but will therefore also require considering end user DHW micro systems;
- **Routing and deployment of DH Network** - Each city will have its own peculiarities in relation to routing and the resulting earthworks and in some cities there is a desire to reduce road obstruction by for example combining DH deployment with sewer replacement. According to some questionnaires, a routing optimizer for the DH deployment could be a plus in order to reduce the time and the size of sub-surface works, indeed this kind of civil works require long time interventions and bureaucracy procedures particularly in Cultural Heritage cities (i.e. Athens). It's likely that small scale (block level) or above ground networks (common in permafrost regions) can be more easily analyzed by this kind of tool.
- **Financial incentives** - Some cities have mentioned providing subsidies in specific areas for refurbishment, renewable energy systems and other sustainable measures. As this effectively lowers the threshold for deployment of HC plans, it would for planning purposes be beneficial to include a cost multiplier of sorts that can apply these in specified areas or for specified categories of buildings or income levels.

	Planning module
Operative functionalities	Create scenarios at district scale and building scale Identify potential from renewables and from urban waste heat Considering existing infrastructure in the development of new DHNs Consider different level of temperature for heat delivery in the definition of future energy scenarios Consider economic and environmental indicators besides energetic indicators in the definition of future scenarios Prioritization of potential supply function of current energy policies or local constraints Definition of renovated or new DHNs

	Possibility to plan a mix of sources to satisfy current or future demand
Input data required	GIS based maps of energy demand and source availability at city/district level Current local energy policies or constraints Current energy scenario definition Hourly/daily demand profile at district level and power peak values Technology library to create different scenarios
Output data generated	Standard data format interoperable with other tools Future scenarios to be simulated Benchmark with current scenarios
GUI requirements	Easy-to-use

Table 3: Technical requirements for the PLANHEAT planning module

3.2.3 Simulation module

According to the information included in the questionnaire, there is an interest for modelling and simulating H&C scenarios both at district (e.g. extension/replacement of existing DHC network, impact of new plants proposed by ESCOs or local energy providers) and building scale, in order to assess their economic, environmental, social and energetic impact in comparison with the baseline situation. However, only a few interviewees claim the use of specific tools to run numerical simulations at building at district level (e.g. TRNSYS).

Representatives were asked about the Key Performance Indicators they considered important to rate future H&C options with. These were divided in four categories: energy, environment, economic and social. Some KPIs fall under more than one category and have been included as such. Although most of the KPIs mentioned are quantifiable, some of the social KPIs are less straightforward and will require further research if they are to be included. Although security of supply seems similarly ethereal to the 'acceptability' KPIs, considering a HC source's future prospects (for example a local steel mill, or imported natural gas) and the length and origin of its supply chain may provide a basis on which to assess this.

The questionnaires highlighted the importance of quantifying the KPIs through specific, simple and comparable units of measurement, that could allow the end-users to handle the results of the simulations, and compare the different energy sources potential in order to facilitate their autonomous decisions.

The results of this part of the questionnaires about KPIs will be crucial for the activities to be performed in Task 3.4 – "KPIs panel and cost-benefits evaluation". These issues will be taken into account, considering the available outputs of the simulation module, towards the definition of a set of relevant KPIs that describes the impacts that would derive from the implementation of the sustainable H&C plans proposed by the PLANHEAT tool.

Smart City indicators

Two cities mentioned smart city projects that document the numerous sustainability related KPIs they use in their plans: **iCityRate** (http://www.icitylab.it/) for Lecce and fellow H2020 project **CityKeys** (http://www.citykeys-project.eu/) for Rotterdam.

Energy related KPIs:
• Global Energy performance (at district or city level [kWh/m^2/year])
• Specific Energy Consumption (at district or city level [kWh/m^2/year])
• Global Insulation Quality (Qualitative evaluation i.e. Low-Medium-High)
• U-coefficient of building envelope [W/m^{2}K]
• Heating and cooling demand ([GJ/year] or [kWh/year])
• Energy Production ([GJ/year] or [kWh/year])
• Fuel consumption (in terms of kWh of primary energy (for a comparison among sources) or in terms of t/year of Natural Gas, oil or biomass)
• Thermal losses in DHN [kWh/m/year]
• Final Energy Consumption [kWh/year]
• RES and waste heat energy share [% on the total primary energy use]
	Environmental KPIs:
	• RES share [% on the total primary energy use]
	• CO_2 emission / reduction [tCO_2/year]
	• Emission Impact on the environment in terms of
	  • *NO_x*
	  • *SO_x*
	  • *PM*

Economic KPIs: Investment: • CAPEX [€] • IRR [%] • NPV [€ underlining plant lifetime] • Payback period [years] • OPEX [€/yr] • Maintenance Costs [€/yr] • Affordability (Number of yearly stops due to maintenance or faults or Yearly Equivalent Operating Hours)	**Social** KPIs: • Political acceptability (Qualitative evaluation i.e. Low-Medium-High) • Social acceptability (Qualitative evaluation i.e. Low-Medium-High) • "NIMBY syndrome" risks (Qualitative evaluation i.e. Low-Medium-High) • Affordability (Number of Maintenance interventions per year) • Energy poverty reduction • Number of new jobs created • Security of supply (Yearly Equivalent Operating Hours in Nominal Conditions) • Living quality improvement (Qualitative evaluation i.e. Low-Medium-High

Table 4: Relevant KPIs

Technical requirements

	Simulation module
Operative functionalities	Scenario simulation (daily average) at district and building scale Baseline simulation KPI assessment to allow comparison among scenarios
Input data required	
Output data generated	KPI related to 4 domains: energetic, environmental, economic, social
GUI requirements	User friendly to be used without the support of an expert

Table 5: Technical requirements for the PLANHEAT simulation module

3.2.4 PLANHEAT integrated tool

As for the PLANHEAT integrated tool, no specific sections were included in the questionnaire. Nevertheless general conclusion could be draft as well with respect to two main aspects claimed by the interviewees during the survey.

- **Platform:** Based on the interviews and global desktop usage statistics, the most common OS is Microsoft Windows (various versions). As far as GIS software is concerned, both ArcGIS (various versions) and QGIS (various versions) seem to be in common use. One respondent has stated the explicit wish of his municipal government to migrate from ArcGIS to QGIS as part of a general move to open source software;
- **Output formats:** The ability to read from and write to common and/or non-proprietary data formats should be included for all modules, as this makes it easier for cities to include PLANHEAT tools in their existing planning processes. Although the users of the PLANHEAT toolbox will be professionals of various backgrounds (for example urban planning and energy consulting), some have stated that the ability to provide an easy to read output, suitable for both decision makers and the general public, would be beneficial. Some countries in fact see a return of hyperlocal ESCOs funded by local inhabitants and owners' associations, and simply making potentials visible may unlock additional crowd funded investments that can help cities reach their SEAP targets. Finally, **transparency** on how module output is generated should be a general theme. One respondent stated it should "not be a black box" in which input data disappears and a result of unknown reliability comes out. This is especially the case when including economic assumptions.
  .

4 Conclusions

This deliverable describes the information collected in the first four months (M1-M4) of the PLANHEAT project with the objective to extensively map desiderata and needs of local public authorities in their current practice, concerning the development of sustainable heating and cooling plans, intended to guide the design and implementation phases of each software module that constitutes the PLANHEAT integrated platform.
This bottom-up approach has been pursued through different instruments such as questionnaires, telephone interviews, on-line surveys, webinars and physical workshops gathering the inputs from 26 cities from 10 different European countries.

The results of this campaign (cities' desiderata) have been translated into specific technical requirements, to be taken into account during the process of definition of the technical specifications of the PLANHEAT modules and integrated tool, as intended in Task 1.2.

These specifications will be further analysed and detailed on the basis of the outcomes of additional surveys and analysis, currently ongoing, in the framework of T1.2, T1.3 and T1.4, where the role of EU cities as end-users of the PLANHEAT tool will be prominent. Although Validation cities and other end-users of the tools (i.e. local public authorities, consultants for public authorities, etc.) have already been involved in the shaping of this document, the on-line questionnaire will continue to be available and promoted. New responses in the next two months, as well as those during the PLANHEAT Launching Event in Krakow in March, will therefore be taken into account, in order to tailor the PLANHEAT tool specifications on the needs of local authorities.
All this information will be incorporated, together with the results of preliminary technical activities (i.e. the Milan Technical workshop) into the D1.3 "Report on modules specifications" (DAPP, M6).

ANNEX I
Questionnaire template

PLANHEAT Questionnaire (WP1)

How are Heating & Cooling plans currently implemented at urban level?

PLANHEAT's goal is to create a software to support public authorities for mapping and planning Heating & Cooling (H&C) at local level. To perfectly match the software functionalities to cities' needs and wishes, a bottom-up approach is adopted trying to involve cities as much as possible in the process of definition of software specifications.

To this purpose, we have prepared the present questionnaire where cities are directly asked to provide knowledge and information about mapping and planning H&C at local level. Specifically, the questionnaire is divided into three sections (i.e. quantification of H&C demand, quantification of current and potential H&C supply sources and planning and estimation of new H&C scenarios) plus an introductive part dedicated to cities' general information. For each section, information on needs and wishes, current practices in terms of used tools and methodologies and related deficiencies are required.

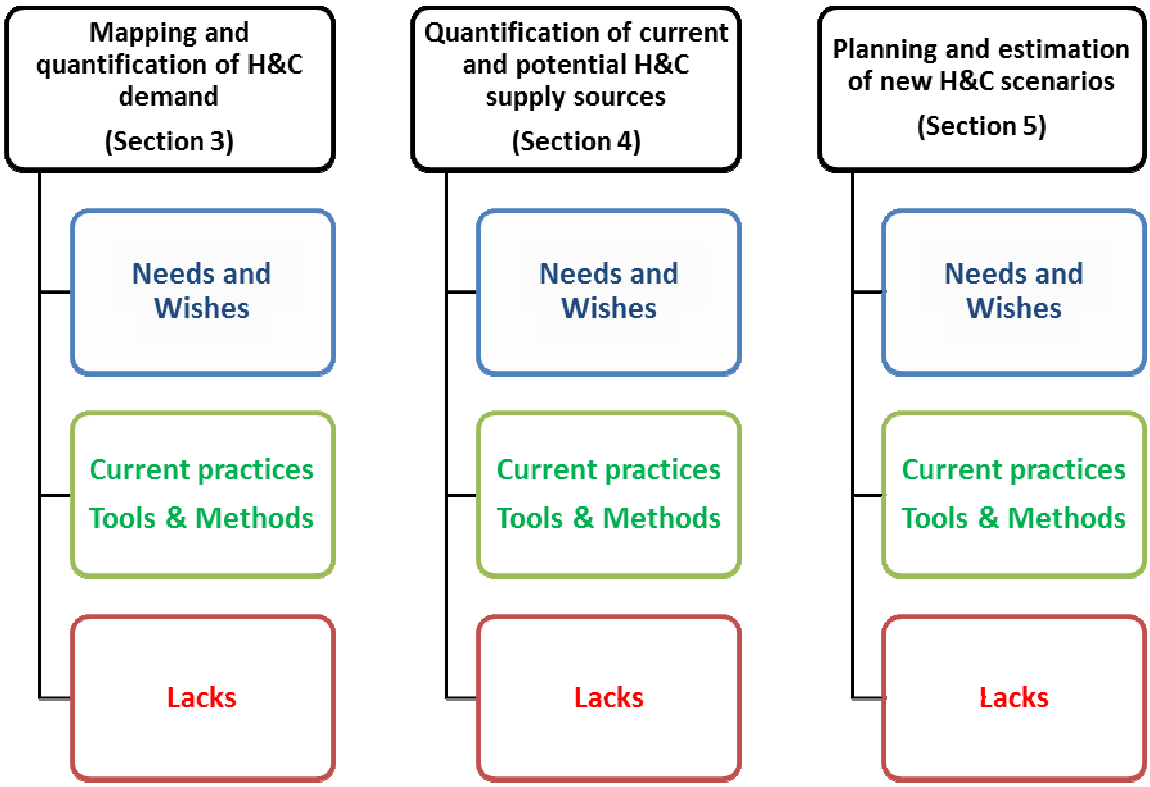

Figure 2: Questionnaire's fields of investigations

1 City general information

- Short description of the City
  - City Name (Country)
  - Inhabitants No.
  - Climatic zone
  - Peculiarities: Harbor, specific industrial activities…
-
- Did your city prepare and publish the Sustainable Energy Action Plan (SEAP)? Y/N
  - SEAP Publication year: XXXX

- SEAP Revision year: XXXX

-
- Status of development of H&C planning - Have you already developed plans for future decarbonisation of H&C systems at urban level?
- If yes, please specify your macro-strategic objectives
- ……
  ……..

2 Quantification and mapping of H&C demand

2.1 Heat demand

1. What are your needs/wishes?
□ To map and quantify heat demand at neighbourhood scale
□ To map and quantify heat demand at building scale
□ If other, include here a description
……
……
2. Do you quantify Heat Demand? Y/N
If yes which percentage of the city do you cover already? XX%
3. If yes, specify current:

- Tools to quantify and to map

1	Tool name	
Objective		□ Quantifying heat demand □ Mapping heat demand
Input		
Output		
Strengths		
Weaknesses		

Duplicate table if you need to include more than one tool

- Methodologies to quantify heat demand
- e.g. estimation from average consumptions and no. of inhabitants, statistical data, etc.
  ……
  ……
- Monitoring real consumption data
- Specify: type of monitored data, scale, etc.
- ……
  ……

4. What is missing in current tools and methodologies to reach your needs/whishes?
……
……

2.2 Cooling demand

1. What are your wishes/needs?
□ To quantify and map cooling demand at neighborhood scale
□ To quantify and map cooling demand at building scale
□ If other, include here a description
……
……

2. Do you quantify Cooling Demand? Y/N
3. If yes, specify current:

- Tools to quantify

1	Tool name	
Objective		□ Quantifying cooling demand □ Mapping cooling demand
Input		
Output		
Strengths		
Weaknesses		

Duplicate table if you need to include more than one tool

- Methodologies to quantify cooling demand
- ……
  ……

4. What it is missing in current tools and methodologies to reach your needs/wishes?
……
……

3 Quantification of H&C supply

3.1 Current H&C supply sources - Baseline

1. What are the sources used to supply H&C at urban level?

- Solar
- Biomass
- Geothermal
- Wind
- Sea/Lakes/rivers
- Sewage networks
- Underground networks
- Data centres
- Waste heat from industries
- Waste heat from ports
- Waste incinerators
- Power plants
- Natural gas
-

2. What are the installed H&C facilities?

- o District Heating and Cooling network
- o Natural Gas network
- o Combined Heat and Power Plants
- o Biomass generator
- o Other:…… ……..

3. Do you quantify current H&C supply? Y/N

4. If yes, how do you quantify H&C supply?

- Tools

1	Tool name	
Objective		
Input		
Output		
Strengths		
Weaknesses		

Duplicate table if you need to include more than one tool

- Methodologies
- …… ……

3.2 Potential H&C supply sources – Future plans

1. What are your wishes/needs?

□ To quantify annual extractable potential from different resources available at local level
□ To quantify annual effective potential from different resources available at local level
□ To improve the reliability and level of detail of supply quantification
□ If other, include here a description
……
……

2. Do you quantify potential H&C supply?

Source	**Do you quantify potential H&C supply?**	**Is it source relevant for your city?**
Solar	Y/N	Y/N
Biomass	Y/N	Y/N
Geothermal	Y/N	Y/N
Wind	Y/N	Y/N
Sea/Lakes/rivers	Y/N	Y/N
Sewage networks	Y/N	Y/N
Underground networks	Y/N	Y/N
Data centres	Y/N	Y/N
Waste heat from industries	Y/N	Y/N
Waste heat from ports	Y/N	Y/N
Waste incinerators	Y/N	Y/N
Power plants	Y/N	Y/N

3. If yes, <u>specify for each source</u> current:

- Tools to quantify potential H&C supply sources

1	Tool name	
Strengths		
Weaknesses		
Input		
Output		

-
- Methodologies to quantify potential H&C potential supply sources
- ……
-

4. What is missing in current tools and methodologies to reach your needs and wishes?
……
……

4 Planning and estimation of new H&C scenarios

1. What are your wishes/needs?
□ To create and simulate scenarios at district scale
□ To create and simulate scenarios at building scale
□ To be guided in the creation of new scenarios
□ To Evaluate specific environmental outputs to be compared with the current baseline
□ To Evaluate specific economic outputs (e.g. Pay Back Period, Capital costs…) and discuss local energy contracts
□ To identify local renewable potential for H&C application
□ To identify urban waste heat potential for H&C application
□ To simulate feasible extension of the District Heating Network (distribution system)
□ To simulate the increase of the end-users' demand due to new connections to the existing District Heating Network
□ To evaluate replacement of existing H&C equipment (e.g. from conventional boilers to renewable, from decentralized system to District Heating Network)
□ To evaluate the economic feasibility of new plants proposed by EsCOs or local energy providers.
□ Other:
……
……
2. Do you use planning tools? Y/N
3. Are you supported by external consultants?
4. If yes, specify current:

- Tools

1	**Tool name**	
Strengths		
Weaknesses		
Input		
Output		

-
- Methodologies
- ……
  ……

4. What it is missing in current tools and methodologies to reach your needs/wishes?
……
……
5. What are the indicators to assess different scenarios against each other?

Domain	**Indicators**
Energetic	
Environmental	
Economics	
Social	