

Project No: IEE/13/650



## **Local action: Methodologies and data sources for mapping local heating and cooling demand and supply**

*WP 3: National plan – local action: supporting local authorities  
Task 3.1: Mapping local heating and cooling demand and supply*

*INTERIM REPORT supporting DELIVERABLE 3.7.  
Summary report about 44 proposed projects*



Co-funded by the Intelligent Energy Europe  
Programme of the European Union

**May 29, 2015**

Authors: Erwin CORNELIS, Frank MEINKE-HUBENY

Contact: Erwin Cornelis: [Erwin.cornelis@vito.be](mailto:Erwin.cornelis@vito.be) – tel: +32 14 33 58 29

Deliverable No. 3.7a: public document.

The STRATEGO project (Multi-level actions for enhanced Heating & Cooling plans) is supported by the Intelligent Energy Europe Programme. The sole responsibility for the content of this document lies with the authors. It does not necessarily reflect the opinion of the funding authorities. The funding authorities are not responsible for any use that may be made of the information contained therein.



Co-funded by the Intelligent Energy Europe Programme of the European Union

STRATEGO website: <http://stratego-project.eu>

## Contents

<b>1</b>	<b>Introduction</b>	<b>5</b>
1.1	About the STRATEGO project	5
1.2	Aim of this report	6
<b>2</b>	<b>Mapping methodology</b>	<b>7</b>
<b>3</b>	<b>Mapping heating / cooling demand</b>	<b>13</b>
3.1	Demand mapping based on generic data	13
3.1.1	Land use maps	13
3.1.2	Population, demographical data and energy data	14
3.2	Mapping on a city and neighbourhood level	14
3.3	Mapping individual properties and installations	15
3.4	Mapping of future heat demand	16
<b>4</b>	<b>Mapping heating and cooling infrastructure</b>	<b>18</b>
4.1	Grids	18
4.2	Heating and cooling generating installations	18
<b>5</b>	<b>Mapping sustainable heating and cooling potential</b>	<b>20</b>
5.1	Reduction of heating and cooling demand	20
5.2	Tapping excess heat	20
5.3	Geothermal energy and energy from water bodies	23
5.4	Bio-energy	25
5.4.1	Biogas sources	26
5.4.2	Solid biomass sources	26
5.5	Solar thermal	27
<b>6</b>	<b>Mapping methods</b>	<b>30</b>
6.1	GIS-tools	30
6.2	Other mapping tools	30
<b>7</b>	<b>Checklists for projects to consider based on the maps</b>	<b>32</b>
7.1	Lessons from the Pan-European impact assessment of increased energy efficiency in heating and cooling	32
7.2	Projects to consider based on the local heating and cooling maps	34
7.3	Areas of priority to look for	36
<b>8</b>	<b>Example maps</b>	<b>38</b>
<b>9</b>	<b>References</b>	<b>39</b>

## List of figures

Figure 1: Infographic on the STRATEGO project structure	5
Figure 2: Repowermap: example of Brussels	19
Figure 3: E-PRTR installations in Tulcea, Romania	21
Figure 4: CEWEP waste-to-energy in Europe in 2012	21
Figure 5: EU28 excess heat facilities by main activity sectors and assessed annual excess heat volumes. Thermal power generation activities > 50 MW	22
Figure 6: GeODH project: Hot sedimentary aquifers (red), niogene basins (yellow) and other potential reservoirs (green)	23
Figure 7: Energy Atlas Amsterdam: energy from soil and water	24
Figure 8: Potential to extract heat from sewage pipes in the city of Antwerp, Belgium	25
Figure 9: CEWEP: Municipal waste treatment practices in Europe	27
Figure 10: SolarGIS: Global Horizontal Irradiation map for Romania	28
Figure 11: JRC: Global irradiation map for Romania	28
Figure 12: ZonatlasNL: global irradiation in some streets in the city of Eindhoven, the Netherlands	29
Figure 13: Thermographic map of Leuven, Belgium (left) - Map of energy labels of buildings in Amsterdam, the Netherlands (right)	35

## List of tables

Table 1: Data sources to look at for local heating and cooling mapping in function of level of detail of available data	9
Table 2: Industrial excess heat supply related to fuel consumption	23
Table 3: Overview of the steps and technologies analysed in the heating sector	32
Table 4: Key changes considered in the cooling sector	34
Table 5: Areas of priority to look for in function of the projects to consider	37

# 1 Introduction

## 1.1 About the STRATEGO project

The overall aim of the STRATEGO project is to support local and national authorities in the implementation of more efficient heating and cooling solutions. This support is provided in a variety of ways throughout the different work packages (WPs), see Figure 1.

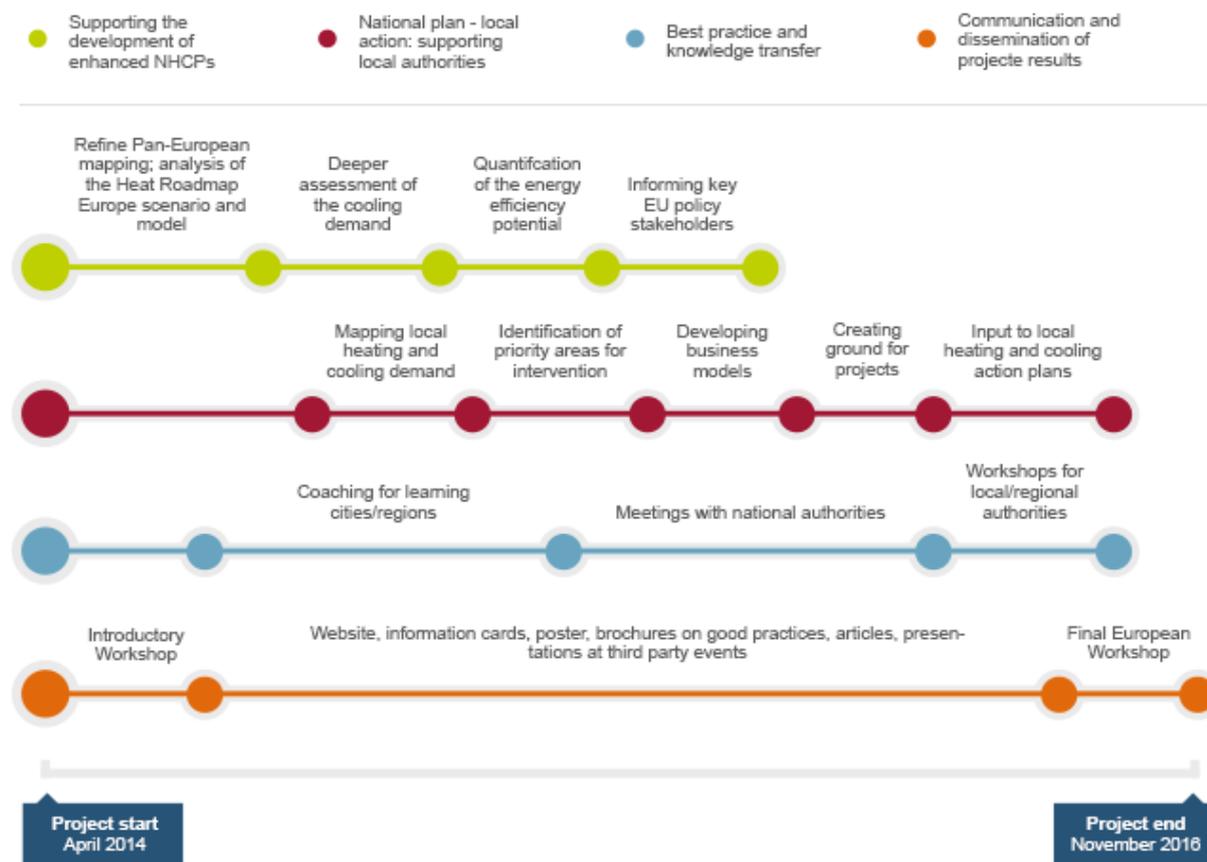


Figure 1: Infographic on the STRATEGO project structure

WP3, which is the focus in this report, provides support to local authorities by supporting 23 cities/regions to map their local heating and cooling demand and supply, to subsequently identify areas of priority for intervention. It builds upon WP2 which supports the development of advanced National Heating and Cooling Plans (NHCP), which are required under Article 14 of the European Commission's Energy Efficiency Directive [1]. More in particular, new methodologies and tools were developed in WP2 to create new knowledge about the combination of heat savings, heat networks in urban areas, and individual heating in rural areas at a Member State level [2]. One of these tools is PETA – the Pan-European Thermal Atlas (<http://maps.heatroadmap.eu>) [3]. This tool combines the mapping of the technical potential of district heating based on different heat density classes with an economic assessment of the district heating potentials in the maps. The PETA also includes the cooling demand in the service sector.

WP3 provides input to WP4, which supports key actors in policy and industry by exchanging best-practice knowledge between various regions across Europe.

## 1.2 Aim of this report

The aim of this report is to provide guidance to the first task of WP3: mapping the local heating and cooling demand and supply. The aim of this first task is to have a more detailed picture of the demand of heating and cooling in a particular city, how it currently is provided and how this can be upgraded to a more sustainable way. Based on this map, areas of priority for intervention will be defined in a next step. These are areas where the local conditions are favourable for developing projects first, such as the development of district heating networks. At least 2 concrete projects will be proposed in each of the 23 cities/regions that are involved in this project.

This report discusses the various data sources one can use to map local heating and cooling demand and supply. The report first presents a general considerations on mapping local heating and cooling demand and supply (Chapter 2). This report then groups the various data sources according to three dimensions:

- Heating and cooling demand (Chapter 3)
- Heating and cooling infrastructure (Chapter 4)
- Potential for sustainable heating and cooling (sources) (Chapter 5)

Chapter 6 discusses how these data can be mapped, while Chapter 7 presents a checklists for projects to consider based on the maps.

Chapter 8 reserves room for example maps; that chapter will be completed in a later stage of the STRATEGO project.

## 2 Mapping methodology

As indicated in the introduction to this report, the aim of the local heat maps is to create a more detailed picture of the heating and cooling supply and demand and the identification of project opportunities in STRATEGO's partner cities and regions. Capitalizing on local data, knowledge and expertise, the goal is to use the local maps to visualize and assess who needs heat, where heat comes from and what opportunities exist to connect them under current conditions or in future development projects.

In contrast to the results of WP2 which is based on maps and data sources of existing heating and cooling demands and supply, in WP3 the local knowledge and stakeholder engagement is being used not only to create a more detailed picture, but also to document valuable information in regard to the *conditions* of existing heating and cooling infrastructure and *future/planned* heating and cooling demands and supply. Examples for valuable information regarding the *conditions* of installations would be the remaining lifespan of installations, maintenance and/or repair backlogs, changes in the end user customer base (e.g. declining number of DH consumer contracts) and known disconnections of existing installations (e.g. pipe sections). Valuable information regarding *planned* heating and cooling demands are for example land areas earmarked for residential, commercial or industrial development, planned construction or major renovation of public buildings and the expansion or renovation of heat supply installations.

While each local partner is different and brings unique circumstances to the STRATEGO project a common systematic approach to the local mapping is essential. At a minimum the resulting maps contain the following three dimensions:

- Heating and cooling demand
- Heating / cooling infrastructure and supply, including existing district heating installations
- Sustainable heating / cooling potential

While on the one hand the local knowledge is a very valuable and essential for the identification of potential projects, it also a challenging task to gather, document and map the information. The challenge is to gather information from stakeholders, spatial data sets and other maps and convert them into a useful format which can be integrated into the local heat maps. Since most of the information was not initially documented for the creation of a heat map, the quality will vary to a high degree. It is important to stress that the quality and value of the final map will depend on the quality of the data sources used to generate it.

In this document distinction is being made among five levels of detail on which data can be found. The more specific the information, the higher the quality of the information and the more useful the map.

1. Data only available at city level
2. Data available for different neighbourhoods within the city
3. Location of distinct customers / installations known, but no data on these customers or installations is available
4. Location and characteristics of distinct customers / installations known
5. Energy data related to distinct customers / installations monitored

The level of information introduced here is closely related to levels of confidence as it is used in the Scotland Heat Map [4]. When different levels of data are available, the higher level of quality should be selected. After data is chosen as being relevant for the local map, it is encouraged to categorize the quality of data and to document the categories and sources of each data set in the map. This can be accomplished by creating separate layers containing data source information in digitized maps (e.g. GIS) or by creating accompanying documentation which can be consulted by the map user. The user of the final map has therefore the possibility to understand what quality of information is given to him and make an informed judgement if the level of detail is sufficient for the specific planning purpose or if additional investigations are required.

Table 1 gives a matrix style overview of the information to be included in each of the four map dimensions and five quality categories. The table should be considered as a general guideline to point towards sources for data collection, categorizing and mapping. While it is encouraged to create a comprehensive map, local knowledge and circumstances should be taken into account and aspects with higher local relevance should be given priority. For examples a city with large scale new developments should focus the given resources on mapping future energy demands and opportunities to connect future development to existing or new heat supply sources. On the other hand cities with existing DH grids may focus more on improving or expanding exiting installations by mapping major changes in the customer base, by identifying new heat supply sources or by connecting and consolidating smaller grids into larger ones.

Table 1: Data sources to look at for local heating and cooling mapping in function of level of detail of available data

		City level only	Neighbourhood level only	Individual installations – no details	Individual installations – additional details	Individual installations – Monitored data
Heating / Cooling demand	Residential	Land use maps x specific consumption / area  Population maps x specific consumption per inhabitant	Population maps x specific consumption per inhabitant; adjusted for type, age of building if available	Individual building: specific consumption per building	Individual building: specific consumption per building; adjusted for type, size, age of building	Individual building: energy metering data (or customer specific estimate)
	Commercial / industrial sectors	Land use maps x specific consumption / area	Land use maps x specific consumption / area	Individual installation: specific consumption per site, adjusted for activity	Individual installation: specific consumption per site, adjusted for activity and production level	Individual installation: energy metering data (or customer specific estimate)
	New developments		Land use maps x specific consumption / area, adjusted for activity	Individual building / installation: specific consumption per site, adjusted for activity		
Heating / cooling infrastructure	Gas grids  District heating grids		Area connected to gas / district heating grids	Position of gas / district heating grids; substations	Technical characteristics of gas / district heating grids; substations	Monitored flows with grids / through substations
	Boilers / CHP /	Number of boilers / CHP / cooling		Position of boilers /	Technical	Operational data of



	Cooling installations / solar hot water boilers / heat pumps	installations		CHP / cooling installations	characteristics of boilers / CHP / cooling installations	boilers / CHP / cooling installations
Sustainable heating and cooling potential	Reduction of heating and cooling demand	Land use maps x specific consumption reduction potential / area  Population maps x specific consumption reduction potential per inhabitant	Land use maps x specific consumption reduction potential / area  Population maps x specific consumption reduction potential per inhabitant	Individual building/ installation: specific consumption reduction potential per site, adjusted for activity	Individual building/ installation: specific consumption reduction potential per site, adjusted for activity, size, age (buildings)	Energy audits indicating the heating and cooling potential
	Excess heat: Thermal power plants / Waste-to-Energy plants / Energy-intensive industry			Per installation: specific excess heat potential, adjusted for activity	Per installation: production level x specific excess heat potential based	Per installation: monitored or estimated excess heat flows
	Geothermal: shallow and deep geothermal energy	Potential based on maps of subsoil characteristics	Same potential method as on city level, combined with feasibility indicators specific for the neighbourhood	Potential based on maps of subsoil characteristics, combined with feasibility indicators specific for the specific site		Site specific data of feasibility studies
	Geothermal: heat extraction from sewage system	Potential based on number of inhabitants x	Same potential method as on city level, combined	Position of waste water treatment plants and of	Position and operational data of waste water	Site specific data of feasibility studies



		volume of waste water / inhabitant	with feasibility indicators specific for the neighbourhood	sewage system	treatment plants and of sewage system	
	Bio-energy: biogas	Biogas from sludge digestion: potential based on number of inhabitants x volume of waste water / inhabitant  Biogas from organic waste digestion: potential based on number of inhabitants x volume of biodegradable waste / inhabitant  Biogas from manure digestion (rural areas): potential based on feedstock	Same potential method as on city level, combined with feasibility indicators specific for the neighbourhood	Position of landfills (landfill gas), waste water treatment plants (includes industrial installations), organic waste treatment plants, feedstock breeding sites x specific biogas production indicator	Position and operational data of landfills (landfill gas), waste water treatment plants (includes industrial installations), organic waste treatment plants, feedstock breeding sites x specific biogas production indicator	Site specific data of feasibility studies
	Bio-energy: biomass	Potential based on land use maps, adjusted for type of area (forests, agricultural activity, ...) x specific yield per area	Same potential method as on city level, combined with feasibility indicators specific for the neighbourhood	Position of installations generating or collecting biomass (waste) streams	Position and operational data of installations generating or collecting biomass (waste) streams	Site specific data of feasibility studies



	Solar heat potential	<p>Potential based on land use maps x specific feasibility indicator, adjusted for type of area</p> <p>Potential based on population maps x specific feasibility indicator</p>	Same potential method as on city level, combined with feasibility indicators specific for the neighbourhood	Position of roofs (or other suited surfaces)	Position of roofs (or other suited surfaces), adjusted for size, type of building	Site specific data of feasibility studies
--	----------------------	--	---	--	---	---



### 3 Mapping heating / cooling demand

The objective of the local heat maps is to enable local authorities to take action twofold. First in supporting their national authorities in preparing NCHPs and second in identifying and initiating the development of local and regional projects that are in line with these NCHPs. When mapping heating and cooling demand these objectives should be kept in mind. Which information can contribute to the objectives and what data base information should be tapped into or which stakeholders should be engaged to reach these goals?

Within the demand mapping it can be distinguished among mapping based on generic data, such as land use maps and demographic information, mapping on a city and neighbourhood level and mapping property and installation specific heat demand. While it is the aim of the project to create comprehensive local maps and not to preselect data sources prematurely, the local circumstances are taken into account weighing the detail of information and effort made in the mapping process. This means looking for customers demanding substantial amounts of low temperature heat and an opportune stakeholder structure which makes a successful implementation likely. Large scale projects with heat demand have the benefit of establishing an anchor load for a district heating grid and often have a more simple owner structure. The latter means it is preferable to engage fewer stakeholders with whom significant end user demand(s) can be won for a project.

#### 3.1 Demand mapping based on generic data

Generic data sources and maps can provide valuable information for the creation of local heat demand maps. While the information is not property sharp, a variety of European and national information sources are available to calculate the demand on a city or neighbourhood level by using land use, population density and energy consumption information. A selection of land use maps and population, demographical and energy data sources is provided below.

##### 3.1.1 Land use maps

- **EEA – CORINE**

<http://www.eea.europa.eu/data-and-maps/explore-interactive-maps/corine-landcover-2006>

The Corine programme has established a computerised inventory on the land cover for the 15 EC Member States and other European and North African countries at an original scale of 1: 100 000, using 44 classes of the 3-level Corine nomenclature. It provides quantitative data on land cover, consistent and comparable across Europe.

- **EEA – CORINE – Artificial surfaces**

<http://www.eea.europa.eu/data-and-maps/explore-interactive-maps/europe-artificial-areas-land-cover-2006>

CORINE land cover (CLC) 2006 is the latest update of the CLC database as part of the European Commission programme to COoRdinate INformation on the Environment (Corine) started in the early 1990s. It provides information on land cover and its changes during the period 2000-2006 across Europe. The CLC2006 database covers 38 countries.

- **EEA - European Soil Sealing V2**

<http://www.eea.europa.eu/data-and-maps/explore-interactive-maps/european-soil-sealing-v2>

This raster data set of built-up and non-built-up areas includes continuous degree of soil sealing ranging from 0 - 100% in aggregated spatial resolution of 20m x 20m. It was made available in 2010.

- **EEA – Urban Atlas**

<https://open-data.europa.eu/en/data/dataset/ubA7B6xTx7cnWNWcsjnQ>

The Urban Atlas provides land use and land cover data for every European urban zone with more than 100,000 inhabitants. The data sets include for each city image files (maps), shape files (GIS data) and a report available for download.

### 3.1.2 Population, demographical data and energy data

- **GEOSTAT**

<http://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/population-distribution-demography>

Data on population density can be accessed on the Eurostat website. The GEOSTAT data base provides files for download showing population density on a 1km x 1km grid.

- **Eurostat data**

<http://ec.europa.eu/eurostat/data/database>

Eurostat statistical information according to the NUTS 3 region classification can be found on the Eurostat website. Of particular relevance are the data files 'Area by NUTS 3 region (demo\_r\_d3area)' and 'Population density by NUTS 3 regions (demo\_r\_d3dens)'.

- **ODYSSEE-MURE**

<http://www.indicators.odyssee-mure.eu/online-indicators.html>

The ODYSSEE-MURE project is co-funded by the Intelligent Energy Europe Programme of the EU and provides two complementary internet databases. While primarily focused on energy efficiency and CO<sub>2</sub>-emissions related activities, it also provides comprehensive data for energy consumption according to sectors (households, services and industries) covering all EU countries. In addition further information to support heat demand calculations can be downloaded, e.g. total stock and average floor area of dwellings in a country or the total number of employees in the service sector and industrial sector.

## 3.2 Mapping on a city and neighbourhood level

- **Residential demand**

High heat demand in residential neighbourhoods is likely to be found in higher density housing areas and public or communal housing complexes. In contrast existing areas of single family homes with a diverse ownership structure will be economically difficult to connect to a DH grid. Special attention should be given to large scale housing projects or housing with a simple ownership structure. Examples would be housing owned by cooperatives, retirement homes or social housing projects. Heat and energy consumption data should be mapped and documented as detailed as possible to create a good basis for the evaluation of potential district heating or renewable energy projects. In addition local knowledge in terms of the conditions of housing should be documented: the age of buildings, the energy efficiency, up-coming or required renovations (especially in regard to the heating and hot water systems), changes of ownership and changes in heating and energy

consumption behaviour. A switch by households from one energy source to another in recent years can signal issues with existing DH systems or point towards opportunities for the introduction of alternative renewable energy or hot water supply systems.

On the neighbourhood level land use and population density can be used as a proxy for heat demand. If statistical data are utilized for the heat demand calculations of neighbourhoods, adjustments should be made according to the age and type of the housing stock.

- ***Commercial and industrial sectors and public building demand***

Commercial, industrial and (public) service buildings can vary significantly in their energy and heat demand. Offices, public service complexes, schools, pools, recreational buildings, etc. can constitute a significant anchor load for a DH system.

In Flanders the energy demand for the private service sector was estimated by tapping into statistical data. To calculate the average energy consumption per employee in the service sector, the total energy consumption of the sector for Flanders was multiplied by a generic 85% efficiency factor and divided by the number of employees in this sector. The average per employee consumption was then used to calculate the consumption of office and service buildings based on the staff number. Again, it is important to document the methodology which is applied during the mapping process. This provides opportunities to up-date information in case better statistical data or sector specific insides become available in the future.

### **3.3 Mapping individual properties and installations**

The highest quality (local) heat map is based on property or installation sharp heat demand mapping and real historical consumption data should prevail over any other information. If no real consumption data are available (e.g. in form of historical meter readings) heat demand can be assigned to a building or property by using city-wide, regional, or national averages. When using averages it should at a minimum be differentiated among the use of the building according to sectors (residential, service, industrial). If additional installation details are known adjustments should be incorporated taking into account the building type, size, use, age and energy efficiency. The best installation demand information can be derived from actual energy metering data and customer specific estimates.

Other forms of energy related records can also be useful. For public buildings these can be data on procurement records or energy performance certificates, which can provide an estimates of the heat demand with a good confidence level. Sources for such data can be national and central government, local authorities, public works departments, local utility providers and universities or colleges.

In this context the dialogue with stakeholders and owners of service, commercial and industrial buildings can provide valuable and unexpected opportunities to utilize heat supply. For example in Flanders excess hot steam is used to sterilize medical instruments in a local hospital.

If high quality data in form of metering or billing histories are available two problems are likely to arise: the issue of data management and confidentiality.

The utilization of individual consumption data requires a strict data management procedure. Experience from the Scotland Heat Map process has shown that at a minimum the following steps

need to be followed [4]: data cleaning and merging, checking of addresses (requires a unique property identification), deletion of duplications and standardisation of data formats. While this property sharp process will create the highest quality map output, it has to be pointed out that only local authorities with significant knowledge and resources in terms of GIS and data management are able to manage such a process.

At the same time property specific metering data can cause confidentiality issues. For example industrial installation are frequently cautious to release energy consumption information which could then be used to estimate emissions or production output. These problems were encountered in Flanders [5]. In order to address these privacy concerns property sharp information was aggregated with surrounding properties and 'scaled up' to a coarser grid, so map users are not able to view individual consumer histories. Nevertheless the handling of confidential data in the process of the map creation need to be addressed.

### **3.4 Mapping of future heat demand**

Construction of new higher density housing, commercial and industrial areas and public buildings are opportunities for the introduction of district heating and renewable energy sources. During the planning and construction of new developments specific requirements for district heating can be taken into account. This can significantly reduce costs because traditional heating systems can be reduced in size or potentially be replaced. Also sufficient space in the public areas for piping or within the buildings for technical installations can be incorporated early on in the design process. Another aspect is that in the early planning stages of new developments it is often easier to engage stakeholders, developers and owners of buildings to consider district heating or renewable alternatives as a heat source. Local authorities can support such efforts by providing (financial) incentives or by introducing regulations which support or require the connection to the DH systems and the utilization of renewable energy.

Two issues can arise while mapping new developments. First, while new developments can establish a significant anchor demand, they also pose of the risk of uncertainty if and when the projects are realized. Economic cycles, change of ownership or a shift in political power can delay or mothball projects. Second, future heat demand is often difficult to predict. For industrial and commercial building projects it is recommended to engage directly with stakeholders to receive as detailed information as possible regarding future projects, in particular in terms of building floor area, building use and energy efficiency . If this is not feasible one should find comparable projects with real consumption data to support good quality estimates. As a last resort national average demand data can be used, but these should be adjusted for the proposed activity and latest energy efficiency standards.

For the development of larger land areas with several commercial buildings it is advisable to estimate the number of buildings, the floor area and building use. Based on these parameters consumption data from buildings with similar use can be utilized and estimates can be made.

For future residential developments the heat demand varies significantly depending on the density and number of residential units. For the Scotland Heat Map the vacant land designated as future Housing Land in local plans was taken into consideration. In this case a raster resolution of 50x50 meter was used and the heat demand was calculated by the following formula: (proposed housing

units / area of the development) x (2500m<sup>2</sup> x heat demand coefficient per unit per year). As a heat coefficient 11,375 kWh/year/dwelling was used.

Estimations for existing and future heat demand should be carefully reviewed and validated by local experts to improve the estimates.

## 4 Mapping heating and cooling infrastructure

Next to mapping the heating and cooling demand, one needs to map the main heating and cooling infrastructure, i.e. the district heating and cooling grids and the main installation providing heating and cooling to these grids.

It is evident to focus on district heating and cooling grids when mapping heating and cooling in a city. However, the gas grids should be included on the map as well. Gas grids are competitors to district heating grid; it is not cost-effective to deploy these both in the same area. On the other hand, information on the presence of gas grids is needed if one considers to develop district heating grid in a particular area fuelled by gas.

Mapping information on heat, cooling and gas networks provides a better insight topography of these installations and leads to ideas on how to improve it and – if possible – to expand it.

### 4.1 Grids

Heat, cooling and gas networks can be mapped in various levels of detail. The grids operators have of course all details of the grids they operate but they might be reluctant to provide these details to third parties. The data might also be delivered in a format that poses challenges to include in a mapping tool.

The least detailed level is just an indication of the neighbourhoods in the city where buildings are connected to either a district heating, a district cooling or a gas grid.

Most often, a map showing the topography of these maps is available. It shows in which streets district heating, district cooling or gas grids are present.

A next level of detail are technical characteristics that can be added to the pipes of these grids, such as diameters and temperature of pressure levels. Information on the age of the pipes might an indication on the likelihood that these segments needs to be refurbished in the near future, which might open a window of opportunity of potential projects.

Operational data on flows of heat, cooling or gas through the pipes provide a clearer indication of the importance of specific segments in the grid, more than the technical characteristics do. They also give an insight on segments where there is currently an over or under capacity. These data might be treated as confidential by the grid operators and are less likely to be made available for the local heating and cooling maps.

### 4.2 Heating and cooling generating installations

The prime focus of the heating and cooling generating installations lays on those installations feeding heat or cooling into the grids: boilers, cogeneration units, solar hot water boilers, large heat pumps, ... for heating grids; centralised chillers, ... for cooling grids. Similar installations, but not connected to heat or cooling networks, should be added to the extent possible.

Information on Large Combustion Plants (LCP) with a thermal capacity of at least 20 MW can be consulted via the European Pollutant Release and Transfer Register (E-PRTR), which is set up in

accordance with the LCP Directive<sup>1</sup>, see

<http://ec.europa.eu/environment/industry/stationary/lcp/implementation.htm>.

The repository lists these LCPs with their thermal capacity and their annual fuel input, split into biomass, other solid fuels, liquid fuels, natural gas and other gases. It also lists the SO<sub>2</sub>, NO<sub>x</sub> and dust emissions.

Of course, it would add much value to the local heating and cooling maps if smaller installations can be added to the map as well. An interactive map showing various realised renewable energy projects has been made within the framework of the IEE project Repowermap. The countries where most examples have been gathered within this programme are Austria, Belgium, Bulgaria, Finland, France, Germany, Italy, Liechtenstein, Slovakia, and Poland. (See: <https://www.repowermap.org/>) The map is still open for data input although the project has finished. Figure 2 shows as example the map of Brussels, Belgium.

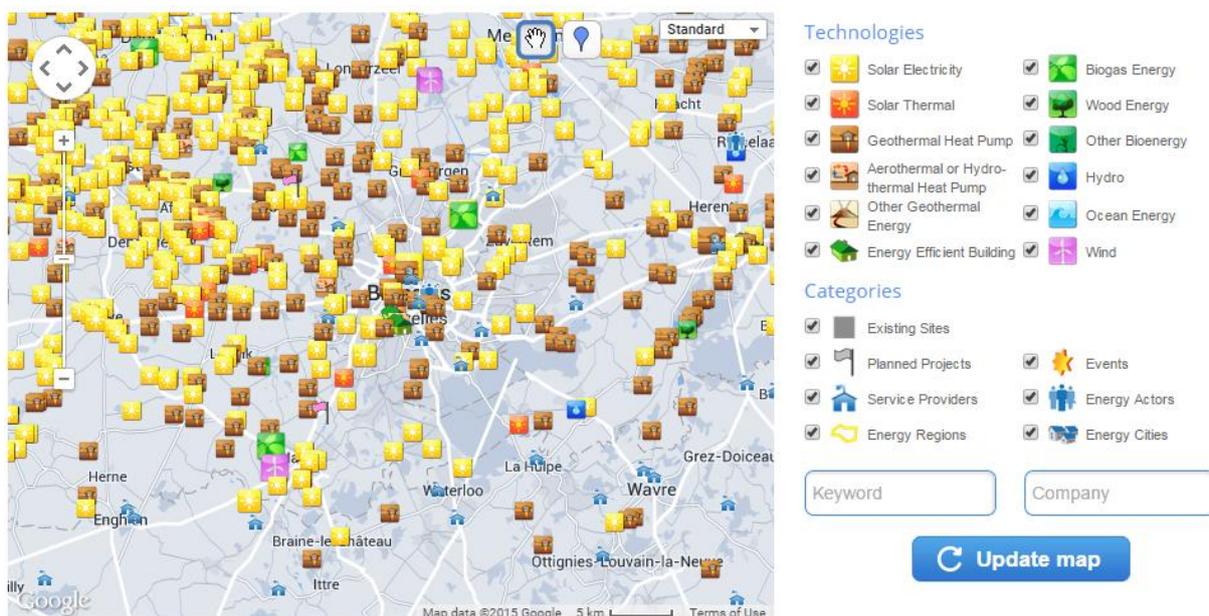


Figure 2: Repowermap: example of Brussels

<sup>1</sup> The Directive on the limitation of emissions of certain pollutants into the air from large combustion plants (LCP Directive, 2001/80/EC)

## 5 Mapping sustainable heating and cooling potential

The purpose of the local heating and cooling maps is to detect projects to make heating and cooling more sustainable. To this end, the potential to reduce heating and cooling demand and the potential of various renewable energy sources needs to be added to the local heating and cooling map.

### 5.1 Reduction of heating and cooling demand

The data layers on the potential reduction of the heating and cooling demand can be derived from the data layers on the heating and cooling demand. The focus here is on specific heating and cooling consumptions for particular areas or individual end-consumers that is higher than average.

The level of detail in which this heating and cooling reduction potential can be mapped is hence determined by the level of detail in which heating and cooling consumption can be mapped. Adding results from audits indicating the heating and cooling potential of specific end-consumers is the highest level of detail one can add to the heating and cooling map and would allow to verify approximate estimations based on specific consumption reduction potentials.

### 5.2 Tapping excess heat

Potential sources of excess heat that can be fed into the district heating grid are thermal power plants, waste-to-energy installations and the energy intensive industry.

Most of these installations have a thermal capacity above 20 MW and are hence listed as a Large Combustion Plant, see subchapter 4.2. Most of these also have obligations under the Emission Trading Scheme, and if so, they are listed in the national ETS registries. In these registries, which should be open to the public, usually only provides details on the greenhouse gas emissions of these facilities.

Another important data source is the European Pollutant Release and Transfer Register, see <http://prtr.ec.europa.eu/>. It is an EU-wide register that provides easily accessible key environmental data from industrial facilities in European Union Member States and in Iceland, Liechtenstein, Norway, Serbia and Switzerland. It contains data reported annually by more than 30,000 industrial facilities covering 65 economic activities across Europe. For each facility, information is provided concerning the amounts of pollutant releases to air, water and land including greenhouse gases for years 2007 onwards. Figure 3 shows as an example the E-PRTR facilities in Tulcea, Romania.

Statistics on waste-to-energy plants specifically are provided by CEWEP, the Confederation of Waste-to-Energy Plants. Figure 4 shows the number of W-t-E plants operating in European Member States and the number of tonnes of waste that is thermally treated.

These data sources were the main ones to quantify the excess heat that could be available for district heating grids in the Pan-European Thermal Atlas, complemented with data from World industrial information, available at: (<http://industryabout.com/>) and data from the International Solid Waste Association [6]. Figure 5 shows the comprehensive map of potential sources of excess heat in the EU28.

National statistics can provide information on waste-to-energy installations, thermal power plants and industrial installations that do not have obligation under the above mentioned directives and that hence not listed in these public registries. Local surveys on these installations can complement these national statistics.

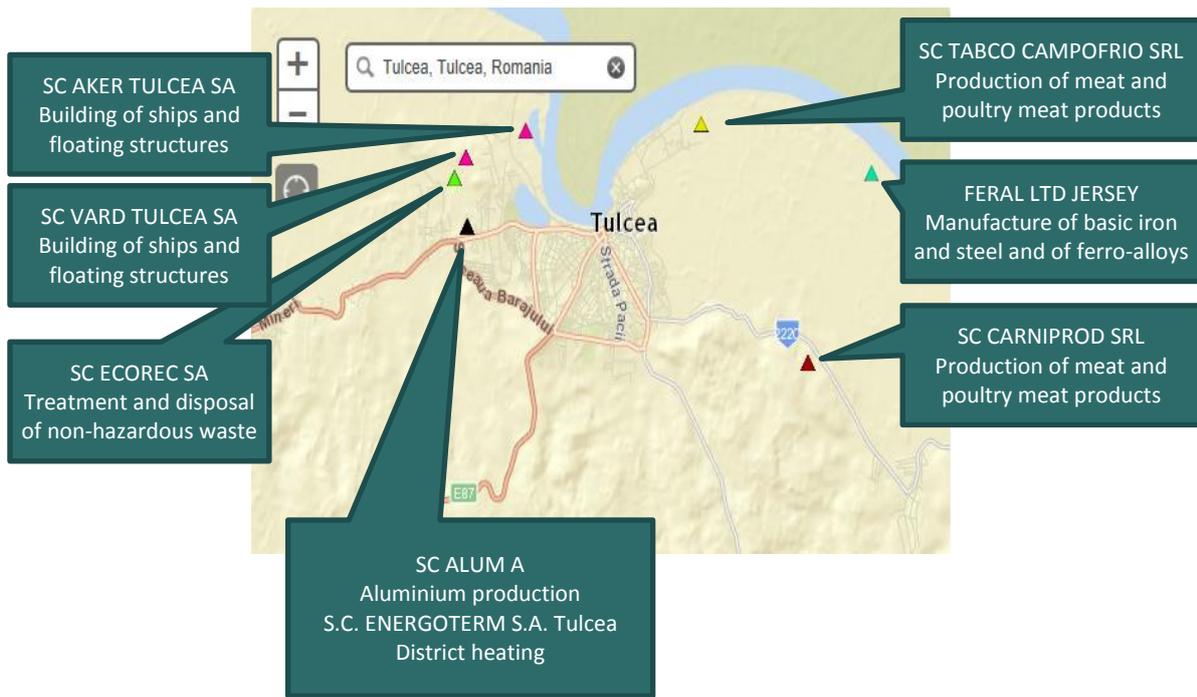


Figure 3: E-PRTR installations in Tulcea, Romania

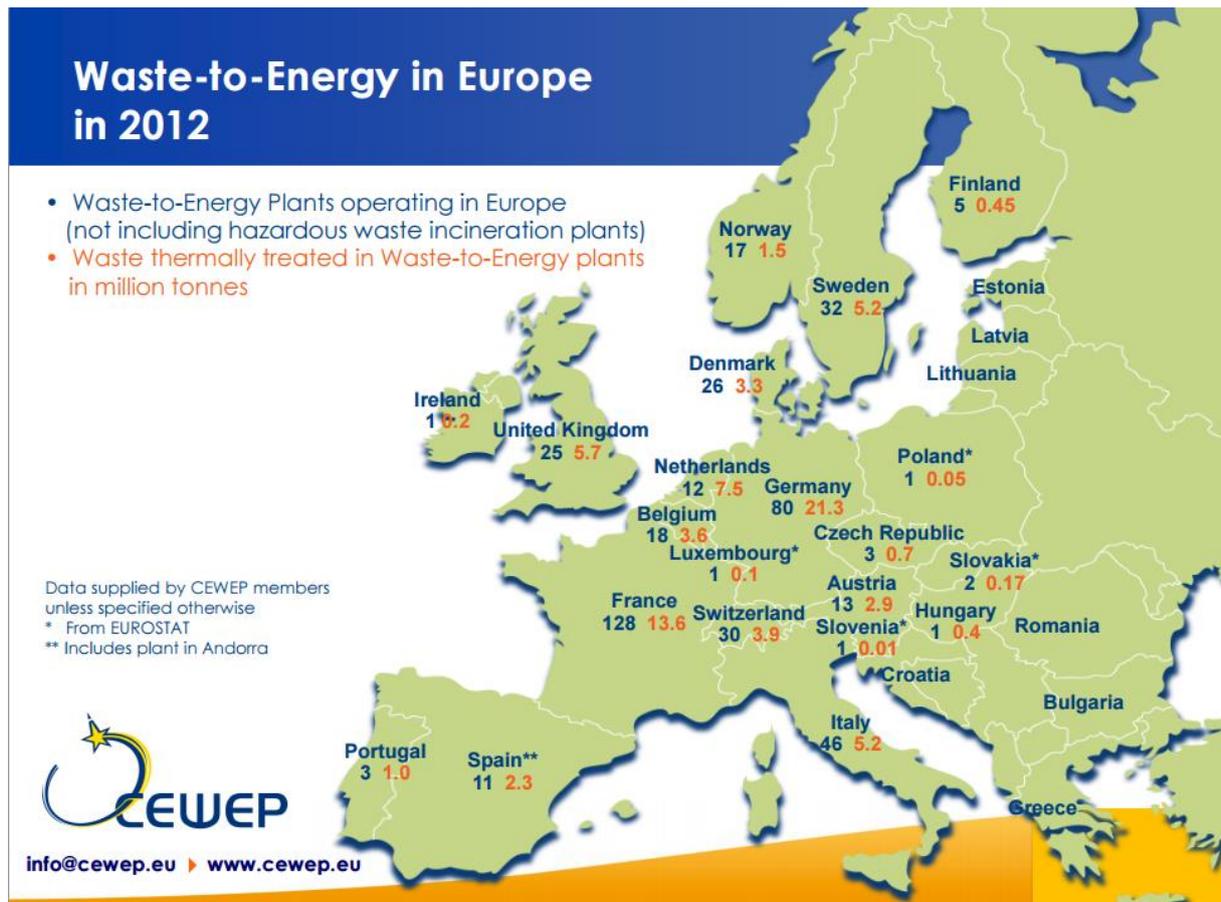


Figure 4: CEWEP waste-to-energy in Europe in 2012

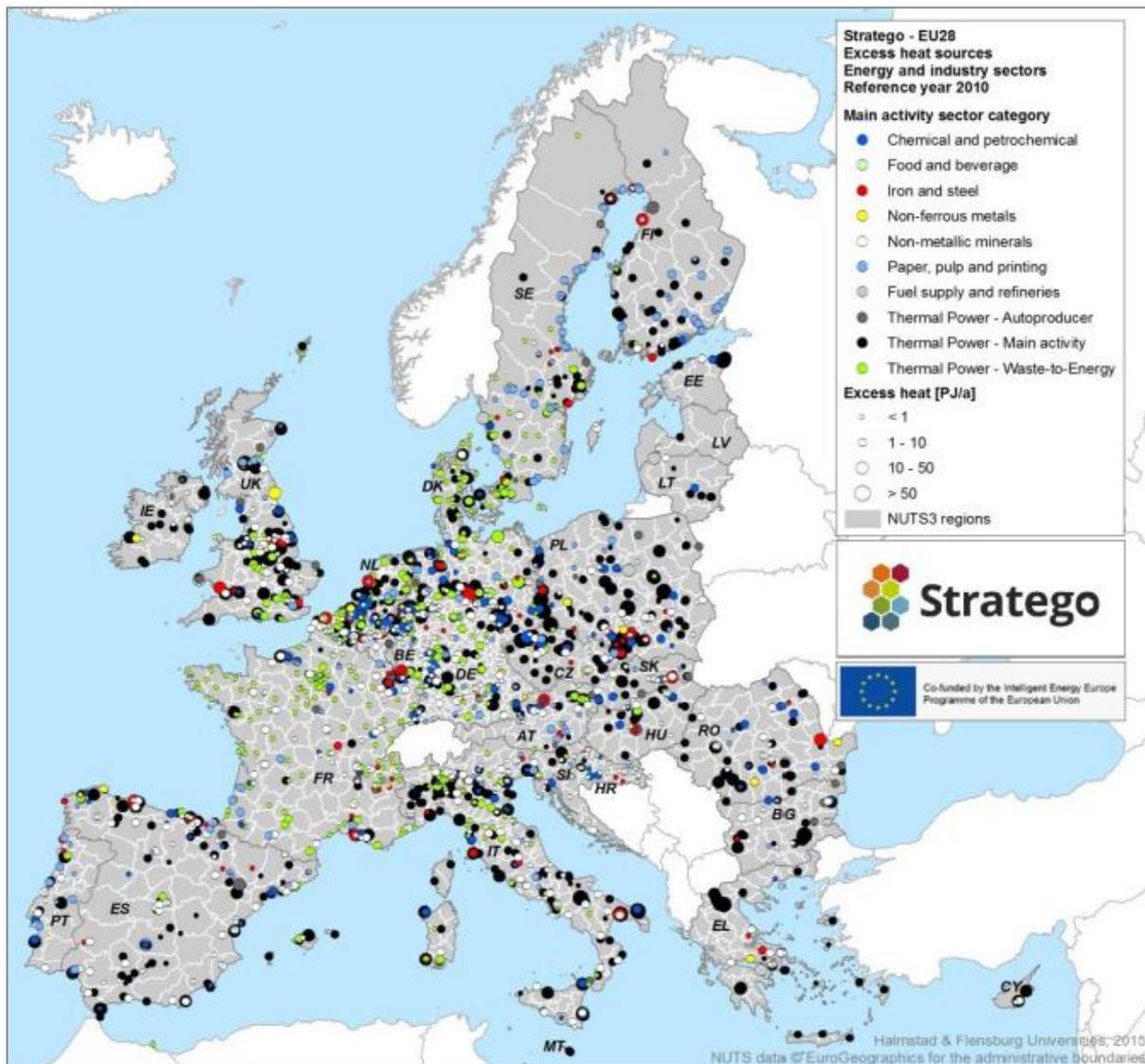


Figure 5: EU28 excess heat facilities by main activity sectors and assessed annual excess heat volumes. Thermal power generation activities > 50 MW

Sources: CEWEP, 2014; EEA, 2013a; IndustryAbout, 2014; ISWA, 2012 (see Ref. [6] for full references)

A calculation will be needed to convert CO<sub>2</sub>-emissions to fuel consumption by these installation from which in a next step potential heat supply can be derived. This is in particular challenging for industrial companies. Their prime processes are NOT the combustion of waste to destroy it or the combustion of fuel to produce electricity. There is a huge variety of thermal processes taking place in the industry. Excess heat is a waste product that is dissipated to the environment and that is very seldom monitored. The potential of excess heat from industry has been assessed In some countries; they result in key figures relating the potential excess heat supply to the fuel consumption of the company. **Error! Not a valid bookmark self-reference.** lists the results for a variety of industrial sector of some studies.

It is worthwhile to consider a survey amongst these installations to gather a more estimation of the potential excess heat supply as such a survey allows to ask additional questions on temperature levels, delivery supply and heat carrying medium.

Table 2: Industrial excess heat supply related to fuel consumption

		Source [7] SE-2002 >120°C	Source [8] SE-2009 >120°C	Source [9] NO-2009 >140°C	Source [10] DE-2010 >140°C
B7-8	Mining and quarrying	3,1%	3,5%		
C10-11-12	Food, beverages and tobacco	6,7%	8,6%	2%	
C13-14-15	Textile, leather and clothing	0%	0%		
C16	Wood industry	0%	18,2%	2%	
C17.1	Pulp & paper	21,9%	5,8%		
C20-21	Chemistry	13,5%	24,3%	10%	8%
C22	Rubber, plastic	11,7%	1,2%		3%
C23	Mineral non-metal products	3,9%	1,7%		3%
C23.5	Cement industry			46%	40%
C24.1-24.3	Steel works	15,7%	11,2%	40%	30%
C24.4	Non-ferrous metals			AI: 1%	
C25	Machinery				3%
	Other			9%	3%

### 5.3 Geothermal energy and energy from water bodies

The technical feasibility of ground source heat pumps (shallow geothermal energy) is dependent on the permeability of the soil and on the presence of free ground around the building to install the heat collector. Data layers showing these characteristics are hence needed to assess to potential of heat pumps.

An alternative to this method is a map showing existing heat pumps or results of feasibility studies as these data provide a direct indication of the feasibility in the neighbourhood.

Harvesting deep geothermal energy is much more capital intensive, have a higher thermal capacity and demand a high enough heat demand to be economic viable. Potential project can be found in areas with hot sedimentary aquifers in the subsoil and a high enough heat demand and heat density above ground. These areas have been mapped in Europe by the GeoDH project ([www.geodh.eu](http://www.geodh.eu) – link to the map: [http://map.mfgi.hu/geo\\_DH/](http://map.mfgi.hu/geo_DH/)), see Figure 6.

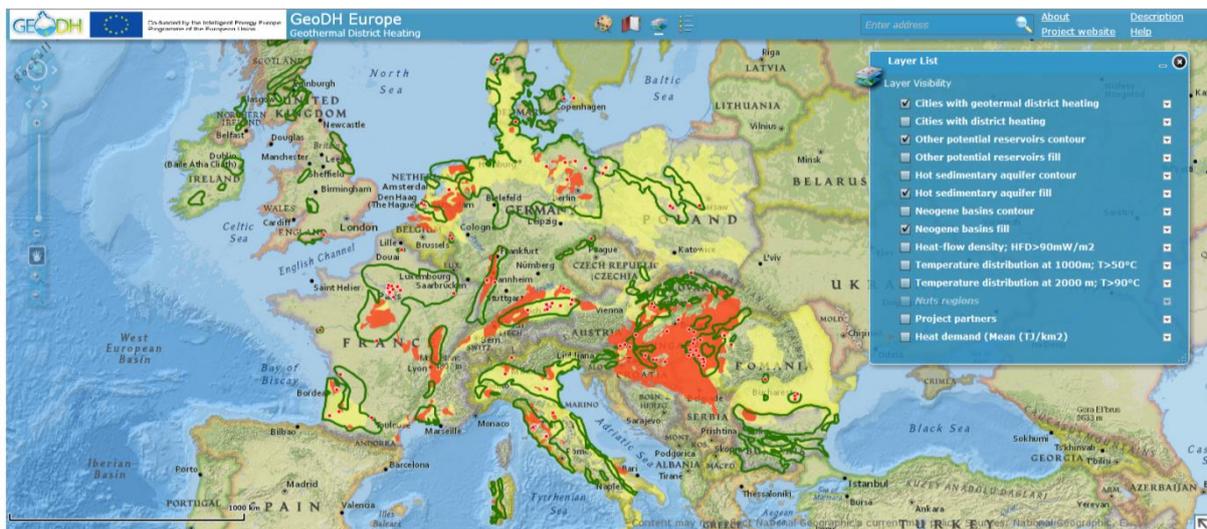


Figure 6: GeoDH project: Hot sedimentary aquifers (red), niogene basins (yellow) and other potential reservoirs (green)

Heat can also be extracted from water bodies; one could call this hydrothermal energy. These water bodies should be well known locally and are hence easy to map. The layer on 'energy from soil and water' in the Energy Atlas of the City of Amsterdam for instance highlights amongst others two lakes in the west of the city centre as current cooling sources, see Figure 7. Cooling grids are also added to this data layer. ([http://maps.amsterdam.nl/energie\\_bodemwater/?LANG=en](http://maps.amsterdam.nl/energie_bodemwater/?LANG=en))

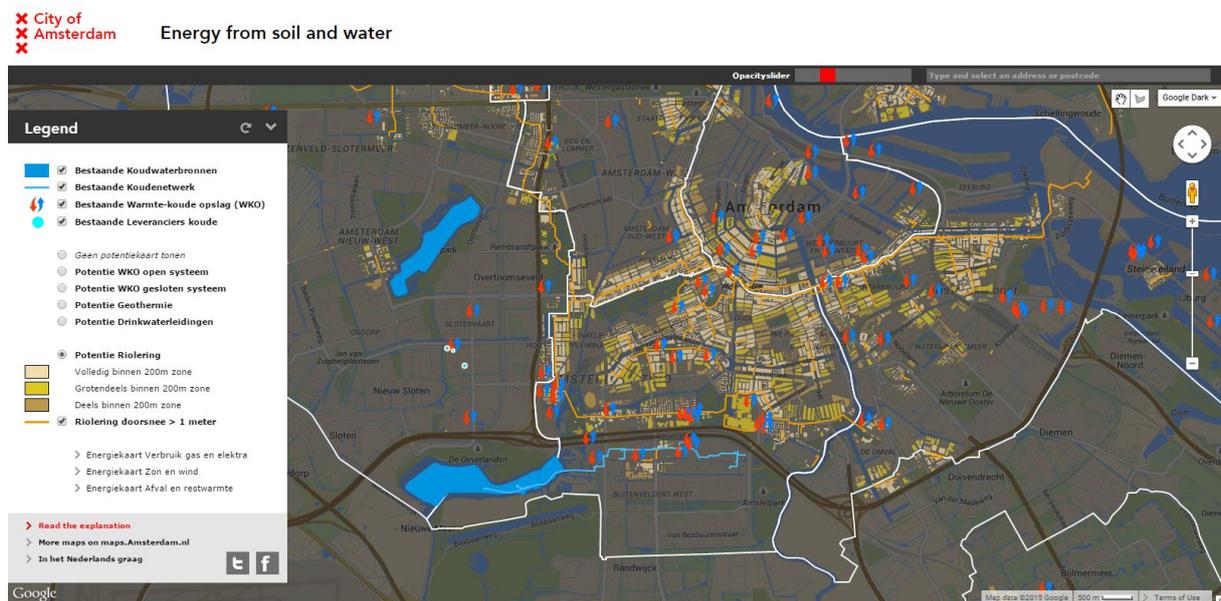


Figure 7: Energy Atlas Amsterdam: energy from soil and water

More and more examples can be found on heat extraction from the sewage system, as the sewage water has a higher temperature than the ground water. While assessing this potential for the whole of Europe, a coverage of 5% of heat demand by heat from the sewage system in towns and cities with more than 10,000 people was assumed.

The Energy Atlas of Amsterdam has a more detailed assessment of this potential; it maps the sewage pipes with a diameter of at least 1 meter and indicates the heat demand areas that are entirely, predominantly or partly within 200 m from these pipes, see Figure 7.

A very detailed assessment of the potential to extract heat of the sewage system was carried out for the city of Antwerp, Belgium based on flow estimations at dry weather conditions for about 29,000 points in the Antwerp sewage system, see Figure 8 [12].

The focus of the maps of Amsterdam and Antwerp is on heat extraction from sewage pipes, but waste water purification plants are a large potential heat source as well, as finished projects in Switzerland, Scandinavia and the Netherland demonstrate. The proximity of heat consumption to these plants is one of the key success factors for such projects.

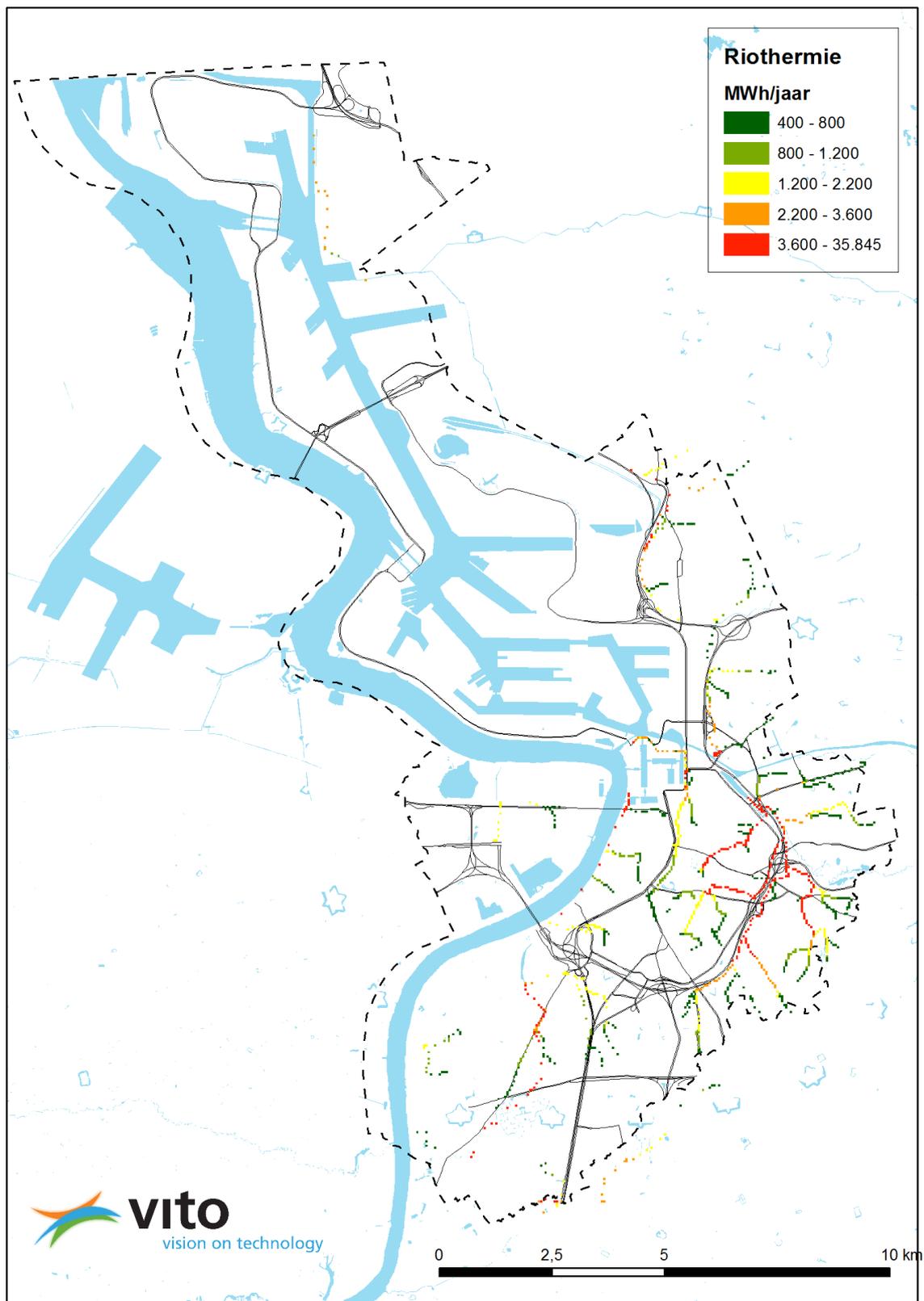


Figure 8: Potential to extract heat from sewage pipes in the city of Antwerp, Belgium

## 5.4 Bio-energy

We consider two categories of bio-energy resources in this report: resources that are digestible to produce biogas and solid biomass resources.

### **5.4.1 Biogas sources**

Biogas can be produced from various sources:

- Landfills
- Digestion of sludge resulting from waste water treatment
- Digestion of organic waste
- Digestion of manure

Landfills are usually known and easy to locate. Details on the waste composition and quantity is needed however to estimate the potential landfill gas production potential.

Sludge from waste water treatment plants is another potential digestible source. One should in this respect not limit to treatment plants of sewage water, but should map industrial waste water treatment plants as well.

This consideration applies also to organic waste. On the one hand, one should look at the organic fraction in the municipal waste; at the other hand, a survey of organic industrial waste sources might reveal unexpected waste sources and related biogas production potential. Especially waste streams from the food industry are relevant in this respect.

The potential of biogas production from organic waste is highly connected to waste treatment practices in the various EU Member States as Figure 9 illustrates. Enhanced selective collecting of biodegradable waste streams might offer opportunities to increase biogas production from the digestion of organic waste. However, changing waste treatment practices might be challenging as this involves many stakeholders, including the citizens.

Manure is a digestible waste source that is typical rural. Mapping the feed stock of cattle, piggery and poultry gives an indication of the biogas production potential from these sources. A common practice is co-digestion in which other waste stream or crops, energy maize mainly, are added to increase the biogas yield, however new mono-digestion methods for manure are developed and commercialised in the recent years.

### **5.4.2 Solid biomass sources**

As for biogas sources is there a multitude of solid biomass sources, such as:

- Forest residues
- Agricultural residues
- Residues from the maintenance of public green
- Waste stream from particular industrial sector, such as the wood processing industry, ...

Land use maps, such as Corine – see 3.1.1 – help to locate these areas. Specific production yields per area are then needed to estimate the biomass production potential. When mapping the Renewable Heat Resources in Europe for instance, forest density maps from the European Forest Institute were combined with Eurostat tables for forest increment and felling, which contain productivity data since 1990, see reference [11].

A targeted survey to specific industrial companies in a selected number of sector is an option to consider for estimating industrial biomass waste streams. This allows also to collect data on the quantity, the quality and the seasonal variation in supply of these waste streams.

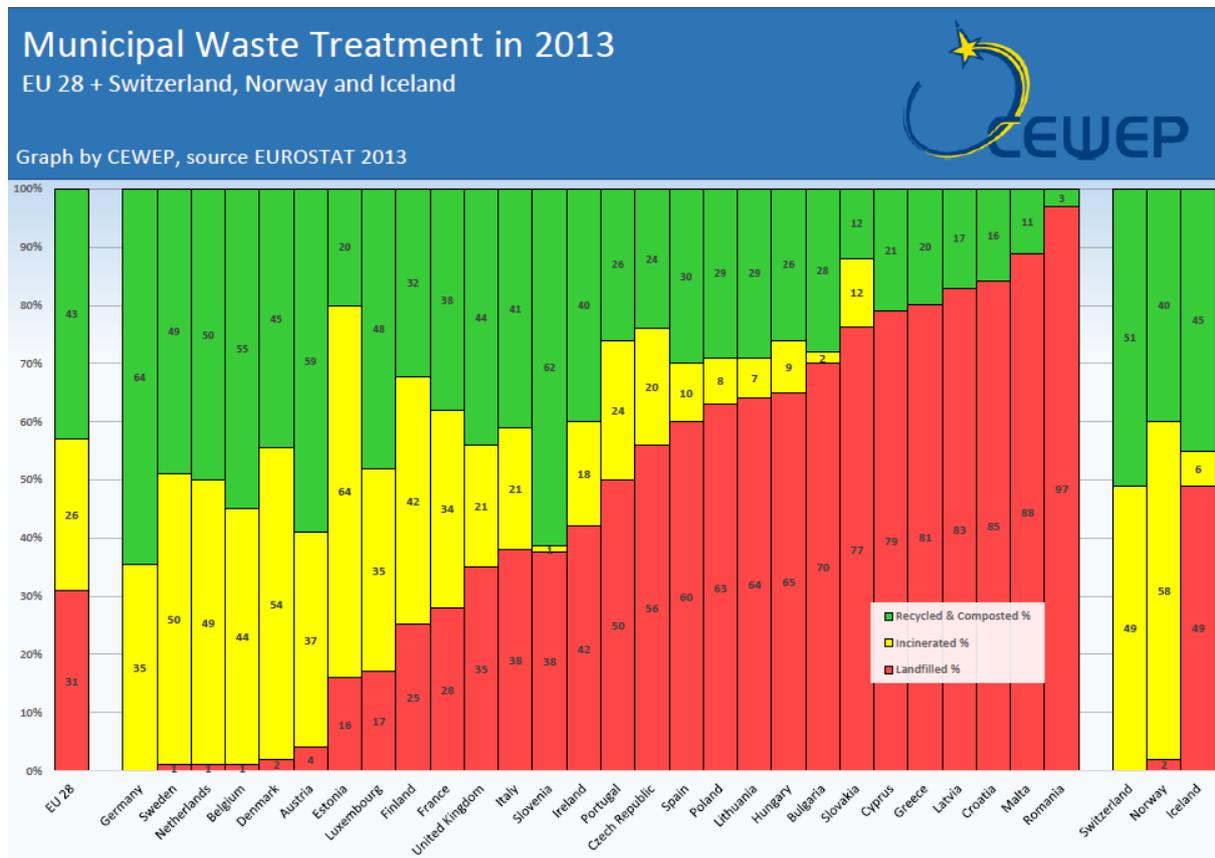


Figure 9: CEWEP: Municipal waste treatment practices in Europe

### 5.5 Solar thermal

A first factor determining the potential of solar thermal energy is the global irradiation. There are two public available maps showing this global irradiation:

- SolarGIS, see: [http://solargis.info/doc/\\_pics/freemaps/1000px/ghi/SolarGIS-Solar-map-Europe-en.png](http://solargis.info/doc/_pics/freemaps/1000px/ghi/SolarGIS-Solar-map-Europe-en.png)
- JRC, see: <http://re.jrc.ec.europa.eu/pvgis/countries/europe.htm>

Figure 10 and Figure 11 show the global irradiation maps of both sources for Romania. The former map shows the global horizontal irradiation, whereas the latter map shows the global irradiation for optimally-inclined devices.

A next factor is the suitability of the roof to install solar hot water boilers. In a first rough estimate, one can start of the footprint of the buildings and assume that a fraction of it can be covered by solar thermal systems. A more precise estimation includes the inclination of the roof. In some countries, such as in the Netherlands, a precise estimation is based on 3D imaging of the city, see Figure 12 for an example of Eindhoven, the Netherlands.

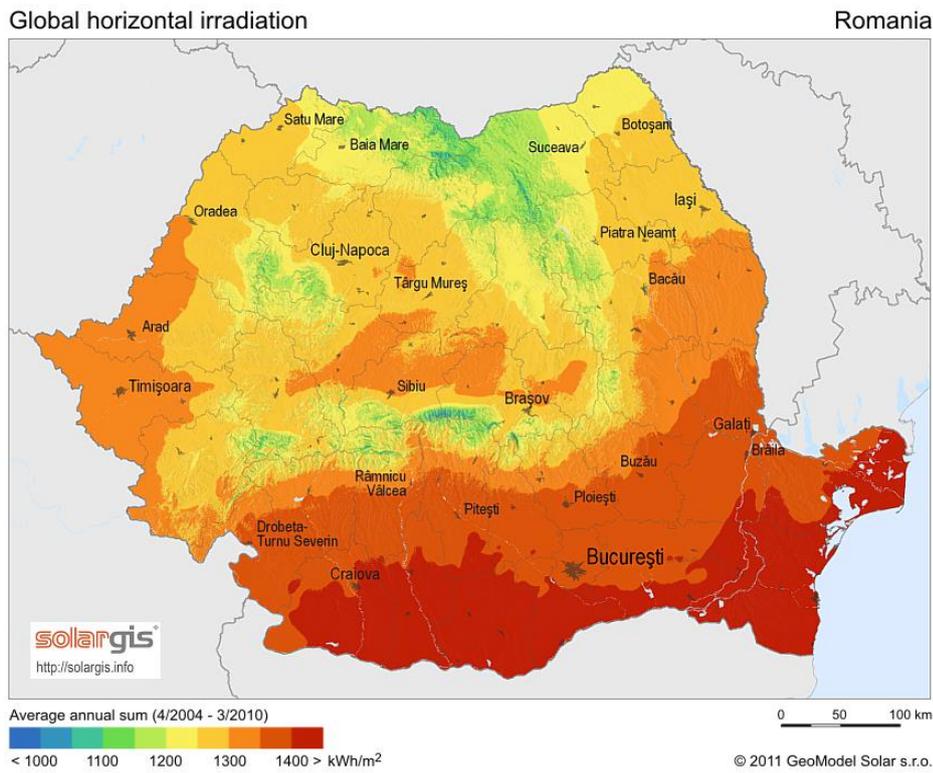


Figure 10: SolarGIS: Global Horizontal Irradiation map for Romania

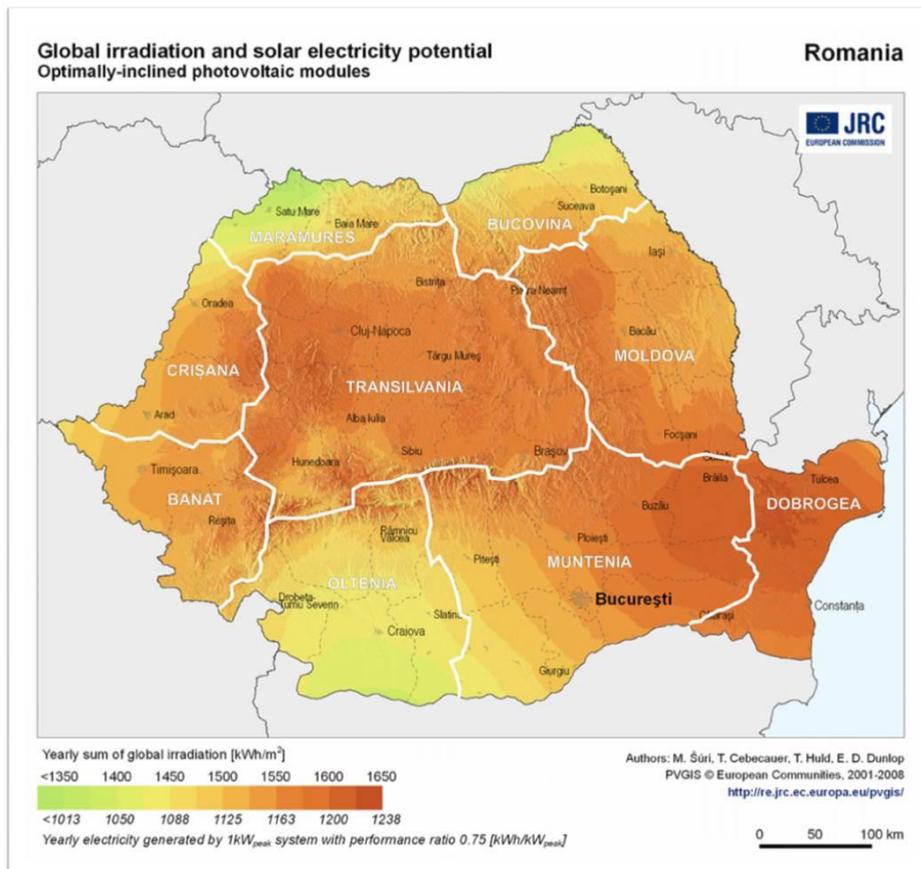


Figure 11: JRC: Global irradiation map for Romania



Figure 12: ZonatlasNL: global irradiation in some streets in the city of Eindhoven, the Netherlands

## 6 Mapping methods

### 6.1 GIS-tools

Creating a digital map with GIS tools results in the most powerful map format. Available information from national or the European Heat Map can be imported in form of layers and shape files and information can be utilized on the local level. Additional local information can be added as features in form of shapes, lines or point data. Land areas with higher density heat demand can be shown as shapes, sources of heat supply or future heat demand projects can be integrated as points and existing heat networks can be displayed as lines in the map. Overlaying the various information can illustrate opportunities for local projects. Spatial proximity of heat demand, heat supply sources or heat networks is easily visualized and can help in the identification process for district heating projects.

The layer structure of the map allows for information to be displayed only when desired and any number of combination of information display is possible. Information corresponding to the features can be stored on separate layers. This way the quality level of the heat supply and demand data can be integrated into the map and turned on if desired.

Previous projects have shown that building such a map requires significant knowledge and resources. It is best done when a map with a property identification base already exists, similar to the Unique Property Reference Number (UPRN) system in Scotland. New information can then either be added connected to the UPRN system or can be located by xy-coordinates.

Nevertheless, the processing of building digital maps with heat supply and demand information requires a strict data management protocol. Experience with the Scotland Heat Map has shown that the data cleaning, merging and processing was the most time intensive part in the map creation process.

A valuable resource for the creation of GIS based heat maps is the detailed description on methodology provided in the manuals Scotland Heat Map – User Guide 2.0 Methodology Report, 2.1 manual for local authorities, 2.2 metadata, limitations and data management and 2.3 local knowledge validation & improvement [4].

There is a manifold of GIS tools available on the market. Many of these are commercial tools for which the user needs to buy a licence, however a lot of open source GIS software is available as well.

A complete list of GIS tools can be found on:

[http://en.wikipedia.org/wiki/List\\_of\\_geographic\\_information\\_systems\\_software](http://en.wikipedia.org/wiki/List_of_geographic_information_systems_software) (assessed on May 29, 2015)

### 6.2 Other mapping tools

In case digital base mapping is non-existent or the effort to integrate information from local sources and stakeholders into digital maps exceeds the available resources, other powerful visualization opportunities exist.

It is recommended to choose a format in which the map can be modified, meaning information can be added and existing information can be modified in the future. Using a computer based map offers

the possibility to review various combinations of information by turning on and off previously defined groups of information.

One simple solution is using online maps, for example Google earth. The advantage being that the software is free, readily available for everyone with internet access and learning to use the interface is possible within a short time period. In the case of Google earth created information can be exported and shared with other users.

Google earth offers the user the opportunity to create 'places' and to organise them in folders. Places can be points, polygons and paths (lines) and images can be overlaid. Each place, or folder of places, can be displayed in any desired combination. The boundaries of areas can have different line types, line colours and areas can be filled with varying shades. Introducing some basic colour coding rules for different categories of places (e.g. heat demand, heat supply, existing heating network system, future development) helps to visualize the information categories. Because the system is easily portable on laptops, the map can be used in dialogues with stakeholders and information can instantaneously be added.

## 7 Checklists for projects to consider based on the maps

### 7.1 Lessons from the Pan-European impact assessment of increased energy efficiency in heating and cooling

In WP2 of this project, the impact of increased energy efficiency in the heating sector was assessed for five countries: Croatia, the Czech Republic, Italy, Romania and the United Kingdom [2]. Citing from the WP2 report: *“Energy efficiency can be achieved in the heating sector in a variety of different ways. Firstly, the heat demand can be reduced by improving the building envelope using measures such as insulation, multi-glazed windows, and more efficient doors. However, after the heat demand is reduced, then energy efficiency needs to focus on the supply of heat, both in terms of the resources consumed and the type of conversion technology it is put into. For example, different types of resources could be gas, excess heat, biomass, electricity, or solar energy, while different types of conversion technologies could be boilers, heat exchangers, electric heaters, or heat pumps.”* More particularly, a five-steps’ approach was followed to examine the transition between today’s heating sector and a future ‘high-efficiency’ heating sector:

1. Reduction of heat and cooling demand
2. Deployment of heat networks (gas grids and district heating grids) in urban areas
3. Efficient heating in rural areas, if possible based on renewable energy sources
4. Integration of excess heat and renewable heat in district heating grids
5. Installation of heating and cooling devices based on renewable electricity

Table 3 provides more details on the steps and technologies analysed in the heating sector.

**Table 3: Overview of the steps and technologies analysed in the heating sector**

Step	Technologies	Purpose
0a. 2010	2010 historical model	A model of the 2010 energy system based on actual 2010 energy statistics, technologies, and costs. Used as a baseline scenario to develop the 2050 BAU model.
0b. BAU 2050	2050 business-as-usual scenario	A model of a possible future 2050 energy system, based on the latest business-as-usual (BAU) projections by the European Commission [25]. It represents what is expected to happen if policymakers do not intervene any further with policies in the energy sector. Fuel and carbon costs are also based on those expected by the European Commission in the year 2050, while technology costs are updated primarily based on forecasts by the Danish Energy Agency [27]. All of the remaining steps are analysed for the year 2050, based on this model as a starting point.
1: Heat savings	ADD: Heat savings	Heat savings are implemented according to potential savings and associated costs.
2: Heat networks	COMPARE: Gas and water (i.e. district heating) networks	Heat network solutions are compared. These are only suitable in urban areas where the heat density is sufficiently high. These heat networks are gas based and water based (i.e. district heating).
3: Individual heating	COMPARE: Oil boilers, Biomass boilers, heat pumps, electric heating	Individual heating solutions are required in the rural areas where the heat density is not sufficiently high to construct a heat network. In this step, various individual heating solutions are compared to establish which one should be combined with the heating network from the previous step.

4: Renewable Heat	ADD: Geothermal, waste incineration, excess industrial heat, large-scale solar thermal	Excess heat and renewable heat sources are integrated into the district heat system based on the potential resource available, their costs and the heat demand.
5: Renewable Electricity	ADD: Large heat pumps, electric boilers	Large heat pumps and electric boilers are installed to improve the efficiency of the system and to further the integration of the heating and electricity sectors.
6. Heat Roadmap	OPTIMISE: Synergies in the new efficient heat sector	New synergies can be utilised after implementing the solutions in the previous steps, so here these are utilised if possible. In addition, a number of checks are made in the final step to ensure the energy system has been simulated correctly when the changes were implemented. For example, we check if the technologies are operating in a manner we would expect in reality.

This impact assessment following these steps resulted in following key messages for heating:

- Heat savings should begin today and be strongly supported in existing buildings while they are undergoing other refurbishments and in new buildings, to the point where their total heat demand is reduced to 60-90 kWh/m<sup>2</sup>.
- District heating can be expanded significantly in all countries. If district heating is expanded in the urban areas (primarily larger cities), then it can potentially reduce the costs of the energy system, reduce fossil fuel imports, reduce carbon dioxide emissions, increase the efficiency of the energy system, and increase renewable energy production.
- Electric heat pumps are the most sustainable option for heating in the rural areas, where the majority of buildings are single-family homes, which is based on balance between costs, efficiency and resources. Further research is required to define the smaller share of other individual heating technologies that will supplement these heat pumps, such as biomass boilers and solar thermal.
- In all the countries there are large amounts of renewable and excess heat available, but there is a limited supply of renewable electricity, while there is likely to be a shortfall of biomass if the aim is to decarbonise the entire energy system.

The WP2 report also quantifies the impact of increased energy efficiency in the cooling sector. In view of the lack of detailed knowledge concerning cooling, this assessment is restricted to the services sector. This choice is supported by two considerations:

1. services buildings are usually the most attractive places to start developing district cooling since they are often located very close together in the city and they have relatively high cooling demands and
2. the mapping in WP2 Background Report 6, which was carried out to estimate the cost of developing district cooling pipes, only includes the services sector to date.

Table 4 lists the key changes considered in this assessment.

Table 4: Key changes considered in the cooling sector

Convert 35% of the cooling demand from individual electric cooling to district cooling	Assume all district cooling is provided using conventional district cooling	Centralised chillers supply the cold, cooling pipes distribute the cold, and substations pass the cold from the pipes into the buildings
--	---	--

The conclusions of this assessment are, citing from the WP2 report: *“The future impact of the cooling sector on the rest of the energy system is very dependent on the future development of the cooling sector. Therefore, the choice of cooling supply is not likely to have a major influence on the overall efficiency of the energy system if cooling demands remain at similar levels to today. However, the choice of cooling supply is likely to have a major impact on the local energy system.”*

## 7.2 Projects to consider based on the local heating and cooling maps

The Pan-European impact assessment of increased energy efficiency in heating and cooling provides us input for options to enhance heating and cooling at local level. Following options can be considered:

### 1. Reduce heating and cooling demand at end-consumers

Energy efficiency is option number 1. Heating and cooling demand can mainly be reduced by improving the building envelope.

Public authorities can immediately take action to reduce the heating and cooling demand of the public buildings. They should assess the current heating and cooling demand of these buildings, the options to reduce it and plan their implementation.

Reducing heating and cooling demand of private buildings, both in the residential or services sector, is more challenging. Nonetheless, public authorities have a role to play here as well. First, they can make the citizens aware of the reduction potential. Some cities order to this end a thermographic image of their city or map the energy label of the buildings, see Figure 13. The local authorities can also inform the citizens about the subsidies there are to reduce heating and cooling demand. Most often, this information is provided by the national authorities and local authorities can pass these messages on to their citizens.

A next step, local authorities can take, is to mobilize citizens in their cities to take action, for instance by organising a collective tendering procedure for insulation walls or roofs.

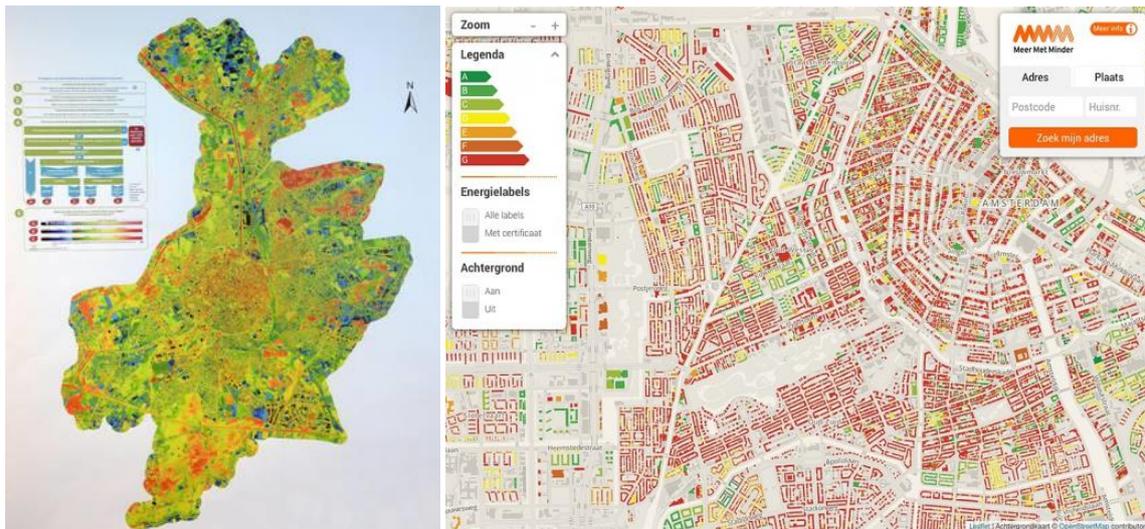


Figure 13: Thermographic map of Leuven, Belgium (left) - Map of energy labels of buildings in Amsterdam, the Netherlands (right)

## ***2. Improve and expand existing heating and cooling networks or build new ones in areas with a substantial heating and cooling density***

Results from the Pan-European impact assessment of increased energy efficiency in heating and cooling indicate that a collective heating and cooling system has a significant reduction potential on the national primary energy consumption and CO<sub>2</sub> emissions.

Existing heat and cooling networks are in that respect an important asset that needs to be sustained. The specific needs vary however from one country to another.

In some countries, the efficiency of the current heat and cooling networks is limited. Options to consider in these countries are refurbishment of the pipes in order to prevent distribution losses of heat or cooling; refurbishment of the substations, with offers to possibility to add control units to these; ...

In others, such as Belgium and the UK, the development of district heating and cooling grids is in its infancy. There, the focus should lay on the deployment of new district heating and cooling grids in area with a high enough heating and cooling demand. Areas that offer in particular the potential to deploy heat and cooling networks are new city districts, as there is no yet competition with an existing gas grid.

Existing networks offer of course the opportunity for expansion and these options should be considered.

## ***3. Look for more sustainable individual heating and cooling solutions in areas with a limited heating and cooling density***

The deployment of heat and cooling network is less viable in rural areas or less densely populated areas. Options to consider are the replacement of less efficient heating and cooling devices by efficient devices, preferably renewable fuelled:

- a) Heat pumps
- b) Biomass boilers
- c) Micro-CHP installations

d) Condensing boilers

**4. *Tap excess heat from thermal power stations, waste-to-energy installation, energy-intensive industry, ...***

In case a heat network seems to be a viable option, it should be considered if excess heat from thermal power plants, waste-to-energy installations or energy-intensive industry can be plugged in as a heat source.

Vice versa, the presence of these heat sources is an opportunity to investigate the option to dispatch this excess heat to heat consumers. For some installations, it is even an obligation in accordance with Art 14 of the Energy Efficiency Directive.

**5. *Tap renewable heating and cooling sources (geothermal, bio-energy, solar thermal)***

As the Pan-European impact assessment of increased energy efficiency in heating and cooling indicates, there is a huge potential of renewable energy sources in Europe to provide heat to heat networks. Local conditions of course do differ of course.

Options to consider are:

- Large heat pumps, tapping heat from the ground water, sewage system or water bodies (rivers, lakes, see)
- Deep geothermal wells
- Biomass fuelled installations; if possible running in CHP modus
- Large solar thermal boilers

**6. *Improving conversion of fossil fuels to heat or cooling***

Fossil fuel might still be needed to produce heat and cooling if the option above are fully exploited. In that case, the conversion of these fossil fuels to heat and cooling should be as efficient as possible. Options to consider in that respect are:

- Installation of a CHP
- Installation of a condensing boiler

### **7.3 Areas of priority to look for**

This list of projects to consider, discussed above, can help to find areas of priority on the local heating and cooling maps. One need to look for each type of project to specific data layers or a combination of data layers in the local heating and cooling map and more particularly to specific areas where these parameters are higher (eventually lower) than average.

Table 5 lists which areas on the local heating and cooling map might give an indication of the likelihood of what kind of projects. For instance, when looking for potential projects to reduce the heating and/or cooling demand at end-consumers, it is evident to look at the map of the heat and/or cooling demand – if available – and specifically those areas where the specific heat and/or cooling demand (expressed in kWh/m<sup>2</sup> or kWh/person) is higher than elsewhere in the city. An alternative is to look to the energy label of the buildings, if that information is available. If not, one can specifically look for areas with older buildings which have not been renovated in the last years. One can also specifically look for areas where people, more than average, suffer from energy poverty.

Another example are areas where the conversion from fossil fuels to heat and/or cooling could be improved. Here, one can focus on areas where there is currently a gas grid, or where a gas grid will be installed in the near future. Gas allows, more than other fossil fuels, to have an efficient conversion as most (micro-)cogeneration units and condensing boilers are gas fuelled.

Table 5: Areas of priority to look for in function of the projects to consider

Projects to consider	Areas of priority to look for
1. Reduce heating and cooling demand at end-consumers	<ul style="list-style-type: none"> <li>• Areas with a higher specific heat or cooling demand than average</li> <li>• Areas with buildings with a high energy label</li> <li>• Areas suffering from energy poverty</li> </ul>
2. Improve and expand existing heating and cooling networks or build new ones in areas with a substantial heating and cooling density	<ul style="list-style-type: none"> <li>• Areas where there is currently a district heating or cooling grid (DHC grid)</li> <li>• Areas currently without a heating or cooling grid but close to an existing DHC grid and with a high enough heat or cooling density or with a cluster of large heat or cooling customers</li> <li>• Areas with a high enough heat density [3]: <ul style="list-style-type: none"> <li>○ DH grid high feasible: &gt; 300 TJ/km<sup>2</sup></li> <li>○ Current DH grid feasible: 100-300 TJ/km<sup>2</sup></li> <li>○ 4<sup>th</sup> gen. DH grid feasible: 30 – 100 TJ/km<sup>2</sup></li> </ul> </li> <li>• Clusters of large heat consumers</li> <li>• Clusters of large cooling consumers</li> </ul>
3. Look for more sustainable individual heating and cooling solutions in areas with a limited heating and cooling density	<ul style="list-style-type: none"> <li>• Areas where roofs are suited to install solar water boilers</li> <li>• Areas where there is enough free land around the building to install heat pumps</li> <li>• Areas with a supply of biomass sources</li> </ul>
4. Tap excess heat from thermal power stations, waste-to-energy installation, energy-intensive industry, ...	<ul style="list-style-type: none"> <li>• Installations that can supply excess heat and that are nearby potential heating (eventually cooling) consumers</li> </ul>
5. Tap renewable heating and cooling sources (geothermal, bio-energy, solar thermal)	<ul style="list-style-type: none"> <li>• Areas where large solar hot water boilers can be installed</li> <li>• Areas where large heat pumps can be installed</li> <li>• Areas with favourable geologic conditions to install (deep) geothermal wells</li> <li>• Related to the previous point: water purification stations or large sewers nearby potential heating (eventually cooling) consumers from which heat can be extracted</li> <li>• Areas with a supply of biomass resources</li> </ul>
6. Improving conversion of fossil fuels to heat or cooling	<ul style="list-style-type: none"> <li>• Areas with a gas grid or where a gas grid can be expanded and where existing, currently less efficient, boilers can be replaced by <ul style="list-style-type: none"> <li>○ Cogeneration units</li> <li>○ Condensing boilers</li> </ul> </li> </ul>

## 8 Example maps

Maps, made in the framework of STRATEGO, will be included in a later version of this deliverable.

## 9 References

- [1] The European Parliament and the Council of the European Union (2012) Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC
- [2] Donnelly et al. (2015) Enhanced Heating and Cooling Plans to Quantify the Impact of Increased Energy Efficiency in EU Member States - Translating the Heat Roadmap Europe Methodology to Member State Level. STRATEGO Work Package 2 Main Report. No. D 2.2 and D 2.4
- [3] Möller B. (2015) Quantifying the Potential for District Heating and Cooling in EU Member States. STRATEGO Work Package 2 Background Report 6
- [4] Carbon Trust Resources and Ramboll Energy (2014) Scotland Heat Map - User guide. 2.0 Methodology report. Commissioned by the Scottish Government. Version 1.0
- [5] Renders et al. (2015) Warmte in Vlaanderen. Commissioned by the Flemish Energy Agency
- [6] Persson U. (2015) Quantifying the Excess Heat Available for District Heating in Europe. STRATEGO Work Package 2 Background Report 7
- [7] Industriell spillvärme – Processer och potentialer (2002) Svenska Fjärrvärmeföreningens Service AB
- [8] Lars-Åke Cronholm, Stefan Grönkvist, Maria Saxe. Spillvärme från industrier och lokaler (spillvärme från industrier och värmeåtervinning från lokaler) (2009) Svenska Fjärrvärme AB. Rapport 2009:12
- [9] Utnyttelse av spillvarme fra norsk industri – en potensialstudi (2009) ENOVA, referense: SID:08/230
- [10] Pehnt et al. (2010) Die Nutzung industrieller Abwärme – technisch-wirtschaftliche Potenziale und energiepolitische Umsetzung. IFEU-rapport FKZ 03KSW016 A und B
- [11] Möller B. (2015) Mapping the Renewable Heat Resources in Europe. STRATEGO Work Package 2 Background Report 9
- [12] Cornelis and Van Esch (2014) Opmaak kansenkaart riothermie voor Antwerpen – Mapping the potential to extract heat from the sewage system for the city of Antwerp. Report in the framework of the STEP-UP project.