

THE HOTMAPS TOOLBOX

supporting strategic heating
& cooling planning at local level

HOTMAPS

The Heating and Cooling Open Source Tool for Mapping and Planning of Energy Systems

www.hotmaps-project.eu

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table of content

INTRODUCTION

– 3

WHAT IS STRATEGIC HEATING AND COOLING PLANNING?

– 8

THE HOTMAPS TOOLBOX

– 12

LONG-TERM IMPACT OF HEATING AND COOLING PLANNING ON URBAN DEVELOPMENT AND LOCAL DECISION MAKING PROCESSES

– 16

HEATING AND COOLING PLANNING IS EASIER WITH HOTMAPS!

– 26



INTRODUCTION

Many cities and regions are currently preparing ambitious climate and energy

strategies and action plans, committing to net-zero carbon by 2050. In November 2018, the European Commission presented its strategic long-term vision for climate neutrality by 2050: "A Clean Planet for all". In December 2019, the European Green Deal has been unveiled, to provide a roadmap for making the EU's economy sustainable. Decarbonisation of the heating and cooling sector plays a major part in the plan: the largest share of energy consumption in cities (where 75 % of the EU population live) is used for heating and cooling.

Phasing out fossil fuels from the energy system will bring three main advantages: it will reduce greenhouse gas (GHG) emissions, improve the security of supply and positively affect the commercial balance (which at local level means an increase of job opportunities). However, achieving a 100 % renewable energy system, and in particular a fossil-free heating and cooling supply, requires strategic planning. New technical, regulatory and governance frameworks are necessary to transition to a more sustainable and green system.

The aim of strategic energy planning, including heating and cooling planning, is to promote the transition to a more flexible integrated energy system with focus on energy efficiency and renewable energy. In most European cities and regions, there is a need to better identify, analyse and map resources and solutions to make energy demand more efficient on one hand and to meet the demand with efficient, cost-effective and greener energy sources on the other hand.

HOTMAPS: A TOOLBOX TO DISCOVER YOUR CITY'S CLIMATE-NEUTRAL ENERGY FUTURE!

The Hotmaps project addresses this challenge. Leading research institutions in Europe¹ developed a website that allows you to discover in just 5 minutes an estimate of heating and cooling demand in your region and the potential of local renewable energy to cover this demand.

By uploading data that are more detailed and applying Hotmaps calculation modules, you can elaborate comprehensive heating and cooling strategies for your area of interest². Hotmaps can help cities to reach their climate and energy objectives, become greener and more liveable.

¹ TUWien Energy Economics Group – Technical University Vienna; Hes.so – University of Applied Sciences and Arts Western Switzerland; eurac – Institute for Renewable Energy; eThink – Energy Research; PlanEnergi; Aalborg University Department of Planning.

² This publication will focus on the use of the toolbox to plan at local level. However, Hotmaps can also be used to identify potentials and strategies at national level. <https://wiki.hotmaps.eu/en/guide-national-level-comprehensive-assessment-eed>

The toolbox was developed together with cities, to make sure Hotmaps is useful for local authorities and city planners. Seven European pilot areas have been successfully testing it, to develop their heating and cooling strategies: Aalborg (Denmark), Bistrita (Romania), Frankfurt (Germany), Geneva (Switzerland), Kerry County (Ireland), Milton Keynes (UK) and San Sebastián (Spain).

This brochure will guide you through strategic heat planning. You will find out how the Hotmaps toolbox works and how it supported the pilot cities in their urban energy planning.

HOTMAPS SOFTWARE

Hotmaps GIS (geographic information system) – based software is

- **Fast:** it provides a quick indication about which direction to go, in order to kick-start a detailed technical planning.
- **Free and open source:** it is available online, no fees. You don't need to install additional tools.
- **Easy to use:** no need to be a GIS expert, the software combines web-based visualisation of GIS data with flexible selection tool. Data are visualised directly on the website.
- **Adaptable:** You can retrieve indicators at various geographical and administrative level. Moreover, you can upload your own data to your account and use it for further analyses.

Thanks to Hotmaps, users can obtain a large-scale vision of the whole territory covered by their city, allowing them to identify energy issues very easily. Hotmaps helps gather all the information required to identify planning priorities for the future and can be used as a decision making tool. It helped cities to bring together all the actors of the energy sector, in order to refine their knowledge of the territory and to share data and analysis.

www.hotmaps.eu



WHAT IS STRATEGIC HEATING AND COOLING PLANNING?

Strategic heating and cooling planning means developing an action plan to achieve a long-term vision of the heating and cooling supply. To get there, there are usually the following steps:

- 1 Analyse the challenges, formulate strategic objectives and identify key parameters;
- 2 Build scenarios based on cost-effective technical solutions from a societal perspective;
- 3 Evaluate existing framework and identify key stakeholders;
- 4 Make an action plan.

preparatory phase

Strategic planning starts with a preparatory phase to analyse challenges of the current heating and cooling system and to define strategic objectives. Reducing GHG emissions and improving the security of supply are probably one of your objectives. However, you can pursue additional targets depending on local and national contexts, such as:



IMPROVING
AIR QUALITY



TAPPING LOCAL
RESOURCES



INCREASING
JOB CREATION



INVOLVING CITIZENS
AND FOSTERING
CITIZEN OWNERSHIP

techno-economic scenarios

In this phase, technical solutions are defined, described and evaluated to see whether they can meet the strategic objectives. The following steps can be taken to build heating and cooling supply scenarios:

- 1 | Quantify existing heat demand;
- 2 | Identify the potential of heat sources in the surrounding areas;
- 3 | Assess the potential of energy savings (i.e. determine the future energy demand);
- 4 | Develop first technical scenarios to match energy demand and supply on short-, medium- and long-term basis;
- 5 | Assess the scenarios according to the strategic objectives and a socio-economic perspective, especially the balance between investments in energy savings and in energy supply infrastructures;
- 6 | Iterate steps 4 and 5 to find the best solutions.

When carrying out techno-economic assessment, you should consider the whole energy system and not only the heating and cooling supply. A holistic perspective including the different energy carriers (electricity, gas, heat, cold) and different sectors (industry and transport in addition to buildings) allows identifying synergies and possible bottlenecks of limited resources.

HOW HOTMAPS CAN HELP YOU TO ASSESS DIFFERENT ENERGY SCENARIOS

Hotmaps is a powerful tool to work on heating and cooling planning. It has led pilot cities to test and evaluate different energy scenarios, providing an integral analysis of their energy resources. Users can upload their own city's data and calculate precise energy scenarios. Hotmaps can also provide a set of indicators for these scenarios, allowing you to analyse their economic, financial and technical feasibility. You can see in the figure in the following page how the different calculation modules of the tool allow users to develop energy scenarios.

regulatory framework & governance

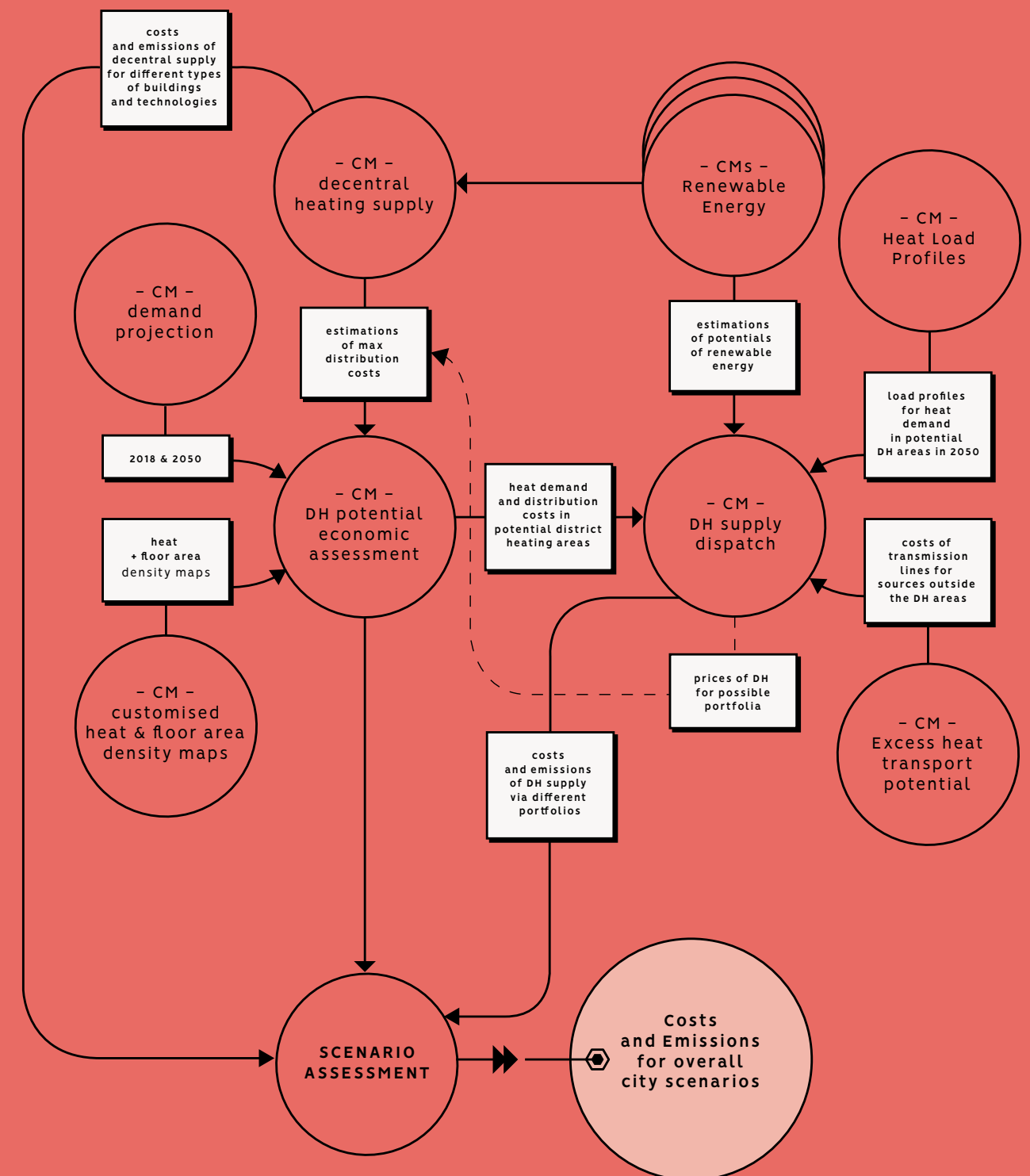
To achieve the desired transition, changes in policies and governance are necessary. In this phase, you perform an evaluation of the existing policy framework and identify the key stakeholders. In particular, you should analyse the economic, political and legal barriers and opportunities. These can concern price regulation, ownership and market

organisation at local, national and European levels. There can be regulations depending on the expected actions, regulations applying to the heating sector, to the building sector or to the energy sector in general.

action plan

The action plan will support the implementation of the long-term scenario. Relevant stakeholders (who could implement the heat plan) and planning authorities (who are able to influence the framework conditions) need to be involved. You should identify business models and governance processes to support the transition and achieve the strategic objectives.

hotmaps scenario toolchain



CM : Calculation Module
DH : District Heating

THE HOTMAPS TOOLBOX

OVERCOMING YOUR HEAT MAPPING AND SCENARIOS DEVELOPMENT CHALLENGES!

engineering capacities and data collection

Mapping and quantifying heating and cooling demand and sources is a difficult task: before investing in a long-term heating & cooling solution, access to reliable data is key. The collection and integration of fragmented and often inconsistent data is tedious and time-consuming. It usually requires involving a large number of stakeholders like municipal services, building owners, facility managers, utility companies including transport and distribution system operators, civil groups, industrial companies, social property owners and energy companies.

Assessing locations and energy potential of different energy sources (geothermal, solar thermal, biomass...) also requires engineering capacities, as well as developing techno-economic scenarios. It involves knowledge about different technologies, their technical potential, their environmental impacts and their costs (investment, operational and maintenance costs).

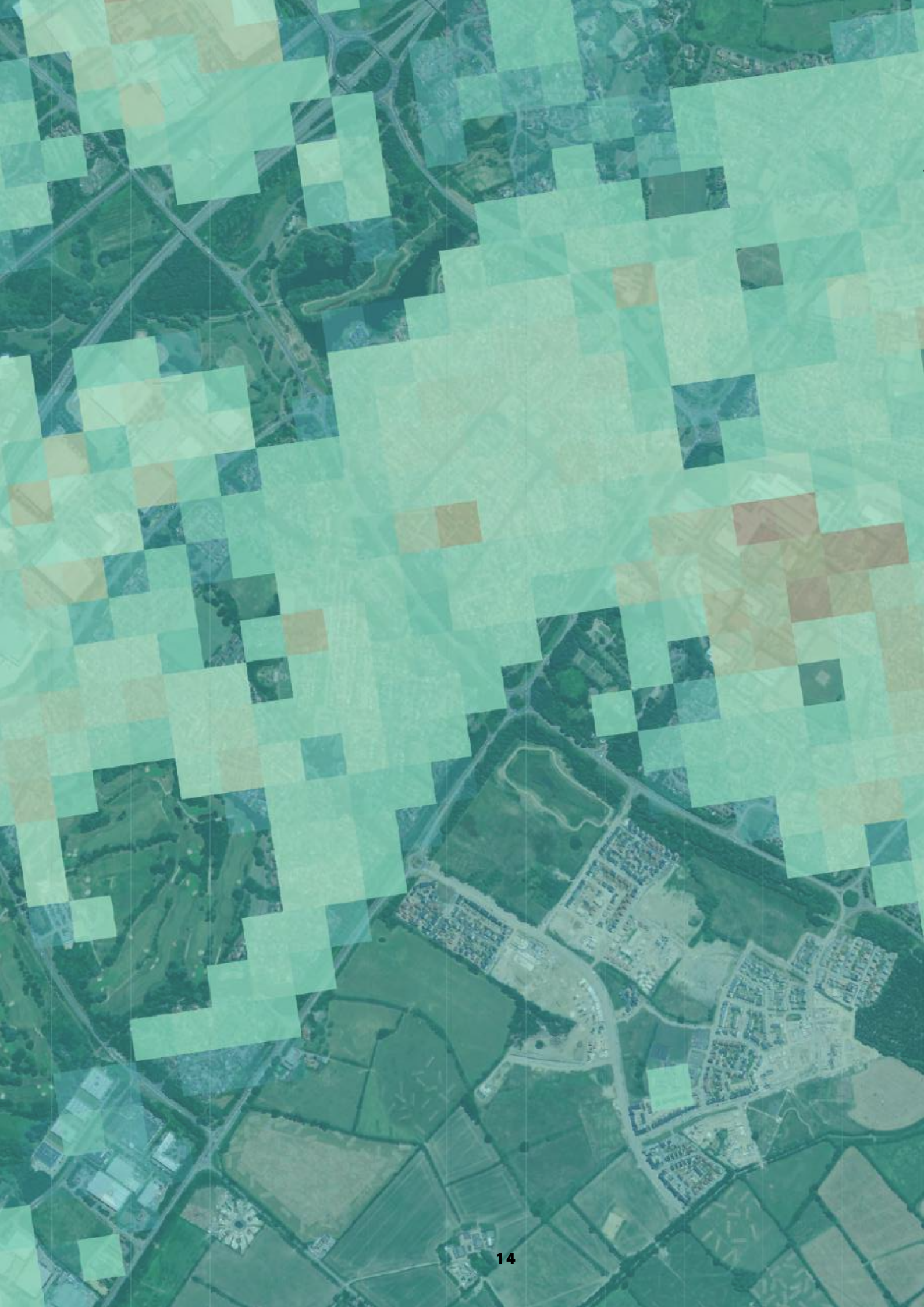
HOTMAPS: AN OPEN DATASET

The Hotmaps team brought together a unique presentation of open source and transparent data, collected at national or, if available, at regional and local levels. Information has been gathered for three different sectors: residential, service and industry.

A comprehensive summary of the data collection process is available¹ and the Hotmaps team is updating the dataset on a regular basis. All datasets are freely accessible and downloadable at <https://gitlab.com/Hotmaps>.

You can download the datasets, edit them and visualise them in the Hotmaps software later. Hotmaps dataset is open, so it can be integrated in other software. On another hand, you can also upload your own datasets in your Hotmaps personal account if you have better information, in order to make simulations that are more precise.

¹ <https://www.Hotmaps-project.eu/d2-3-wp2-report-open-data-set-eu28/>



different levels of heating and cooling planning

Data required for analysis depends on the planning goals. Strategic planning requires data at the city level, ideally with a 100m*100m square accuracy, or even at building level. Yearly energy data for consumption and production can be sufficient to start (although monthly and daily data are better). As well, preliminary models can be based on generic cost information, to analyse macro-options and set strategic directions. For instance, if a city were to be supplied by 100 % renewables, understanding the technical potential of local and renewable sources to cover the heating demand would give a framework and set the energy savings goal for buildings.

However, to derive the strategic plan in different actions, you will need more detailed data, such as:

- Information on buildings (individual energy consumption, load profile, type of heating systems, level of insulation, potential for energy production, type of building owner...);
- Existing energy networks (gas, electricity, district heating and cooling networks);
- Urban development and retrofitting projects;
- Natural and artificial barriers and constraints (rivers, protected natural areas, railways and high traffic roads, policies on land use, air pollution, building architecture...).

Feasibility studies will be the last step, to validate assumptions and hypotheses, once concrete projects are defined.

HOTMAPS: A LARGE ARRAY OF DATA SETS

Hotmaps provides a large array of data sets with detailed resolution: from NUTSO data down to LAU2 and even Hectare-level. Default data is available for the entire EU28 and Switzerland, with the aim to support local, regional and national heating and cooling planning.

Hotmaps open source data sets provide information on:

- Building stock;
- Space heating, cooling and domestic hot water demand;
- Climate context;
- Industrial processes;
- Heating and cooling supply;
- Renewable energy sources data collection and potential review;
- Hourly load profiles.

LONG-TERM IMPACT OF HEATING AND COOLING PLANNING

CITIES' INSIGHTS

Where are the Hotmaps pilot cities on their journey to long-term planning?

In the framework of the Hotmaps project, the pilot cities were supported in the development of their heating and cooling strategies using the Hotmaps toolbox. Each of them were at different stages on their planning but all found the toolbox useful and contributed to its testing and validation.

The development of the strategy included an analysis of barriers and drivers, a stakeholder analysis, the mapping of the heat demand and available resource potentials, the development of scenarios for heating demand and supply in the city in the year 2050 and the discussion of these steps and their outcomes with relevant persons in the city.

AALBORG, DENMARK

In certain countries and cities, there is already a long tradition of heat planning. For instance, in Denmark, the oil crisis in the 70s led to the first heat supply act according to which the local city council is responsible for the heat planning. In recent years, the local planning considers the entire energy system, including heating, electricity, transport, etc.

The municipality of Aalborg has recently, in cooperation with Aalborg University and other relevant stakeholders (utility companies, industries, organisations etc.) developed an energy vision for Aalborg 2050: Smart Energy Aalborg. The vision shows that it is possible for the city to be fossil free by 2050. It is implemented via an energy strategy that includes milestones for 2030 and 2040. Aalborg does not yet have a cooling plan, but started planning a district heating and cooling project for the new local hospital.



FRANKFURT, GERMANY

In Frankfurt am Main, district heating is one of the key pillars of the sustainable energy action plan. The first priority is to cut in half the total energy demand of the city by 2050 and then cover the rest with renewable energy and/or waste heat.

The city has the overall ambition to reduce GHG emissions by 95% in 2050 compared to 1990.

The calculations performed with the Hotmaps toolbox confirmed that in order to reach the city's goal, a reduction of heat demand in buildings between 40% and 50% is needed. That could be achieved only with an ambitious renovation policy, to upgrade 75% of the city's buildings. Calculations also show that further decreasing the heating demand in buildings would highly increase the costs of the transition compared to supplying the remaining heat demand with local heat sources. The analysis indicates that local resource potentials might be sufficient for supplying the remaining heat demand almost entirely. By 2050, district heating and cooling should supply 60%–80% of the remaining heat demand, as it allows exploiting the local resources in a cost efficient way, especially industrial excess heat

and excess heat from wastewater treatment plants, data centres and river water. However, the supply of peak load in district heating without GHG emissions is a challenge. Green gases (hydrogen or synthetic methane) could be a solution, depending on their prices, as well as multi-weekly heat storage.

The next steps for the city of Frankfurt am Main are to develop

policies in order to foster retrofit of buildings and heating systems and to expand the district heating system. The planning process performed in the context of the Hotmaps project has also reinforced the links between the city and the local utility Mainova, which will lead to concrete projects such the heat recovery from data centers.

“Thanks to Hotmaps, we have a quick overview of where the heat demand is high enough to make an investment in district heating pipelines. This enables us to easily identify hot spots which our energy utility can then investigate in more detail. A strategy across city boundaries is also made easy with the default data.”

Paul Fay, Frankfurt am Main



GENEVA, SWITZERLAND

In Switzerland, the Geneva Energy Act requires, since 2010, energy planning for new districts or districts undergoing renovation. In 2005, the City of Geneva adopted a long term vision: «100 % renewable in 2050». This is guiding Geneva's action on energy policy with the objective to gradually transition from fossil fuels to renewable energies. To implement this vision, the City has developed an energy policy focused primarily on its 800 municipal buildings. To meet its commitments, the City must now develop a plan that is consistent with its vision 2050, across its entire territory, focusing on existing buildings and districts as well as on the largest consumers. Thanks to Hotmaps, the City was able to understand the impact of the different projects already in the pipeline (such as “GeniLac”, a scenario developed by the Canton and the Industrial Service of Geneva based on the use of the lake for heating and cooling buildings) and to determine their economic and climate impacts. According to a first analysis done with the toolbox, three scenarios were created for Geneva to reach its climate objectives. They showed that the City should focus on renovation and increase the energy standards for new constructions, but also develop district heating and cooling networks in four specific areas adjacent to the lake. Only renewable energies should be used to feed such networks: while waste incineration meets the requirement for the development of heating networks, it does not allow the City to reach its climate targets. Outside the district heating zones, Geneva should adopt a decentralised strategy based on the promotion of air–water heat pumps or the use of local resources. The

next step for the Municipality of Geneva will be to refine the analysis done with Hotmaps in order to come up with a more detailed picture of its territory, for example by taking into account additional challenges such as subsoil congestion, traffic, trees etc. This would allow them to define a medium and long-term territorial strategy to meet their ambitious political objectives.

“We quickly realized that we lacked a planning tool to, first, identify local energy resources and second, adapt them to urban development and the high concentrations of energy consumed throughout the municipal territory. Hotmaps brought real and important benefit to the planning process, especially for the discussion with stakeholders.”
Etienne Favey, Geneva



BISTRITA, ROMANIA

The city of Bistrita developed a 2050 energy vision with supporting strategic documents, such as the Action Plan for Climate and Energy 2030, and the Local Development City Strategy 2010–2030. Since 95 % of the fuel used to heat buildings in Bistrita is natural gas and most houses have individual boilers, it is necessary to consider the transition to renewable individual heating systems. Although «cooling» was not a problem for Bistrita, the last summers' high temperatures are raising more and more questions related to the need for cooling systems, in particular for non-residential buildings.

In the framework of Hotmaps, a high number of calculations has been performed, with the variation of numerous input parameters. Savings of around 30 – 40% of the overall heat demand in the buildings (space heating and hot water) seem to lead to the lowest overall system cost. A retrofit of around 70% of the buildings is needed to achieve

this saving. Different portfolios of clean technologies for individual and centralised heating systems have been studied and lead to similar overall system costs. Further detailed studies are needed as the results highly depend on the assumptions for 2050, especially the availability of energy resources, their costs, the CO2 price and the efficiency of the DHC system.

For instance, Bistrita will now study in detail the potential of local biomass, the installation of a waste incineration plant near the city, the potential of using excess heat from wastewater treatment plant and from the river. The creation of a district heating system will also be discussed with citizens: currently, DHC has quite a negative image in Romania. The Hotmaps strategy also revealed the need to have better data on the local building stock, which is one of the next actions for the city.

“Thanks to Hotmaps, we will develop the strategy for the city's heating and cooling system, on medium and long term, which will be promoted within the local community. These results will be included in the city's strategic documents: Action Plan for Climate and Energy 2030, Local Development Strategy 2010–2030, Energy Vision 2050.”
Corina Simon, Bistrita

DONOSTIA – SAN SEBASTIÁN, SPAIN

Donostia – San Sebastián is a city of around 180 thousand inhabitants in the northern part of Spain, on the Atlantic coast. Currently around 600 GWh/yr of heat is needed for space heating and hot water generation in the buildings of the city. Currently, this demand is almost entirely supplied with natural gas. The municipality published in 2018 its climate plan to become carbon neutral by 2050. The municipal company Fomento De San Sebastián is leading the Smart City transition. It promotes sustainable development models and efficient energy systems based on renewable energies. In this sense, Fomento De San Sebastián has built the first municipal district heating system, powered by biomass, in a new part of the city.

San Sebastián started the heating and cooling planning thanks to the Hotmaps tool. The technical analysis done with Hotmaps showed that district heating could potentially supply considerable parts of the buildings' heat demand in the area. A waste incineration plant has recently started operation nearby and it is generating electricity. A first analysis shows that transporting the excess heat of the plant to the city and using it in a potential district heating system leads to lower costs than more ambitious heat savings and a higher share of decentral heat supply. The results also show that very ambitious saving targets in San Sebastián lead to higher overall system costs compared to lower saving levels together with supply from district heating. Therefore, a detailed analysis of the costs and effects of renovation measures in the different buildings of the city should be performed taking into account also the state of renovation and the occupation of the buildings. This should feed into a renovation strategy for the city.

“The Hotmaps project is a very interesting opportunity to start developing a heating and cooling plan in San Sebastián and to begin a planned process in this topic for the local 2050 Strategy.”
Iker Martinez, Fomento de San Sebastián

The next steps on the road to a low carbon heating system in San Sebastián are a feasibility study for the integration of the heat from the waste incineration plant into a potential district heating system and a more detailed analysis of the heat savings in the buildings of the city.



MILTON KEYNES, UK

According to the UK Climate Change Act (2008) the net UK carbon account for 2050 should be at least 80 % lower than the 1990 levels. The City of Milton Keynes approved its Sustainability Strategy for 2019–2050 at full council meeting in January 2019, with the ambition to achieve climate neutrality by 2030. Work is now in progress on the action plan to support the Strategy. There is not a specific policy

for heating and cooling in Milton Keynes at the moment, although the city's 2050 strategy highlights the importance of heating/cooling networks in contributing to a low carbon future for the city.

The heat strategy developed

during the Hotmaps project aims at helping city planners but also private developers to identify opportunities and trigger investments. The analysis identified three areas of interest for potential district heating projects: central Milton Keynes, where an existing DHC system could be expanded, Old Wolverton and Fullers Slades, where urban refurbishment is foreseen. Different techno-economic studies have been performed, and indicate that the most cost-efficient solutions would include biofuel Combined Heat and Power (CHP) plant burning oily waste from a nearby waste treatment centre, biomass CHP, and air- and ground-source heat pumps. The results have been discussed with the stakeholders and will lead to new policy developments to promote DHC as an enabler for clean heat and facilitate the connection of buildings.

The Hotmaps toolbox has been useful to identify and verify additional resources in our area, not just for heating/cooling networks, but other sources of locally generated energy.
Jeremy Draper, Milton Keynes



KERRY COUNTY, IRELAND

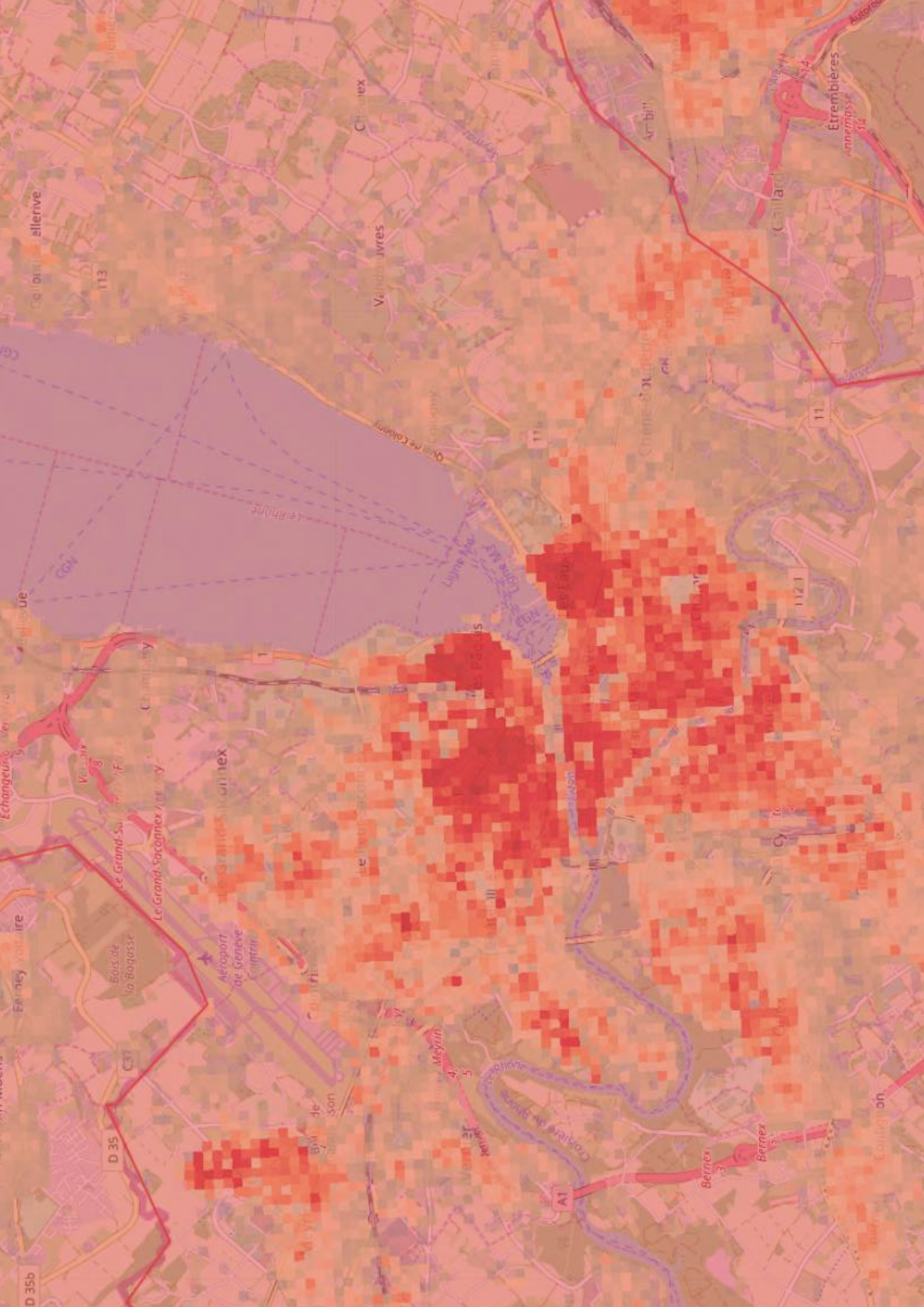
Ireland has committed to a National 2020 renewable energy target of 16 % of its final energy requirement by 2020. The government plans to achieve a 40% reduction in greenhouse gas (GHG) emissions by 2030 relative to 1990, and has to reach the binding EU-wide target for renewable energy of at least 32% by 2030. The heating sector is the largest user of energy in Ireland and 12 % will come from renewable sources by 2020. District Heating is relatively new in Ireland and not very widely used, but smart district heating has been identified as a central element of the country's potential transition to 100 % renewable energy supply. Kerry County is a rural peripheral area

in the southwest of Ireland and the most westerly point of Europe. The majority of the population lives in rural areas (66%). The council has a target of 33 % reduction on the energy consumption by 2020 based on 2006 baseline. Kerry was the first county in Ireland to have a fully operational biomass district heating system in the town of Tralee, commissioned in 2008. They are now examining Phase II of this project, which would extend biomass district heating to 53 of the largest energy users in

The results of this process will greatly assist in enhancing the design and financial viability of any potential schemes. Kerry County Council are also collaborating on the preparation of an Energy Master Plan for the Dingle peninsula and it is anticipated that the Hotmaps tool will be used to compare various heating technologies as options for renewable heating on the Dingle peninsula and for the production of heat maps.

Jimmy O Leary, Kerry County Council

the area. Thanks to Hotmaps, Kerry County is currently elaborating its first heating strategy, evaluating two key areas for potential district heating grids, which can be used as a techno-economic sector-analysis and as input in a trans-sectoral energy planning initiative for Kerry County, alongside with corresponding analyses for other sectors such as electricity, agriculture, tourism and transportation. An additional objective is to use the toolbox to analyse relevant future individual supply options outside the towns of Tralee, Killarney and Dingle.



THANKS TO HOTMAPS, CITIES ARE ABLE TO:

- identify the location of current heating and cooling demand as well as supply on a map for EU28;
- identify renewable energy potential to supply heating and cooling for a selected area;
- calculate the potential for efficient district heating options within a selected area;
- estimate and compare the costs of individual heating vs. district heating options within a selected area;
- compare the results from local heating and cooling planning with national and regional de-carbonisation pathway;
- compare the impact of different scenarios for the future development of heating and cooling in a certain area;
- calculate the optimal energy mix for district heating supply within a certain area.

The cities involved in the project have been using this free and open source tool to get preliminary information, before committing further resources to more detailed studies. They have also checked Hotmaps data against existing scenarios – created with other tools or by consultancy firms. simulations that are more precise.

HEATING AND COOLING PLANNING IS EASIER WITH HOTMAPS!

**IN ORDER TO MAKE IT AN ACCESSIBLE
ONE-STOP-SHOP, SUPPORT MATERIALS
ARE AVAILABLE ONLINE.**

What's in it for you?

Hotmaps handbooks: the project developed two handbooks¹ to guide and support strategic planning processes carried out at European, national and local levels. Case studies of district heating planning from

various contexts across Europe complement the handbooks, presenting the diversity of contexts and conditions that can influence local strategies.

- **Hotmaps Wiki:** the wiki² hosts the documentation, guidance and manual of the toolbox. It is a living document: the developers continue updating HOTMAPS Wiki pages by introduction of new updates, improvements, functionalities and calculation modules.
- **Hotmaps tutorials:** step-by-step videos are available in all EU languages, to show how to use the software and all its functionalities.
- **Hotmaps trainings materials:** The Hotmaps team organised trainings to show how to create energy scenarios, develop heating & cooling plans and choose between different resources options available in the area of choice. The training materials are available in the wiki³.

¹ <https://www.hotmaps-project.eu/Hotmaps-handbook-and-wiki-released/>

² <https://wiki.hotmaps.eu>

³ <https://wiki.hotmaps.eu/en/Training-Material>

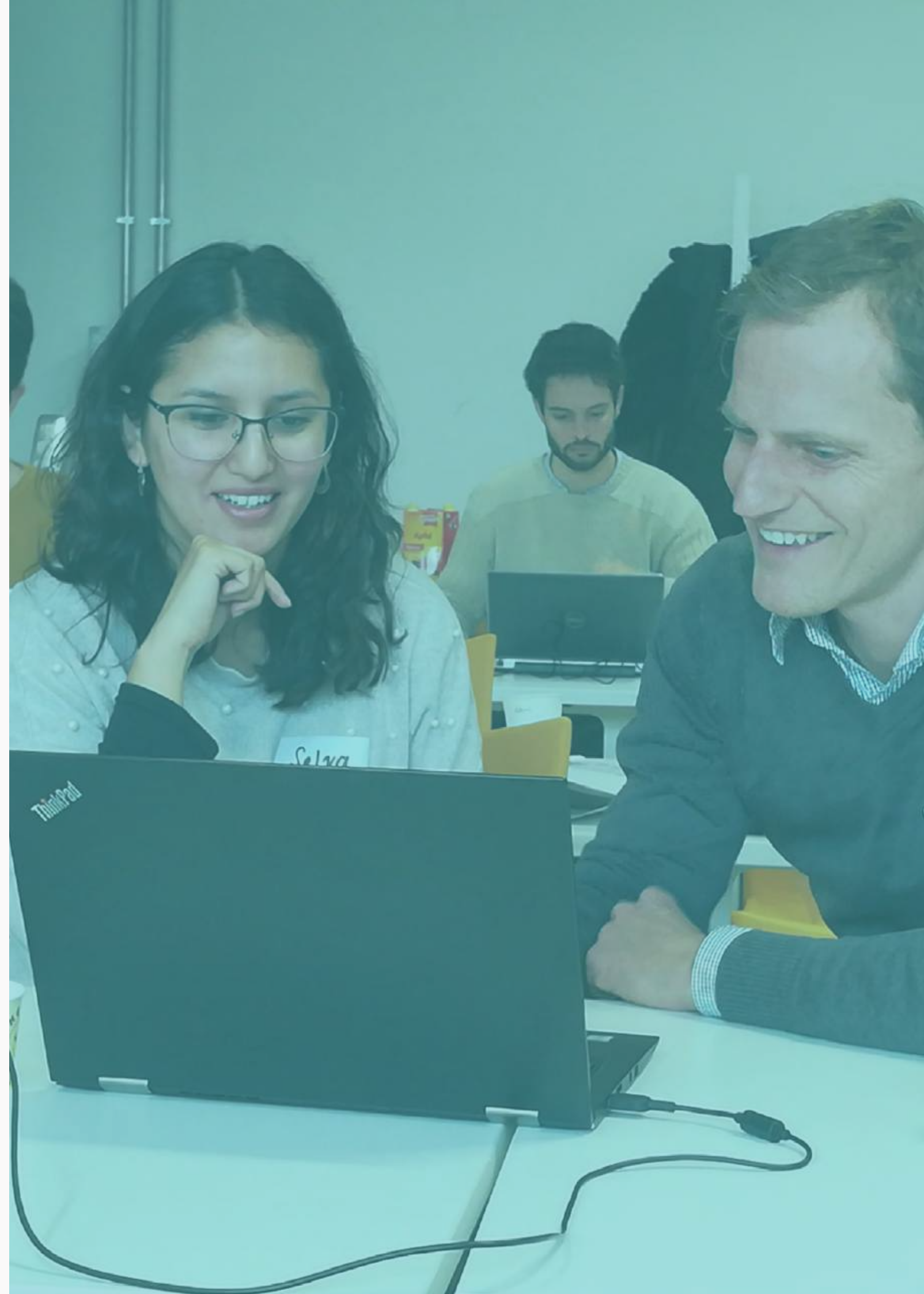
**LEARN HOW TO USE HOTMAPS AND JOIN THE
"HOTMAPS FOLLOWERS" COMMUNITY!**

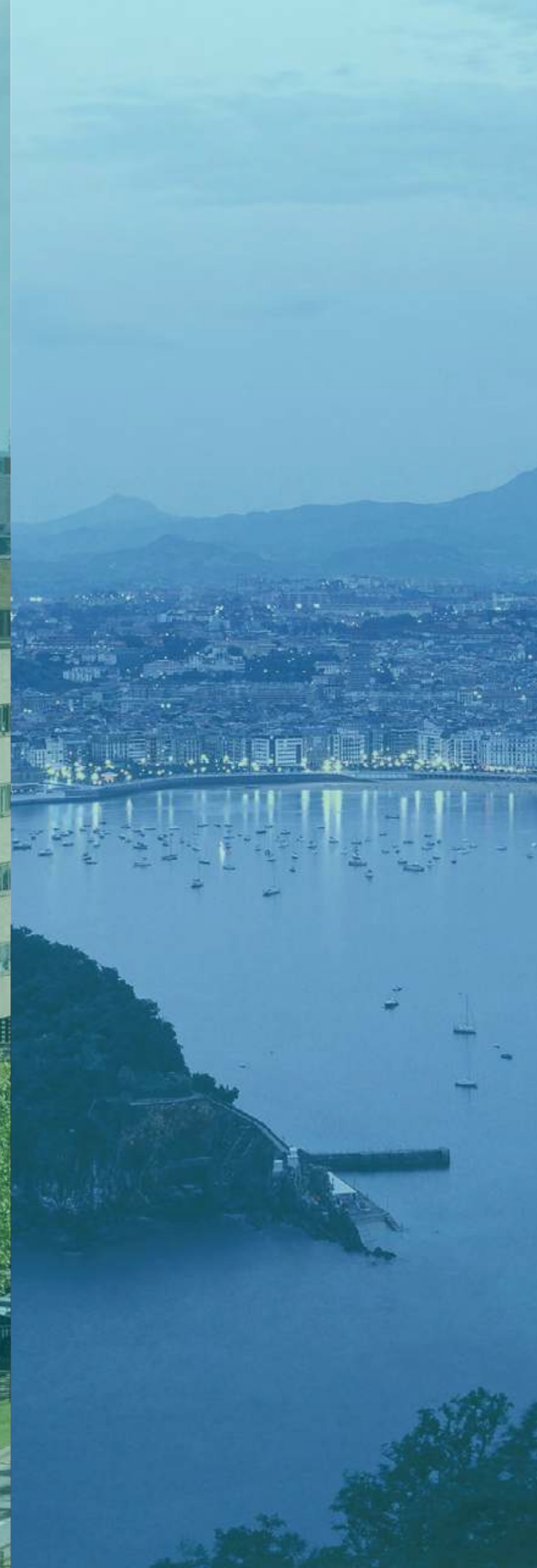
The training materials developed during the project are available to anyone willing to learn how to use the tool-box. Step-by-step exercises have been designed to allow a fast and easy understanding of the calculation modules. Supporting documents are also provided, such as videos and spreadsheets.

Participants to the trainings appreciated the modular approach of the tool, but also the possibility to work using the default dataset and seeing the results by selecting an area on the map.

Check our website www.hotmaps-project.eu to learn more !

**"HOTMAPS IS VERY
USER-FRIENDLY,
AND THE MAP
NAVIGATION WORKS
SEAMLESSLY."**

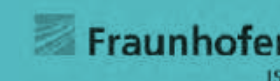




THE PROJECT

Hotmaps is a project funded by the EU research and innovation programme running from October 2016 until September 2020. The overarching goal of Hotmaps is the development of an open source heating / cooling mapping and planning toolbox. The project also provides default data for EU28 at national and local level. Such data and tool allow public authorities to identify, analyse, model and map resources and solutions to supply energy needs within their territory of responsibility in a resource and cost efficient way. Hotmaps helps authorities to develop heating and cooling strategies on local, regional and national scale which are in line with renewable energy and CO₂-emission targets on national and EU levels.

THE CONSORTIUM BEHIND





www.hotmaps-project.eu

The open source planning tool
for heating and cooling in cities.



*funded by the H2020
programme of the European Union*